FOUNDATION
DESIGN AND CONSTRUCTION
MANUAL

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Kansas City, Missouri
and
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Milwaukee, Wisconsin

Preface

The purpose of this manual is to acquaint Butler Builders* and engineers with the basic fundamentals of soil and foundation engineering and to provide basic data on standard foundation designs for the various building systems manufactured by Butler. Included in this manual are foundation systems applicable to the:

WIDESPAN^{TM}
and LANDMARK^{TM} Building Systems.

The manual provides general information on such topics as soil properties, soil testing, foundation designs and details, as well as providing load tables for various standard foundation types.

In addition, the manual will also serve to alert the reader to potential troubles and to special conditions wherein it would be advisable to seek professional help for foundation design. The manual has been purposely limited in technical scope and certain liberties have been taken with the theory of soil mechanics to enable the presentations to be made <u>without</u> major theoretical discussions.

The authors are especially grateful to Roger A. LaBoube, Ph.D., P.E., Donald L. Johnson, P.E., James E. Churchman, P.E., Neil C. Montgomery, P.E., and David E. Evers, P.E., for their help in developing the manual.

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INTRODUCTION

In keeping with their history of providing quality building systems to their customers, Butler Builders have recognized that the area of soil and foundation engineering seems to develop many questions and that serious consequences can occur if proper attention is not given to this aspect of the building process.

Butler Manufacturing Co. decided that a basic design manual would be of considerable value to the Butler Builder. To develop this manual Butler Manufacturing Co. (BMC) retained the services of Computerized Structural Design, Inc., consulting engineers in Milwaukee, Wisconsin. This firm has designed major building and foundation projects all across the country. The manual was intended to be as practical as possible so that persons not familiar with soil mechanics and foundation engineering will still be able to obtain considerable benefit from its use.

The manual will acquaint the reader with all the practical aspects of foundation and soil engineering, particularly as they relate to Butler buildings. There will be many situations for which it will be advisable to retain the services of a consulting engineer to assist in the design process. BMC hopes that the manual will assist the Butler Builder to further expand the quality service to customers which has existed throughout the years.

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CHAPTER I - INTRODUCTION TO SOIL TERMINOLOGY

General Characteristics of Soils

To introduce the topic, soil may be described as a combination of solid particles (usually inorganic but sometimes organic such as peat), water and air. The characteristics of a soil, in terms of its engineering value, are highly dependent on the nature of the soil particles, the size of the particles and the relative amounts of particles, air and water in the soil make-up.

Soil Particle Sizes

Engineers have classified soil based primarily on particle sizes since it is this parameter that has the most dominant effect on soil engineering properties. Soil sizes are determined by using sieves for the coarser particles and by sedimentation for the finer particles.

For purposes of this manual we may use the following terminology:

Classification	Size
Silts and Clays	Passes a No. 200 mesh sieve*
Fine Sand	Passes a No. 40 sieve Retained on a No. 200 sieve
Coarse Sand	Passes a No. 4 sieve Retained on a No. 10 sieve
Fine Gravel	Passes a 3/4" sieve Retained on a No. 4 sieve
Coarse Gravel	Passes a 3" sieve Retained on a 3/4" sieve
Cobbles	Coarser than 3"

(*) A sieve with 200 openings per inch.

Distinguishing between silts and clays is not based on size. The general difference relates to the plasticity of the material. Clays are much more plastic (moldable) than silts. A more precise distinction is given in the glossary of terms. Most soils do not exist in the ground in a pure state (i.e. fine sand, silt, etc.) but in combinations such as silty-clay, silty-sand, etc. There are a few special terms which are used to describe special combinations of soil particles commonly encountered. These include.

Loam: An even mixture of different sizes of sand and of silt and clay.
Loess: A wind blown silt.

Soil Color

Color is an effective means to distinguish between layers in the soil stratification or "soil profile". But color is of great importance to determine soil properties as well. Black and dark brown colors usually relate to presence of organic materials. Red colors usually indicate the presence of iron and good drainage. Yellow soils also indicate iron but poor drainage. Gray and blue soils indicate poor drainage soils while white soils usually have high silica or lime contents.

Soil Profile

A vertical cross-section through the earth showing the various layers of soil encountered is called the soil profile. Unfortunately, soil strata are not of uniform thickness so that soil profiles can vary greatly even on a small lot.

Soil Water

The amount of water in a particular soil can have a profound effect on not only its engineering properties but on construction operations as well. The amount of water in soil is always given as a percentage of its dry weight, and is determined by weighing the soil in its natural state, drying it out and then weighing it again. Since the water content of natural soil can vary due to changes in temperature, ground water, climate conditions, etc., it is important to know the variation in properties of soil as they relate to moisture content. There are several indices which are useful to relate soil properties to water content.

Liquid Limit

The Liquid Limit (LL) is the moisture content (%) at which a soil passes into the liquid state.

The test to determine the LL is a measure of the cohesion of the soil. Sandy soils have a low liquid limit and low cohesion. Silts and clays have higher liquid limits (40 to 60). A high liquid limit soil usually indicates high clay content and low load carrying capacity. For example, a liquid limit of 50 shows that at the liquid state a soil is two-thirds soil particles and one-third water.

Plastic Limit

The plastic limit (PL) is the moisture content (%) at which a soil changes to a plastic state. This is "defined" as having just enough moisture to be able to roll the soil into 1/8" diameter threads. The plastic limit relates to the clay content and is of no value for non-plastic soils.

Silts and clays have plastic limits and the moisture contents of such soils relate to their bearing capacity. Soils with moisture contents below their PL generally have high bearing capacities. As the moisture content reaches and exceeds the PL, the bearing capacity decreases markedly.

Plasticity Index

The plasticity index (PI) is defined as the difference between the Liquid and Plastic Limits (PI=LL-PL), The PI gives the range in moisture contents at which a soil is plastic. A small PI (e.g. 5) shows that only a small change in moisture will change the soil from a semi-solid to a liquid state. A large PI (e.g. 20) shows that a large change in moisture will not create a liquid state in the soil.

The LL, PL, and PI. are referred to as the Atterberg limits after the inventor of the tests.

Density Relations

Soil particles have a specific gravity of about 2.65. Specific gravity is the term used to relate the weight of a material to the weight of water. Thus a solid block of soil would weigh 2.65 x 62.4 or 165 pounds per cubic foot. Natural soils weigh in the range of 90 to 130 pounds per cubic foot (pcf). Obviously natural soils must then have some spaces or voids. These voids may be filled with air or water (accounting for the variation from 90 to 130 psf).

The density of a soil is often a good measure of its suitability as a foundation material. Other parameters are also used to describe this aspect of soil characteristic.

Density (γ)

This is the weight of a unit volume of soil (usually pounds per cubic foot). It may be expressed either as wet density (including soil and water) or dry density (soil only after drying).

Porosity (n)

This is the ratio of the volume of the voids (V_e) in a sample to the total volume (V) of the soil sample, expressed as a percent.

$$n = \frac{V_e}{V} \times 100 \qquad (1.1)$$

Where $V_e = V - V_s$.

Void Ratio (e)

This is the ratio of the volume of the voids (V_e) to the volume of the solid particles. (V_s)

$$e = \frac{V_e}{V_s} \qquad (1.2)$$

Both porosity and void ratio give a measure of the degree of compaction of a soil.

Degree of Saturation (s)
This is the ratio of the volume of the water (V_{ev}) to the voids (V_e) expressed as a percentage.

$$s = \frac{V_{ev}}{V_e} \times 100 \qquad (1.3)$$

It gives a measure of how much of the voids are filled with water. A 100% degree of saturation is a soil with all voids filled with water.

Moisture Content (m)
This is the amount of moisture in a soil sample expressed as a percentage of dry density.

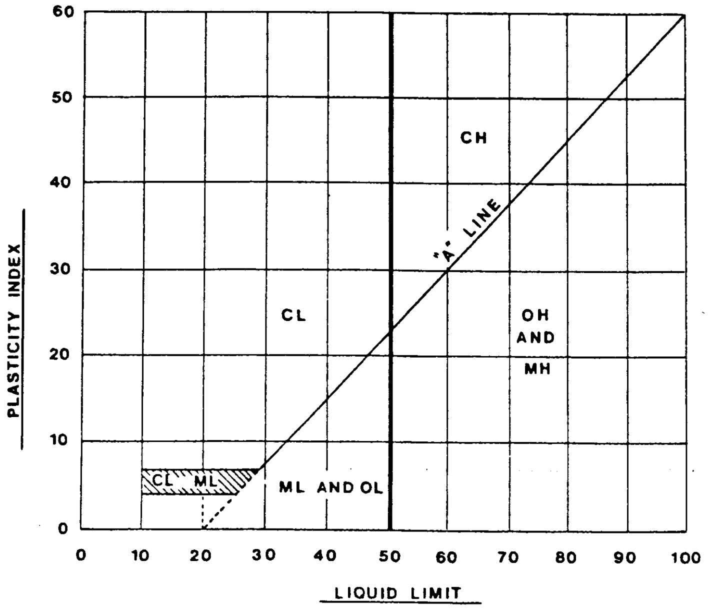
$$m = \frac{W_w}{W_s} \times 100 \qquad (1.4)$$

The term is also referred to as natural moisture (NM). It is critical to know the NM of a soil. If, for example a soil has a LL of 35 and a NM of 34 it means that a change of one percent moisture will cause the soil to change to the liquid state. Knowing the Attenberg Limits without knowing the NM is quite useless.

Soil Classification

Soils have been classified by various agencies depending on the use of the soil. For example there are classification systems developed by the U.S. Department of Agriculture for studying agricultural properties. This classification is obviously of little use to engineers. Other systems of classification have been developed by AASHO (American Association of State Highway Officials) and the FAA (Federal Aviation Agency). The classification system that is most meaningful to foundation engineers is the Unified Soil Classification System. The basic terminology is summarized in Table 1-1.

It is important to obtain a proper classification of a soil. A silty CLAY will not exhibit the same behavior as a clayey - SILT.



PLASTICITY CHART
(FOR USE WITH TABLE 1-1)

TABLE 1-1
UNIFIED SOIL CLASSIFICATION SYSTEM (SIMPLIFIED)

Major Divisions			Grp. Sym.	Typical-Names
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction is larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		Gravels with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-sand mixtures
			GC	Clayey gravels, gravel-sand-clay mixtures
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures
			SC	Clayey sands, sand-clay mixtures
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands rock flour, silty or clayey fine sands or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
	Silts and clays (Liquid limit greater than 50)		CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
	Highly organic soils		P_t	Peat and other highly organic soils

CHAPTER II - BEARING CAPACITY AND SETTLEMENT

In the design of any foundation system whether it involves use of spread footings, piles, or caissons, there are three basic criteria that must be satisfied in order to have a safe, stable structure.

1. The structural element must be proportioned (area, depth) and located in a suitable soil stratum such that a soil "failure" does not result. Such a failure is more appropriately called a bearing capacity failure. Such a failure is obviously not tolerable and foundations must be proportioned to have an ample factor of safety against such a failure.

2. The structural element must be proportioned and located such that total and differential settlements are kept below tolerable levels.

3. The structural element (footing, pile, caisson) must be structurally capable of supporting the loads. This implies adequate thickness and reinforcing. These parameters are determined from a complete structural design. The soil characteristics are not really relevant to this design phase.

Each of the above three criteria will be discussed in this chapter and in subsequent sections of this manual. It is essential to consider both bearing capacity as well as total and differential settlement aspects of the foundation soil interaction. This is analagous to having a steel floor beam with a 4 inch deflection yet which is perfectly safe in terms of collapse. Such a design would not be acceptable.

The balance of this chapter will be devoted to a discussion of the mechanism of bearing capacity and settlement of foundations. By becoming familiar with these mechanisms, the reader will also become acquainted with the properties of soil which are inherently involved in bearing capacity and settlement phenomena. These engineering properties of soils are discussed in Chapter 5. Chapters 3 and 4 deal with field tests used to obtain soil samples and laboratory tests used to determine necessary soil characteristics.

Factor of Safety

Engineers and contractors are acquainted with the concept of a factor of safety. We want every element of a structure to have a strength which is larger than the load to which it is subjected. A structural element with a factor of safety of 1.0 is on the verge of collapse. In steel structures we commonly use a factor of safety of 1.65 which is recommended by AISC. A similar factor of safety is used in the design of reinforced and prestressed concrete members.

When dealing with soil a substantially larger factor of safety is commonly used. Unlike steel and concrete which are manufactured, controlled and tested to meet prescribed standards, soils are natural materials. Our knowledge of soils is considerably less than that of steel and concrete, and soil borings may be 50 or more feet apart on a given site. Soils are highly variable and even on very uniform sites there may be pockets of poor, weak and compressible materials.

Therefore it is common practice to apply a factor of safety of at least 3.0 in soil engineering work. We want to emphasize the words "at least". When for reasons of time, economics or politics it is not possible to have a complete and thorough soil boring and laboratory analysis program we recommend that even larger factors of safety be used.

It is worth emphasizing that if a steel beam or column is overloaded it can be strengthened with relative ease by the addition of cover plates, stiffeners, etc., at a relatively low cost. If a footing is overloaded, the cost to strengthen involves underpinning, bracket caissons, chemical instrusion or other expensive remedies. Due to the variability of soil and the high cost of remedial work a large factor of safety is recommended.

Mechanism of a Bearing Capacity Failure

A bearing capacity failure can occur under a shallow spread footing, a deep caisson or a group of piles. For convenience the case of a shallow footing will be described. If we load a footing to failure the failure mechanism will be as follows (See Figure 2-1):

> As the column and footing move downward, a pyramid or cone-shaped colume of soil will move down with it. This is labeled ① in Figure 2-1.

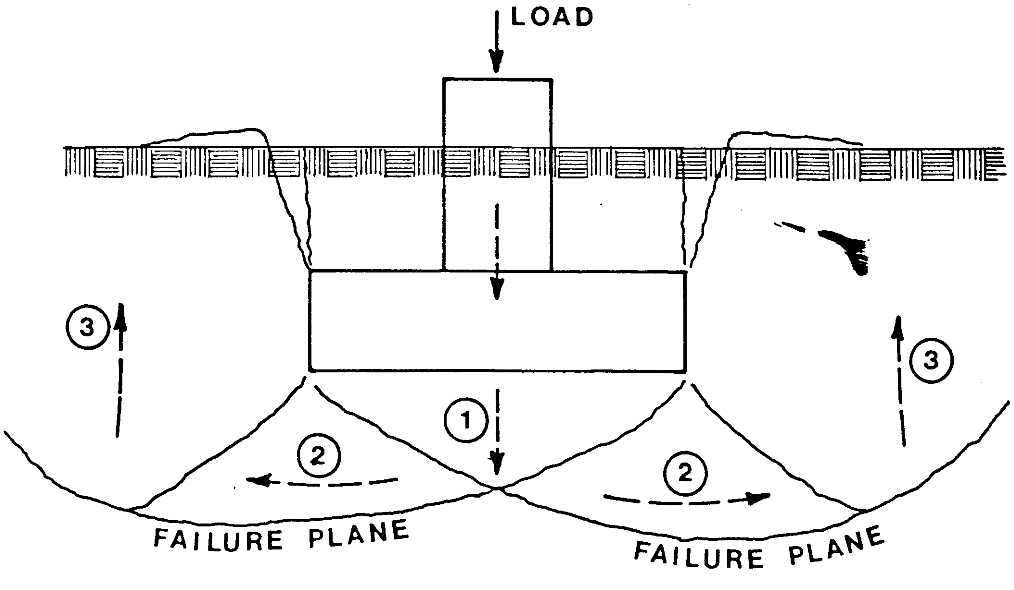


FIGURE 2-1

As this cone or "wedge" moves downward the soil around it will move outward and upward with a failure plane occurring as shown. This material, labeled ② in the Figure 2-1, continues to move out and forces zone ③ up until the surface of the ground actually bulges upwards, if load is continually applied.

The "failure" of the soil is a shearing action along the "failure plane" shown. To cause failure, the footing load must be large enough to shear through the soil and raise up the weight of the material in volume ③. There are a number of factors that affect this bearing capacity. (See Figure 2-2)

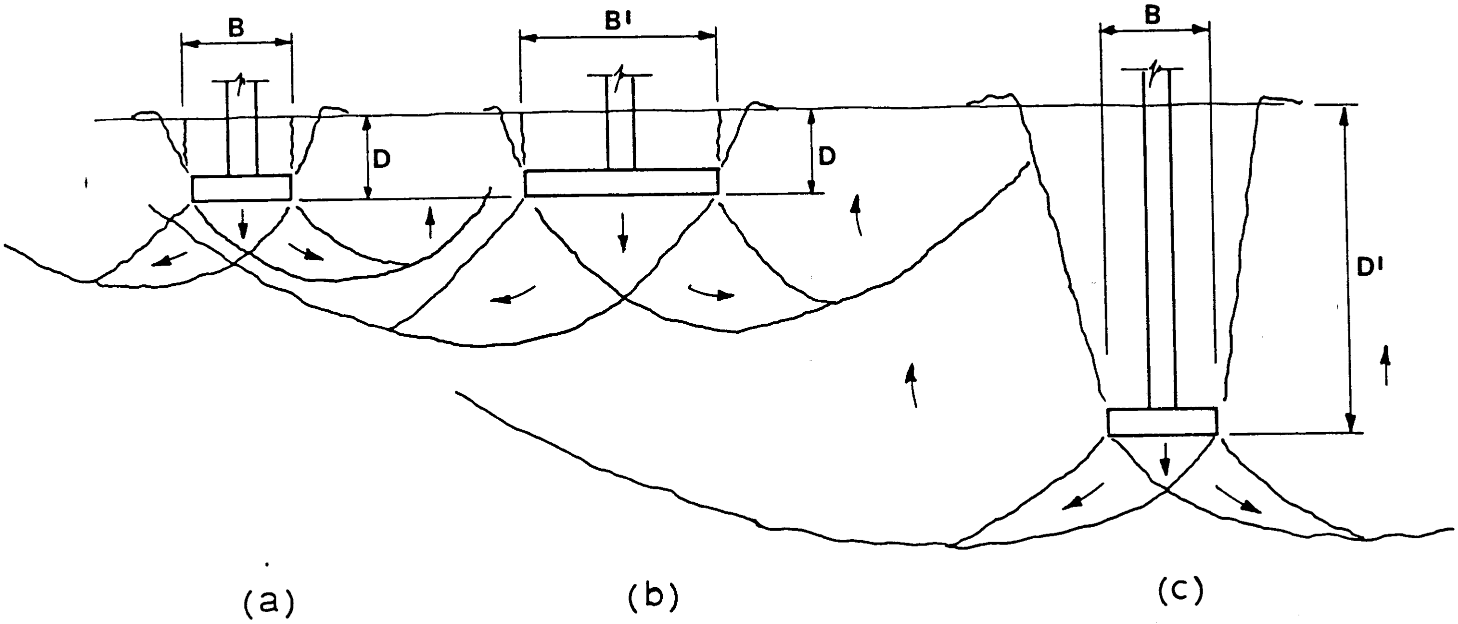


FIGURE 2-2

Figure 2-2(b) shows the effect of foundation width. The "failure plane" is increased substantially due to the footing width increasing from "B" in Figure 2-2(a) to "B'" in Figure 2-2(b). Retaining the original footing width "B" but increasing the depth from "D" to "D'" also creates a major increase in the length of the failure plane. Since there is more "failure plane" that must be "sheared" before a failure can occur, the load to cause failure is much higher. As stated previously, the failure involves not only shearing along the failure plane but also raising the weight of the soil in volume ③. It is clear from Figure 2-2 that as the footing or depth is increased, not only does the length of the failure plane increase but the weight of material in this volume increases also.

Thus the bearing capacity of a foundation is related to the following specific parameters.

1. Shear Strength of the Soil.
2. Footing Width.
3. Footing Depth.
4. Soil Weight.
5. Water Table.*

Of the above quantitites, all but one relate to things which can be readily measured, selected or weighed. The engineer selects the width and depth of the footing, the soil weight can be determined and the level of the water table can be established by drilling a bore hole. Only the soil shear strength is not readily known.

The shear strength of soil is the single most important structural property. It is a property which can be approximated by field tests but can only be established accurately with a laboratory test program. After many years of research we have learned those particular properties and tests on soil which can be made to determine the shear strength.

The two basic soil properties which affect shear strength are:

c = cohesion

ϕ = angle of internal friction

These may be expressed in the equation to establish shear strength.

$$s = c + \sigma' \tan \phi \qquad (2.1)$$

where: σ' = the intergranular pressure between the grains of soil. For soil with no cohesion, such as dry sand, this angle of internal friction is roughly equal to the angle of the pile created when gently dropped on a level surface. (See Figure 2-3)

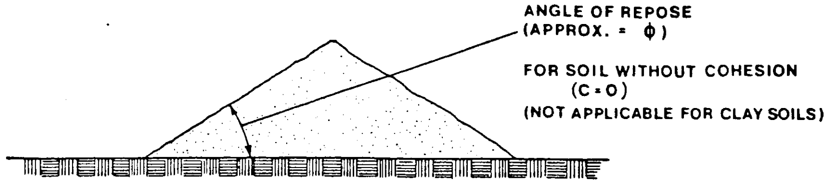


FIGURE 2-3

(*) The level of ground water affects the weight of the soil due to buoyancy. Soil under water is lighter due to the buoyant uplift.

Sandy soils generally have a value of ϕ of about 30 degrees while clays in their natural state have a ϕ of from 0 to 10 degrees. For purposes of design, clays are usually assumed to have $\phi = 0$. The "tan ϕ" is roughly equivalent to the "coefficient of friction" of the soil. The coefficient of friction times the normal force or "intergranular pressure" gives the friction portion of the shear strength.

The cohesion "c" is a measure of the "stickiness" of the soil grains. Sands have no cohesion and derive all of their shear strength from friction. Clays, on the other hand, have practically no friction and their shear strength comes from the cohesion. Soils found in a natural state derive shear strength from a combination of cohesion and friction. Moisture content has a very important effect on both "c" and "ϕ".

Mechanism of Settlements

Settlements of soils can result from a number of different causes and will vary greatly depending on a considerable number of parameters. Sandy (cohesionless) soils have entirely different settlement characteristics than clayey (cohesive) soils.

Sandy soils settle primarily due to elastic compression of the grains. The settlements are generally small, usually occur immediately upon application of the load (during construction) and (except for very loose sands*) are usually not a problem. Often soils engineers will not bother to estimate settlements of foundations on sandy soils. For moderately loose sands, vibration can also cause settlement.

Clayey soils exhibit entirely different settlement behavior. Settlements occur slowly (sometimes many years pass before all of the settlement takes place) and settlements are often large. If a structure settles uniformly, even a 2 or 3 inch settlement may not cause building damage. This may, however, create problems with sewers and adjoining sidewalks and driveways.

Due to the non-uniformity of soils in nature, non-uniform settlements can be expected. These "differential" settlements, if large, can cause building damage and cannot be tolerated. It is desirable to have minimum total settlements as well as minimum differential settlements. The designer must have a means of calculating the settlements of clayey type soils.

Settlements in clay soils occur primarily because water in the soil-water mixture "leaves" the clay. When the water "leaves", the pore spaces consolidate and the soil can now occupy a smaller volume. This produces settlement or consolidation.

(*) Very loose sands should not be used as a foundation unless very special study is made or efforts are made to densify the soil.

Water "leaves" the clay as a result of two possible external causes. First, and most commonly, water can be squeezed out of the clay as a result of foundation loads or additional layers of fill placed on a site. A second reason for water "leaving" the soil is that the water level drops, either naturally or as a result of pumping. Pumping (de-watering) in a construction operation can thus result in settlement.

Soils have widely varying consolidation settlement characteristics. We may, for example, have a clay subjected to a heavy foundation load (causing a squeezing action). If a drainage layer exits (such as an underlying sand stratum) there will be a place for the water to go easily. If a clay layer has sand strata above and below, the process of consolidation will occur more rapidly due to the presence of two drainage layers but the total settlement will be the same as if only one drainage layer existed. If no drainage layer is present consolidation will still occur but at a very slow rate due to the difficulty of squeezing water through the tiny pore spaces in the clay.

Another important aspect of consolidation relates to the history of the soils in a particular area. There are many areas of the country in which glacial action has taken place. Generally this includes the northern states. In these areas the heavy weight of the glaciers squeezed the water out of the clays thousands of years ago. Such soils are "pre-consolidated" and exhibit settlements of only about 10 to 20 percent of the settlements of "normally consolidated" clays. For example, soils in Wisconsin, Minnesota, and Michigan are almost all pre-consolidated.

CHAPTER III - SOIL BORINGS AND FIELD TESTING

Soil borings are made for a number of reasons:

(1) To locate all soil strata under the proposed structure.

(2) To determine the water table elevation.

(3) To determine the types of soils in each stratum.

(4) To locate the extent of problem soils (such as peat and organic silt).

(5) To obtain samples from which properties of soil can be determined in the laboratory.

Soil Boring Program

Unless soil characteristics are known prior to the construction of any building project, a well thought out soil boring program should be established. Based on the number of failures and lawsuits which have occurred it is clear that the development of a soil boring program is the most consistently overlooked and ignored phase of the entire building construction program. The authors of this manual have personally investigated many building failures which were directly attributable to the complete lack of soil borings or an attempt to minimize the cost of an adequate soil boring program. If, in a building project, one steel beam has been improperly designed, there are several relatively inexpensive methods which can be used to strengthen that particular member (cover plates, stiffeners, brackets, etc.). If a similar error is made in terms of the foundation design no simple repair methods exist. Rather, expensive underpinning or soil improvement techniques must be employed. The cost of an adequate soil boring program is insignificant in terms of the potential problems which can result if borings are not taken.

There is generally much controversy about the number and depth of borings which should be taken for a building project. The following set of rules should be taken as a minimum.

Minimum Soil Boring Program

1. Take one boring at each exterior corner of the proposed building (minimum of [4]).

2. Take one boring near the center of the building.

3. One boring should be taken to a depth equal to the building width or 100 feet, whichever is less.

4. All borings should be taken to a depth below any soft, weak or organic soils.

Obviously if shallow bedrock exists under the site, the borings should define the top surface of the rock stratum under the building. Also, if the borings taken show highly variable soils and stratification, additional borings are then required to establish critical areas or a soil profile.

A lawsuit recently resulted from a project in which three soil borings were taken. To "minimize" cost, borings were taken in the locations shown in Figure 3-1.

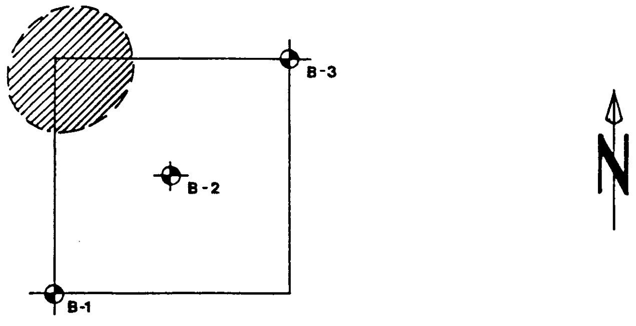


FIGURE 3-1

BORING LOCATION PLAN

Unfortunately there was a "pocket" of organic soil, in the cross-hatched area shown, which of course was undetected. The northwest corner of the building settled about 6 inches.

Repairs involved use of caissons to underpin the footings that settled, and mudjacking of the floor slab. Total damages (including lost business) resulted in a court judgement of over $135,000. This could have been avoided with one soil boring conservatively estimated to cost $300.00. (In this particular case the building contractor paid for the repairs.)

Soil Boring Operations

There are several methods used for the making of soil borings. It is important to consider the soil boring operations in two distinct phases. The first phase is making the boring, which simply involves "making the hole". The second phase involves taking soil samples for testing.

The hole is made either by use of a flight auger which literally drills a hole into the ground (about 6" diameter) or by use of a procedure called wash boring in which a chopping bit is used to chop up the soil. Water is injected into the boring hole through a hole in the chopping bit. The soil and water mixture is then pumped out. It is important to remember that augering and wash boring methods only accomplish one thing - they make a hole in the ground.

In order to determine the engineering properties of soils it is generally necessary to take soil samples for laboratory analysis. There are two commonly used techniques for taking these samples.

Split Spoon Sampling and the Standard Penetration Test

The type of sampler that is most commonly used to take soil samples is the "split spoon" or "split barrel sampler". The split spoon is a "pipe" with a threaded coupling at each end which can be split into two halves for easy removal of the soil. The split spoon is driven into the ground by use of a falling weight. The split spoon is about 2 inches in diameter and the soil sample which is inside the spoon is a disturbed sample. The soil can be tested for certain properties but the tests are limited.

Split spoon samples are usually taken at intervals of 5'-0" or wherever the soil stratification changes.

Since the split spoon is driven into the ground, soil engineers have learned through experience that the number of blows required to drive the split spoon into the ground is a measure of the density and bearing capacity of soil. This procedure is called the standard penetration test. The number of blows required to drive the split spoon 12 inches into the ground using a 140 pound weight fallling 30" is called the "blow count" or "N" value. The blow count is a reasonable measure of the relative density and bearing capacity of granular (sandy) soils. It is of marginal and perhaps questionable use in determining the bearing capacity of cohesive (clayey) type soils. Table II gives a list of approximate allowable soil pressures for cohesive soils with varying blow counts. These are very approximate and are not recommended except for unimportant structures or as a supplement to other analyses.

TABLE 3-1

APPROXIMATE ALLOWABLE SOIL PRESSURES
(based on blow count "N")

FOR CLAYEY SOILS

SOIL CONSISTENCY	N	ALLOWABLE SOIL PRESSURE (lbs/s.f.)** SQUARE FOOTINGS	WALL FOOTINGS
Very Soft*	0-2	0-600	0-400
Soft*	2-4	600-1200	400-900
Medium	4-8	1200-2400	900-1800
Stiff	8-16	2400-4800	1800-3600
Very Stiff	16-30	4800-9600	3600-7200
Hard	30+	9600+	7200+

(*) Check Settlement

(**) Approximate factor of safety of 3

For <u>granular soils</u> equations have been developed to approximate the allowable soil pressure, based on blow count, with an approximate safety factor of 3.

For square footings

$$P_{allowable} = .7N^2BR_w + 2(100+N^2)DR_{w'} \qquad (3.1)$$

For wall footings

$$P_{allowable} = N^2BR_w + 1.7(100+N^2)DR_{w'} \qquad (3.2)$$

where:

N = Blow Count

B = Width of Footing

D = Depth of Footing

R_w and $R_{w'}$ are factors varying from 0 to 1.0 which adjust for the location of the water table.

$R_{w}' = 1.0$ and $R_w = 0.5$ when the water level is at the bottom of the footing.

$R_{w}' = 0.5$ when the water level is a distance "D" or more above the footing bottom (R_w remains equal to 0.5)

$R_w = 1.0$ when the water level is a distance "B" below the footing bottom. (R_{w}' remains equal to 1.0)

The factor of safety of 3.0 used in the preceding tables and equations is the commonly accepted value for soil.

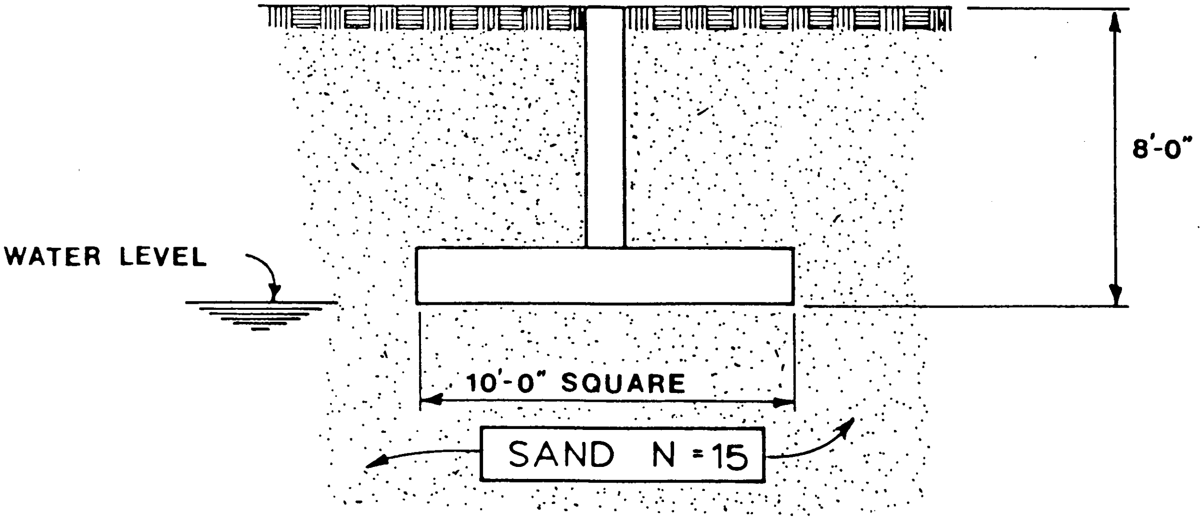
The reader should note that all of the major factors which affect bearing capacity appear in the equations. (See Chapter 2)

For example, a sandy soil with a blow count of 15 supporting a 10'-0" square footing 8 feet below the ground and for which the water level is also 8 feet below grade would have an allowable soil pressure of:

$$P_{allow} = 0.7(15)^2(10)(0.5) + 2\ [100 + 15\ ^2]\ 8(1)$$

$$= 788 + 5200$$

$$= 5988 \text{ psf (say 6000 psf)}$$



As a precaution against settlement problems the following equation should be checked. This is the allowable soil pressure that will result in a settlement of 1 inch. It is very approximate and quite conservative.

$$P_{allow} = 720(N-3)\left(\frac{B+1}{2B}\right)^2 Rw' \qquad (3.3)$$

For the above example,

$$P_{allow} = 720(15-3)\left(\frac{10+1}{2x10}\right)^2 \text{ x } 1.0 = 2614 \text{ psf}$$

At this point a decision must be made as to what settlement can be tolerated by the structure. A corresponding soil pressure must be selected (up to the 6000 psf value imposed by bearing capacity limitations).

Shelby (Thin Wall) Tube Sampling

The standard penetration test and split spoon sampling are not reliable for clayey type soils. The only way to really establish the bearing capacity of clayey type soils is to make a laboratory test called the "unconfined compression test" to determine shear strength. In order to make the unconfined compression test, an undisturbed cylinder of soil is needed. This sample is obtained using thin wall tube sampling techniques.

In this process a thin wall conduit is pushed (hydraulically) into the ground rapidly. The intent is to push the tube rapidly enough that the soil literally does not know that it has been disturbed. Shelby tube samples are usually taken at intervals but sometimes continuously in clay soils.

The Shelby tubes are sealed in the field to prevent moisture loss and taken to the laboratory where the soil is pushed out (extruded) to obtain cylindrical samples for various tests.

Pocket Penetrometer

A commonly used approximate field test, that the reader should be acquainted with, involves the use of the calibrated spring pocket penetrometer. This is a device about the size of a medium screwdriver that is pushed by hand into clay type soils. It is not used for remote testing. A pointer indicates the measure of difficulty required to push the penetrometer into the soil. The penetrometer is calibrated to read directly in tons per square foot. The more effort required to push the penetrometer into the soil the higher reading will result and the higher the soil bearing capacity. The penetrometer gives a measure of the unconfined compression strength of the soil which is directly related to shear strength and bearing capacity for clayey type soils. The penetrometer should not be used for cohesionless (sandy) soils. The user may push the penetrometer into the soil by direct access to the soil (either by physically being in the excavation or by having a large undisturbed sample into which the penetrometer may be pushed).

Vane Testing

A field test device, the use of which is becoming more popular in the United States (after extensive application in Europe), is the vane test. This device consists of two perpendicular thin plates mounted on a shaft. The vane is first pushed into the soil. Then the vane is rotated and the amount of torque required to rotate the vane is measured. The torque is related to the shear strength since the soil must be "sheared" in order for the vane to turn. The vane test is most useful for soft clays and is not reliable for granular soils or hard clays.

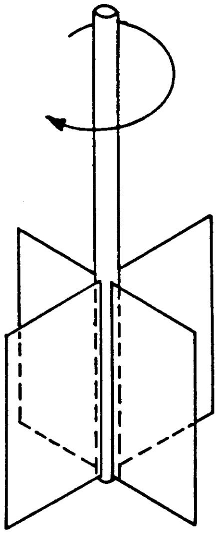


FIGURE 3-3

VANE SHEAR TESTER

The Cone Penetrometer

The cone penetrometer, often referred to as the "Dutch Cone", was developed in Holland and is now considered as a popular supplement to other conventional field testing procedures. Static cone penetration testing consists of punching a standard-sized steel cone into the soil at a constant rate and measuring the thrust necessary to drive the cone. The cone can be driven manually or with hydraulic power units. There are no soil samples recovered with the cone. There is a limit on its use if the soils become too hard and the cone cannot be driven due to limited equipment capabilities. The results of cone resistance are comparable to "blow count" in terms of being a measure of relative density.

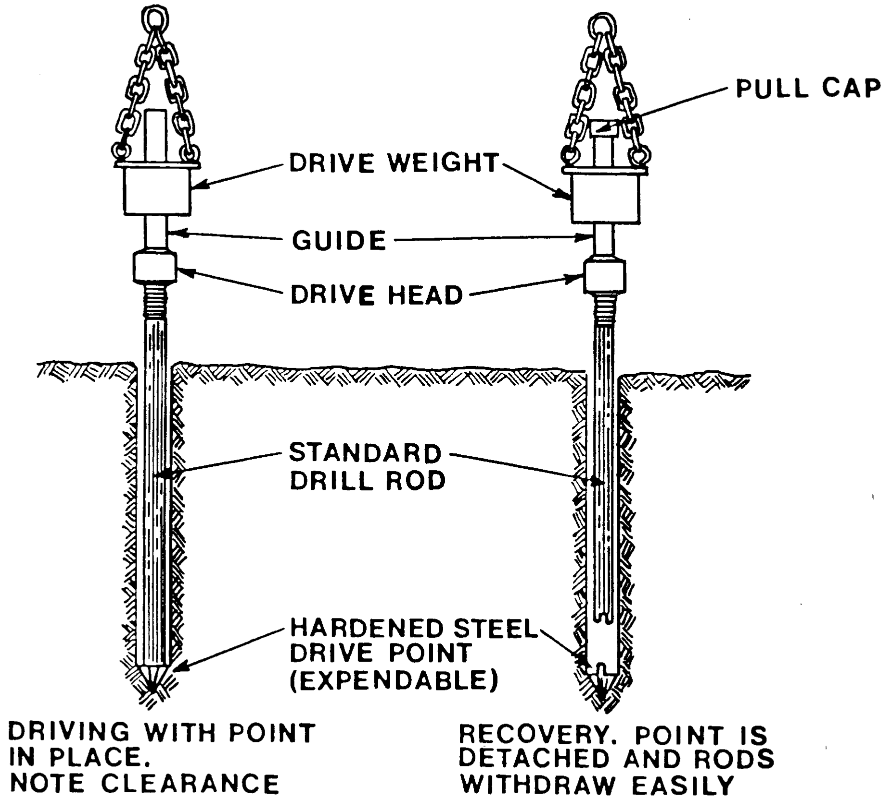


FIGURE 3-4

CONE PENETROMETER

Cost of Soil Borings

Charges for soil borings will vary depending on a number of factors.

(1) Location in the country

(2) Size and experience of boring contractor

(3) Workload of contractor

Prior to describing the various costs included in a soil boring program there is one basic distinction that must be mentioned relative to developing a soil boring program. This relates to the type of firm engaged in making borings. The specific practice will vary in different parts of the country but there are essentially two methods of having a soil boring program carried out.

(1) Retain the services of a soils engineering firm. The firm will hire a soil boring contractor who will make borings under the direction and control of the engineer. The engineer will analyze the soils in his laboratory and develop a report including specific recommendations.

(2) A soil testing laboratory or service may be retained. Such a firm will have soil boring rigs, a soils lab and an engineering staff. They can provide the complete service of borings, lab tests and report.

Once one of these choices has been made the boring program can be started. Each phase of the program carries separated costs although it may be possible to negotiate a lump sum contract for the entire program. Specific charges are as follows:

(a) Mobilization - This will be a flat fee to cover the cost of moving the equipment to the project site. It will vary with the distance from the soils lab to the site.

(b) Cost of Borings - Borings are usually charged on a per foot basis. Sometimes the "per foot charges" include mobilization and report. Another factor which affects soil boring costs is the ease (or difficulty) of drilling. Often costs will go up with blow count. (i.e. borings in soils with N=40 or more will cost more than borings in soft soils). The boring costs will include the standard penetration (blow count) operations in most cases. Also costs per foot will go up if casing must be used to keep the boring hole open.

(c) Extra Charges - Operations not included in the standard per foot costs described in (b) are:

(1) Shelby tube samples
(2) Vane tests
(3) Dutch cone penetrometer

(d) Rock Coring - When "bedrock" is encountered close to ground surface it may be necessary to core into the rock to make sure that the stratum is really bedrock and not a thin rock crust or an isolated large boulder. Rock cores are made with a diamond core drill which enables samples of the rock to be taken. (Not all rock is sound and adequate as a foundation material.) Rock coring is expensive.

(e) Laboratory Tests - The various laboratory tests used to determine engineering properties of soils will be described in the following chapter. Costs for such tests are included in the total boring program and are charged on an individual basis per test. Some tests such as Atterberg Limits are quite inexpensive while other tests such as consolidation or tri-axial testing are quite expensive.

(f) Engineering Report - Normally a report giving the logs of soil borings and results of laboratory tests is included without extra cost. However, if a report is requested to be written by a professional engineer giving specific foundation design, cost of such a report will be extra.

At this point it is important to note a critical item relative to the engineering report. If the project in question has an architect or engineer, that individual may prefer to develop his own conclusions regarding foundation types and soil pressures. In such cases having a separate engineering report from the soil boring company will result in double engineering charges. (The authors of this manual never authorize an engineering report from the boring contractor but prefer to make their own analysis and recommendations.)

Another factor relates to liability. Many soil boring firms do not have (and cannot obtain) professional liability insurance for protection against an error in the report. However, most architects and consulting engineers do have professional liability insurance which includes protection for soil and foundation design. Many professionals feel that if they have the liability and insurance that they should also assume the responsibility to make all professional decisions regarding soil and foundation engineering designs.

Finally, the cost of borings (whatever it may be) is insignificant in terms of the total project budget. Under no conditions should a project be constructed without borings unless absolute knowledge of the engineering properties of soils on the site is available from past experience.

CHAPTER IV - LABORATORY TESTING OF SOILS

The primary purpose of laboratory tests is to determine the specific properties of soils needed to calculate bearing capacities and to estimate settlements. Some of the tests have already been mentioned in previous chapters but will be included in this chapter for the purpose of completeness.

Unit Weight

The unit weight of granular soils is difficult to determine since the soil sample is disturbed in the process of obtaining the sample. The standard penetration test is generally used to get a measure of soil unit weight for granular soils as seen in Table 4-1.

TABLE 4-1

UNIT WEIGHT OF GRANULAR SOILS

COMPACTNESS	BLOW COUNT N	UNIT WEIGHT (pcf) MOIST	SUBMERGED
Very Loose	0-4	<100	<60
Loose	4-10	95-125	55-65
Medium	10-30	110-130	60-70
Dense	30-50	120-140	65-85
Very Dense	>50	>130	>75

The unit weight of clay soils can be readily determined in the lab by measuring the weight and volume of the sample from the Shelby tube. The purpose of acquainting the reader with average values for unit weight may not be obvious and requires comment. If the unit weight of the soil is known, this can be very useful in evaluating soil behavior. If we recall that concrete weighs 150 lbs. per cubic foot (pcf), we can easily see that a soil weighing 125 lbs. per cubic foot is nearly as dense as concrete and would be of high quality and low settlement.

Grain Size

A set of standard sieves is used to determine particle sizes of sands and gravels. For fine grained soils (silts and clays), a "wet" method is required, using a suspension of soil in water. Using a hydrometer and assumptions about particle shape, particle sizes can then be established based on the rate at which particles settle out of suspension.

Water Content

The natural water content of a soil sample is determined by weighing the sample before and after it is dried in the oven under controlled temperature.

Liquid Limit

The liquid limit is the percentage of moisture at which the soil is on the boundary between the plastic and liquid states. A soil sample is mixed with water and placed in a dish to a depth of 1 inch. A 1/2 inch wide groove is cut through the middle of the sample. The dish is raised and dropped by turning a crank on the liquid limit apparatus. The water content at which the 1/2 inch groove is just closed with 25 drops of the dish is the liquid limit.

Plastic Limit

This is the water content at which the soil is at the boundary of the plastic and semi-solid states. The water content at which the soil can be rolled into 1/8 inch diameter threads without breaking up is the plastic limit.

Unconfined Compression Test

This is a test of a small cylinder of soil similar to the cylinder test used to obtain the strength of concrete. The failure of the cylinder is taken at that load which causes a shortening (strain) of 20 percent. This test is of major importance for determining the bearing capacity of clayey soils. For all practical significance, the shear strengths of a clay may be accurately taken as one-half the unconfined compression strength (qu). The ultimate capacity of a clay may be determined as follows:

$$P_{ult} = c\ N_c$$

where: Cohesion = shear strength (s)

N_c = bearing capacity factor depending on size and depth of the footing.

The bearing capacity factor (Nc) does vary, but for a square footing may conservatively be taken as 6.0. For a factor of safety of 3 the allowable bearing pressure for a clay may be obtained as follows:

$$P_{allow} = \frac{P_{ult}}{F.S.} = \frac{P_{ult}}{3}$$

$$= \frac{cNc}{3} = \frac{c(6)}{3} = 2c$$

Since (c) is one-half of (q_u)

$$P_{allow} = 2c = \frac{2q_u}{2} = q_u$$

Thus the allowable soil pressure in (psf) is equal to the unconfined compression strength (q_u). Since the pocket penetrometer reading is an approximate measure of the unconfined compression strength the pocket "pen" is often used to get approximate allowable soil pressures.

Direct Shear Test

This test is used to establish the relationship between s and σ in the basic shear strength equation:

$$s = \sigma' \tan \phi + c$$

For granular soils "c" is essentially zero. The test apparatus is shown in Figure 4-1.

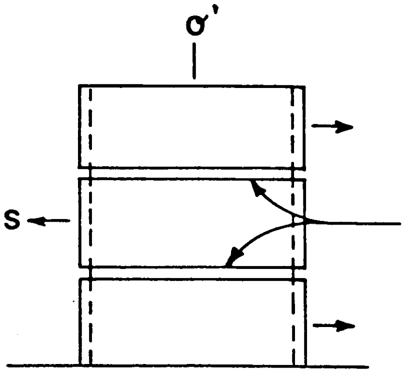


FIGURE 4-1
DIRECT SHEAR TEST APPARATUS

σ' is varied and the shear strength is measured. ϕ can be determined from the test.

Consolidation Test

The mechanism of settlement of clayey soils was described in Chapter 2. It was pointed out that settlement of clays results from squeezing water out of the clay. The consolidation test uses an undisturbed tube sample (preferably 3 inch diameter.) The sample is placed in a cylinder with a porous plate above and below the sample. Load is applied to the sample in increments and the water is squeezed out of the clay, similar to what happens in the ground.

A plot of void ratio (e) versus pressure (σ') enables the determination of a term called the compression index (C_c) which is used in settlement calculations. The consolidation test should always be made for plastic clays of low shear strength. In areas where the soils are known to be preconsolidated it may not be necessary to make this test. The consolidation test is difficult to make and requires careful interpretation by an experienced soils engineer. The compression index (C_c) for clays can be found by the equation: $C_c = .009\ (LL-10)$. This is introduced in this manual only to acquaint the reader with the relation of liquid limit to the settlement calculation.

Sensitivity Test

Some clays have the characteristic of losing a large percentage of their shear strength when they are vibrated or disturbed. Such disturbance can come from such occurrences as pile driving or even normal construction operations (trucks, tractors). These clays are known as sensitive clays. The "sensitivity" of a clay is determined by the following procedure.

An unconfined compression test is made on an undisturbed sample. After the test the sample is remolded (by hand) into another cylinder and a second unconfined compression test is made. The ratio of the unconfined compression strength of the undisturbed sample to that of the remolded sample is the sensitivity. A clay with a sensitivity of more than 4 is considered sensitive. This means that the strength upon disturbance is reduced by a factor of 4 to that in the undisturbed state.

Sensitive clays generally regain most of the lost strength if given time to recover. This characteristic is commonly encountered with pile driving operations.

CHAPTER V - ENGINEERING PROPERTIES OF SOILS

There are a number of important properties of soils with which every engineer and contractor should be familiar.

Properties of Granular Soils (Sands)

1. Immediate settlement.
2. Good backfill material.
3. Vibrations can cause settlement (loose sand).
4. Not a frost problem (unless sand is very fine).
5. Strength depends on density which is determined by standard penetration test. (blow count)
6. Strength of loose sands can be improved by vibratory compaction. (See Chapter 6)
7. High permeability - therefore dewaters or drains easily.

Properties of Cohesive Soils (Clays)

1. Soils are plastic (moldable) when moist.
2. Soils are compressible over a long period of time (consolidation) unless pre-consolidated.
3. May lose strength when wet or disturbed.
4. May develop large lateral pressures (poor backfill).
5. Highly impervious (good for earth dams).
6. Strength depends on cohesion which is generally measured by an unconfined compression test on an undisturbed sample.
7. Clays of high plasticity (LL over 40 percent) are poor foundation materials.
8. High capillarity of medium or soft clays make them susceptible to frost heave. (not as serious as silts)
9. Difficult to drain or dewater.

Properties of Silt (Laboratory tests are mandatory)

1. Very fine particle sizes.
2. Low shear strength. (glacial silty soils may not be weak)
3. Low permeability.
4. Hard to compact.
5. Very susceptible to frost heaving.
6. If cohesive in nature treat like a clay - if cohesion is less treat like a fine sand.
7. Loess (wind blown silt) is very difficult to analyze and can be a major problem. An experienced soil engineer should be consulted for structures on loess.

Properties of Organic Soils (Peat, Organic Silt)

1. Soils are highly compressible. Settlements of 2 feet or more are common.
2. Blow counts may be high (deceptively), often high enough that it may appear that the soil is suitable as a foundation. These soils are not generally suitable for buildings.
3. Organic soils are often stable and possess adequate bearing capacity as long as they are continuously submerged (i.e., as long as the water table does not drop)
4. Organic soils can decompose if they are allowed to dry out or are alternately wet and dry.
5. It is possible to find soils with small amounts of organic materials in a generally suitable inorganic soil. Such soils may be acceptable for buildings but should be carefully reviewed by an experienced soils engineer.

CHAPTER VI - COMPACTION (ENGINEERED BACKFILL)

There are many situations in which the surface soils on a site are of poor quality. If these poor soils do not extend to great depths and if foundation loads are not exceptionally high it may be economical to remove the poor surface soils and replace them with a compacted fill.

The fill materials used for compacted fill applications may be materials which are brought into the site or they may simply be the in-situ (in place) loose materials. Both granular and cohesive soils may be used as compacted fill materials.

There are various methods used to compact soils in place. The method used depends on the soil type and the particular site.

(1) Flooding Loose sands can be compacted in a limited way by flooding with water.

(2) Vibration - Heavy vibratory rollers can compact a granular soil to a depth of several feet.

(3) Vibroflotation - This is a commercial method involving a combination of vibration and jetting. Additional sands are brought in to fill in the voids created by the process.

(4) Sand Drains - Vertical sand drains can be installed to accelerate the consolidation process of soft clays. (More drainage layers into which the water can be squeezed).

A man-made fill can be constructed to develop a soil with large bearing capacities and small settlements. A proper compaction procedure can increase shear strength and decrease compressibility. In order to determine the effectiveness of a field compaction operation it is necessary to have a standard of comparison. The most widely used procedure to determine this standard is by use of the Proctor Density test.

In the Proctor test, a sample of the proposed fill is brought to the laboratory. It is placed in a container at a particular moisture content and a standard weight is dropped on the sample (in layers) to compact the material. The moisture content is changed several times and the compaction process is repeated until the maximum density is achieved. The maximum density (at the optimum moisture content) is called the Proctor density. There are two Proctor tests, one called the Standard Proctor and the other called the Modified Proctor. The designer is cautioned to make sure which test is specified since different compaction procedures are used in each test.

In the Standard Proctor test, the soil is compacted in a cylindrical mold having a volume of 1/30 cu.ft. The soil is placed in the mold in 3 layers and tamped with a 5-1/2 pound tamper falling 12 inches, with 25 blows per layer. The amount of compactive energy was established by testing as approximately equal to that which it is feasible to obtain in normal field compaction operation.

More recently the U.S. Corps of Engineers decided that greater densities (e.g. under airport pavements, earth dams, earth embankments, etc.) might be required. For such projects heavier compaction equipment was needed. The Modified Proctor test was developed to check this higher level of compaction. In this test the soil is placed in 5 layers and is tamped with a 10 pound weight falling 18 inches, with 25 blows per layer. The Standard Proctor test is suitable for most building structures covered in this manual.

For support of slabs on grade and moderate footing loads, engineers often specify that soils in the field be compacted to 95 percent of Modified Proctor density. This means that if the soils in the lab were compacted to 120 pcf the soils in the field need only be compacted to .95x120 or 114 pcf. In order to determine whether or not this has been achieved, field density tests are made. After the soils have been compacted, a hole is dug and the material weighed. The hole is filled with a sand of known density. By weighing the amount of sand put into the hole, the volume of the hole can be computed. From this, the in-place density of the compacted fill can be calculated. It is thus possible to compact soils in the field to more than 100 per cent of Proctor density by doing a better job than is done in the standard test compaction procedure.

Since there is no well defined relationship between Proctor Density and bearing capacity it is advisable to take standard soil borings on the site after the compaction has taken place and evaluate the borings as if the soils were the natural soils for the site.

Compaction of man-made fill is accomplished by spreading fill materials at a moisture content near the optimum water content. If the soil brought in is too dry, moisture must be added; if too wet and slow drying, another source for materials should be found.

There are various types of equipment used in the compaction process. These include rollers, tampers, vibratory compactors and earth moving equipment.

Rollers

(1) Smooth steel rollers are towed by a tractor and used to compact slag, rock or coarse gravel.

(2) Pneumatic-tired rollers are also usually towed. Tires are inflated to about 100 psi and the equipment is used for compacting granular soils.

(3) Sheepsfoot roller is a roller with a series of "footlike" projections used for compacting clay.

(4) Grid roller is a roll covered with a "grid" of steel used for hard, lumpy clays.

Mechanical Tampers

These tampers are for areas inaccessible to rollers and where damage to nearby structures could occur.

Vibratory Compactors

This is either a cylindrical roller or pan type vibrator which develops the compactive effort from a vibrating weight. The unit is excellent for compaction of granular soils.

Earth Moving Equipment

Trucks and tractors are commonly used for compaction but are not generally satisfactory, primarily due to the fact that they do not develop a uniformly distributed compactive effort on the soil.

Specifying Compaction

Most engineers will write a "performance specification" for compaction work. This means that a specific density (such as 90 per cent of Standard Proctor) will be specified. The fill material will be approved and the contractor will then be permitted to use any method he wishes to develop the 90 per cent density. Field density tests would be taken (generally by an independent testing lab) to make sure the compaction has been achieved. The specification may also state a limit on the maximum thickness of one layer of compaction (6-12 inches for clays and 18" for granular soils).

CHAPTER VII - TYPES OF FOUNDATION SYSTEMS AND FOUNDATION BEHAVIOR

It is a fundamental premise in all structural design that all loads which act on a structure must eventually reach the foundations. These loads may be vertical loads, such as those caused by snow and structure weight. They may be horizontal, such as loads produced from wind, earth pressure or seismic (earthquake) effects. They may also be a combination of vertical and horizontal load effects, causing tipping or rotation. The precise load combinations will vary from structure to structure but they must be recognized and taken into account in the design.

There is a well known cartoon depicting a vertical Tower of Pisa and the foundation engineer saying "I cheated a little on the foundation but no one will ever know". All too often a false cost saving is attempted by elimination of soil borings or lab tests. Eventually everyone will know - after the troubles begin.

Foundation systems may be divided into two broad categories:

(A) Systems which support columns and are primarily transmitting vertical loads into the soil.

(B) Systems which support significant horizontal forces and moments as well as vertical loads.

However, foundations encountered in many Butler building structures are subjected to large horizontal forces. Some examples of foundation systems of both classes are pictured in Figures 7-2 and 7-3.

In order to review the various types of foundation systems which are used, it is important to consider that any building column could be subjected to up to five loading components. (See Figure 7-1)

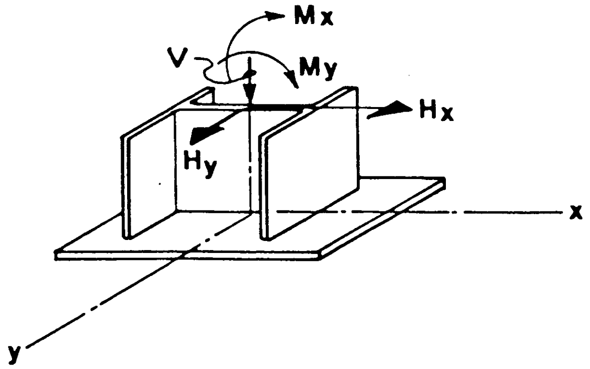
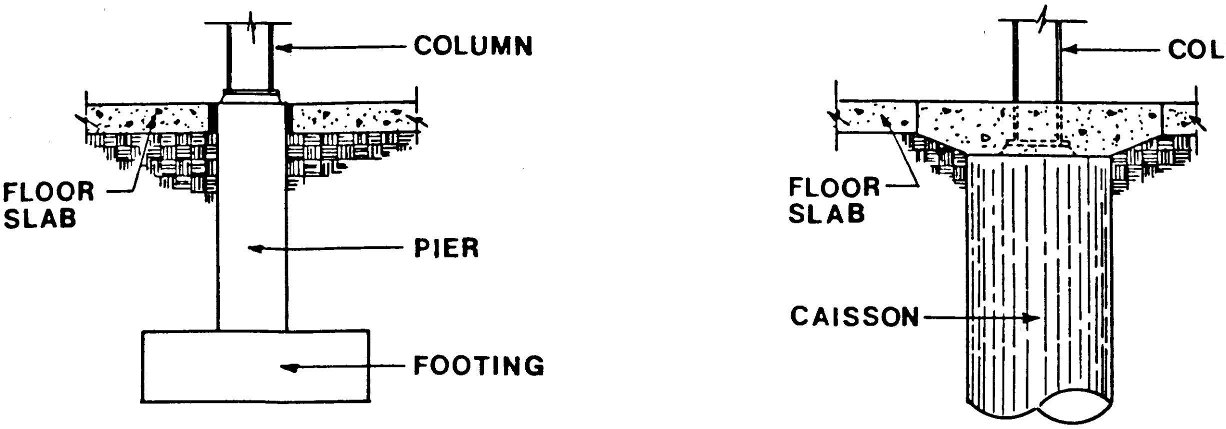


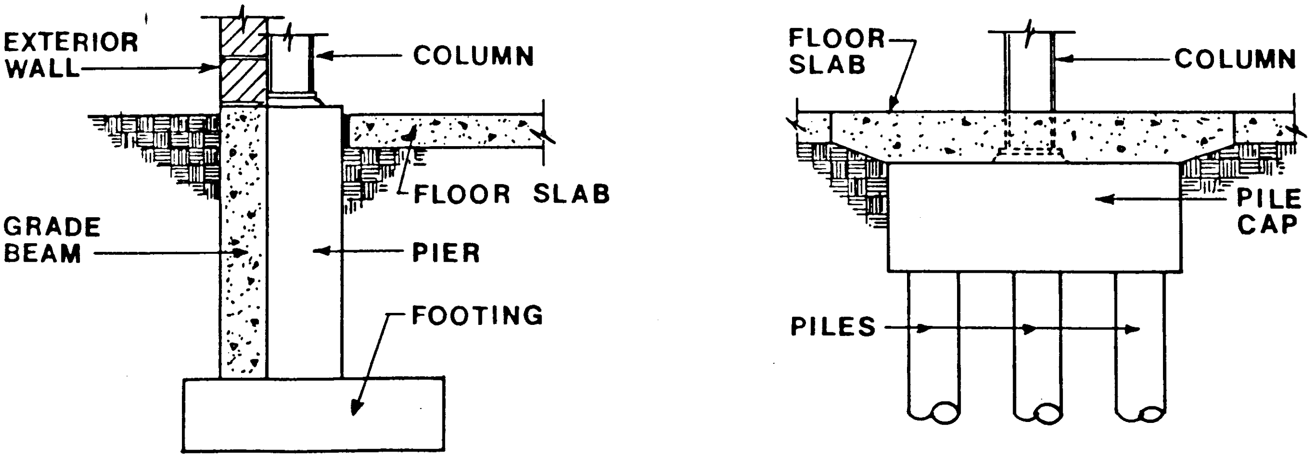
FIGURE 7-1

COLUMN LOADING ELEMENTS



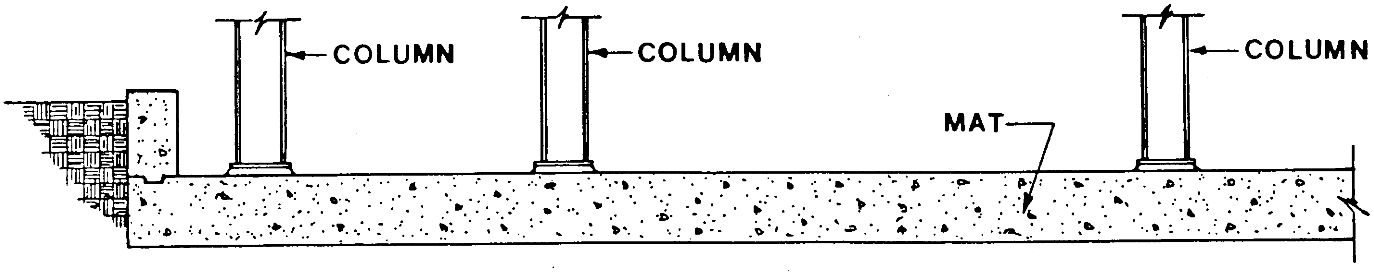
INTERIOR SPREAD FOOTING SUPPORTING STEEL COLUMN

INTERIOR COLUMN ON CAISSON



EXTERIOR COLUMN

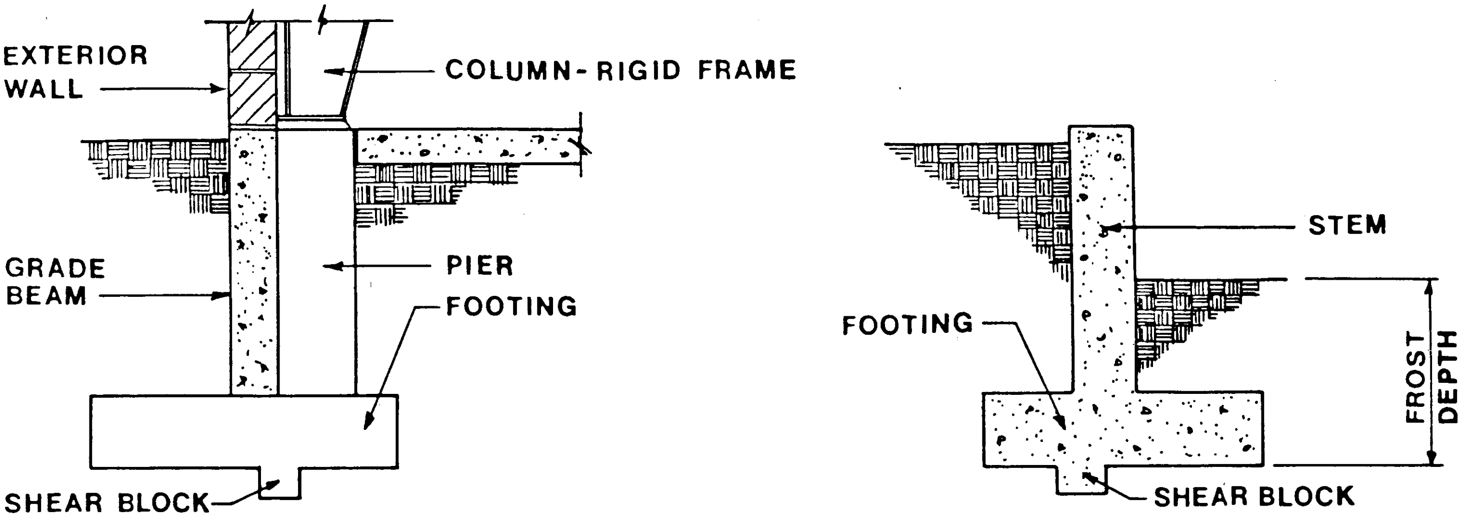
INTERIOR COLUMN ON PILE CAP



MAT OR RAFT FOUNDATION

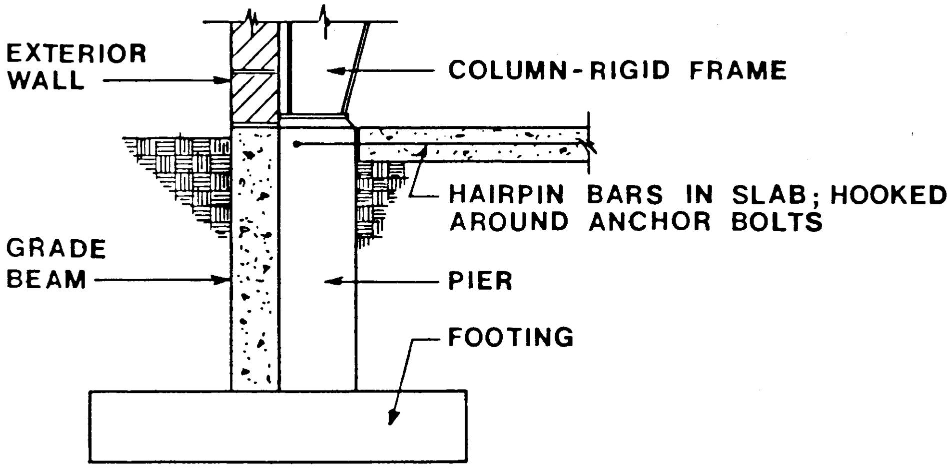
FIGURE 7-2

SOME FOUNDATION SYSTEMS FOR PRIMARILY VERTICAL LOAD



RIGID FRAME COLUMN WITH LARGE HORIZONTAL FORCE

CANTILEVER RETAINING WALL



RIGID FRAME COLUMN WITH LARGE HORIZONTAL FORCE TAKEN BY HAIRPIN BARS

FIGURE 7-3

SOME FOUNDATION SYSTEMS WHICH RESIST HORIZONTAL FORCES

It is possible to have a vertical load (V), a bending moment about each axis of the column (M_x and M_y) and horizontal shearing forces (H_x) and (H_y). Whether or not more than one of these exist in any given column depends on the structural framing and the loads. The foundation system used must be capable of resisting these forces and moments:

(a) without overstressing the soil to create settlement or bearing capacity problems.

(b) without sliding.

(c) without tipping or rotating.

(d) without a structural failure of the foundation element.

Foundation Types

There are four basic types of foundation systems that will be discussed in this manual.

1. Spread footings

2 Mat foundations

3. Drilled piers or caissons

4. Pile foundations

It is essential that the reader be familiar with the behavior of and methods for sizing these various foundations.

1. Spread Footings

Certainly spread footings are the most common and most economical foundation system used. No one would use another type of foundation if spread footings are adequate. The first step in the design of a spread footing is to determine that an adequate soil stratum exists on which the footing may be constructed.

Clearly if the only "reasonable" stratum is 50 feet below ground surface, spread footings are not the answer.

Another factor to consider in the decision on whether spread footings should be used relates to the allowable soil pressure. Generally soil pressures of 2000 pounds per square foot or more are considered adequate. If use of a pressure of 2000 psf results in footings which are 15 feet square it may be more economical to use caissons or piles or to excavate the soft upper materials and replace them with an engineered fill capable of developing a higher soil pressure.

There are other important considerations which must be made in selecting the depth of footing, which do not depend on allowable soil pressures. These include:

(a) Footings should be founded below disturbed ground (frost action, plantings, tree roots, etc.). Frost depth will vary with the location in the country. In the northern-most part of areas like Minnesota and Maine, frost depth is 4'-6" or 5'-0" while in the South frost depth really is not a consideration. In any area of the country, however, there is always some minimum depth to which soils have been disturbed by frost, vegetation or construction activity and footings should always be founded below such depths.

(b) Footings should be located below depths of excavation of adjacent structures (See Figure 7-4).

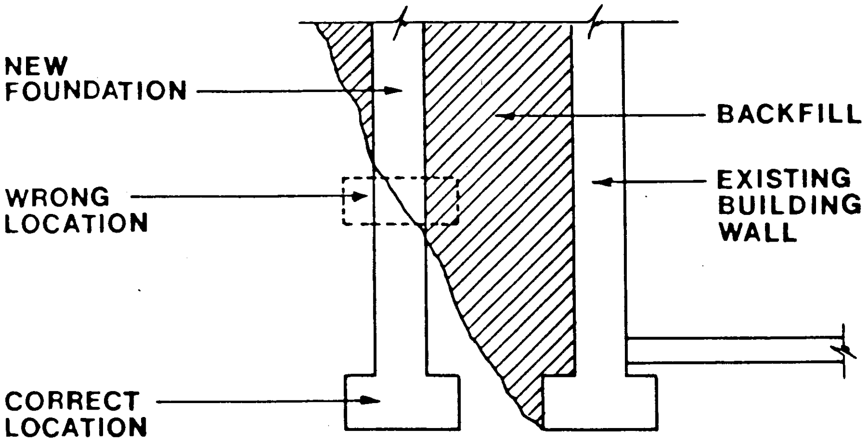


FIGURE 7-4
FOOTING DEPTH CONSIDERATION

(c) Footings should be located below organic soils and top soil.

(d) Footings should be located below sewer pipes, elevator pits, etc., to avoid being founded in backfill as well as to avoid loading these other elements.

Once the footing depth has been selected, the sizing of the footing can be accomplished. This process will now be discussed in terms of various load cases.

Case I - Axial Load Only

The simplest type of spread footing system is one in which only vertical load is present. Such a footing would behave as described in Chapter 2. The soil pressure under the footing is assumed to be uniform. (In reality it is likely to be higher in the center of the footing for granular soils as shown in Figure 7-5, while the reverse is true for cohesive soils as shown in Figure 7-6.

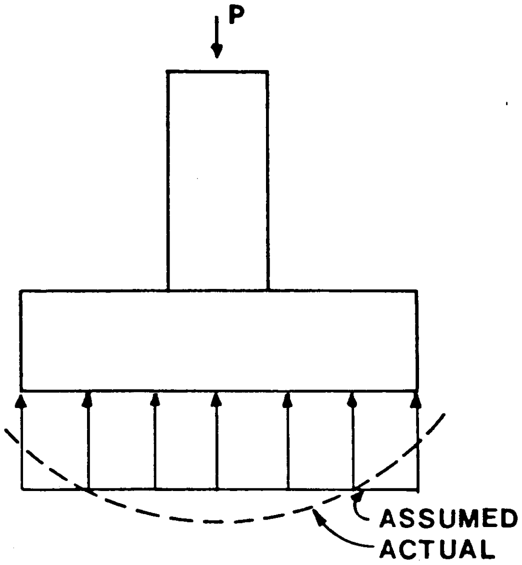


FIGURE 7-5
PRESSURE DISTRIBUTION
GRANULAR SOIL

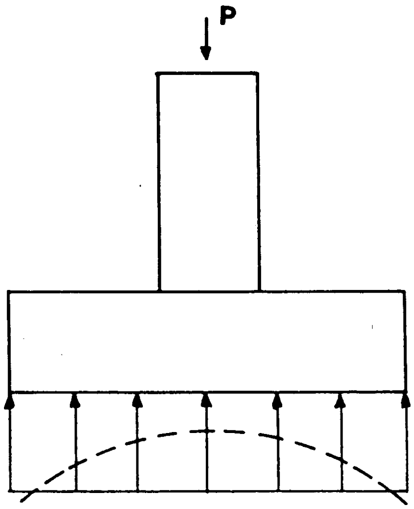


FIGURE 7-6
PRESSURE DISTRIBUTION
COHESIVE SOIL

The procedure for sizing the footing is simply to:

(1) Obtain load to footing (P) (from Structure Analysis)

(2) Obtain allowable soil pressure (P_{allow})

(3) Calculate required footing area (A_f) from:

$$A_f = \frac{P}{P_{allow}} \qquad (7.1)$$

(4) Select footing dimensions to give required area. Normally the footing would be made square unless some limitation exists which would limit the size of the footing in one direction (such as a lot line or a sewer pipe). In this case a rectangular footing would be used.

NOTE: The column must be located in the center of the footing for the above procedure. Otherwise, other provisions must be considered for the eccentric load condition.

Case II - Axial Load Plus Moment

When bending moments exist in columns these moments can (through a proper connection) be transferred into the footings. Moments can exist in two directions simultaneously in many columns (e.g. corner columns), which is the biaxial bending situation.

Moments can also be developed from horizontal forces applied at the top of a pier. The moment due to this force will be equal to (H) x (h). This moment is then added to the moment "M_x" or M_y" from the column to develop a total Moment M.

Thus: $M = M_x$ or $M_y + (H) \times (h)$

For convenience a moment will be shown as M on various figures in this manual. This M could be only a column moment, only the moment from a horizontal force or the combined effects of both sources of moment.

When bending moments are transferred to a footing the soil pressure is not uniform as in the case of a column with axial load only.

Figure 7-7 illustrates the effect of a bending moment on soil pressures. The axial load and moment effects can be treated separately as shown:

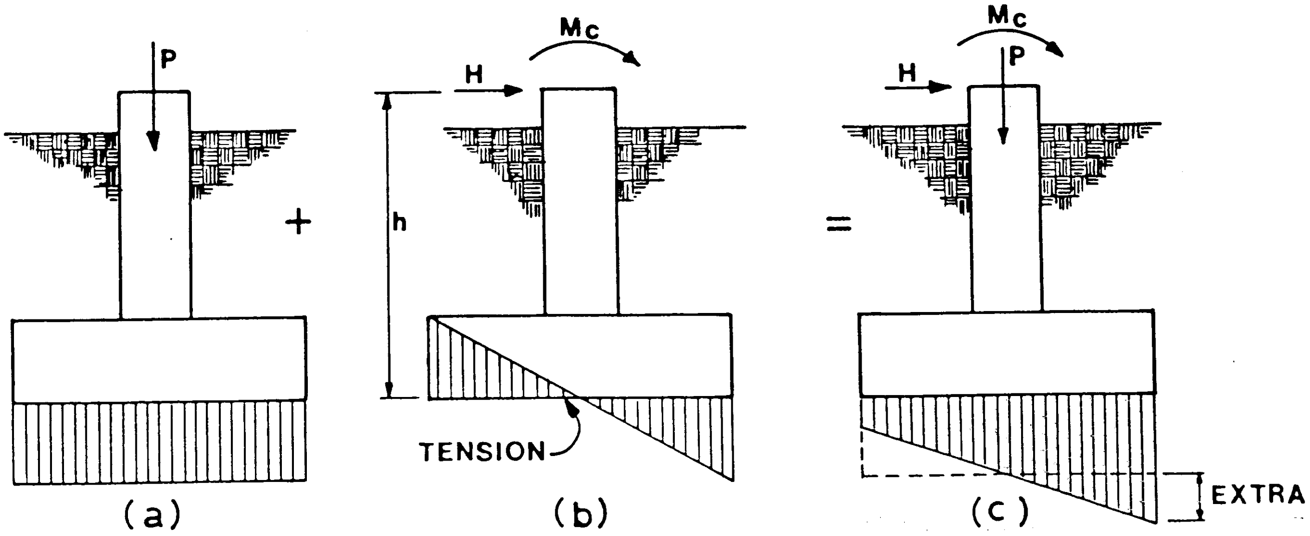
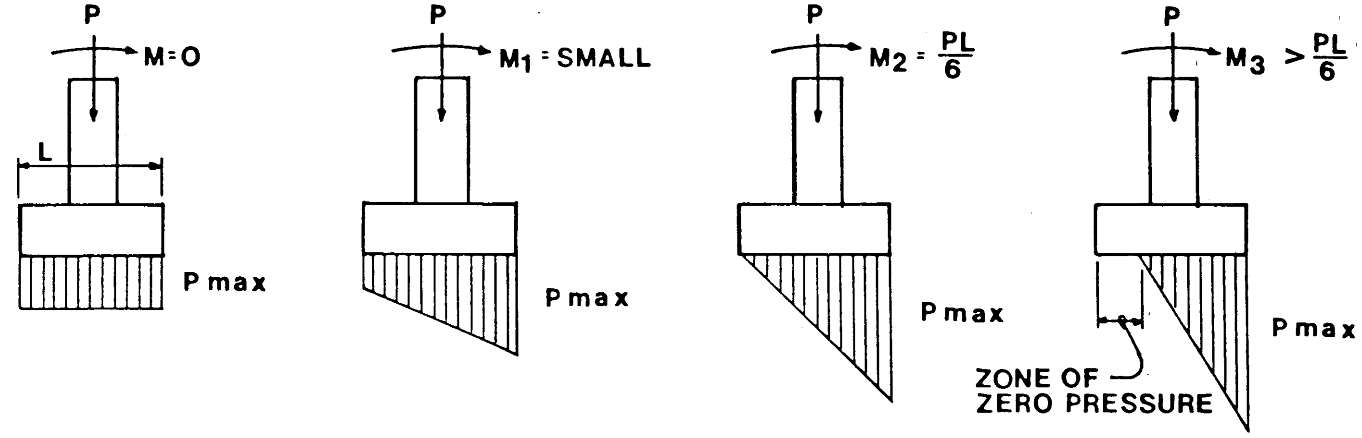


FIGURE 7-7

SPREAD FOOTINGS AXIAL LOAD PLUS MOMENT

It may be noted that the axial load produces the uniform soil pressure (compression) while the bending moment produces a theoretical variable pressure with compression on one side of the footing and tension on the other. The two effects do not act independently and the result is a non-uniform soil pressure. Figure 7-7 shows the "extra" soil pressure which results from the effects of the addition of a column moment to a column axial load. Figure 7-8 illustrates what happens as the moment is increased.



CASE A CASE B CASE C* CASE D*

FIGURE 7-8

(*) Cases C and D are not recommended as a <u>permanent</u> condition. These pressures are acceptable under transient loading conditions such as wind or earthquake.

The maximum soil pressure can be calculated from the following equations:

$$P_{max} = \frac{P}{A}\left(1 + \frac{6e}{L}\right) \qquad \text{Use for Case A, B, C} \qquad (7.2)$$

$$P_{max} = \frac{P}{3A}\left(\frac{4L}{L-2e}\right) \qquad \text{Use for Case D} \qquad (7.3)$$

Where:
M = Total moment (in.-kips)
P = Vertical Load (kips)
A = Area of footing (sq.ft.)
L = Footing dimension in direction of moment (in.)
e = Load eccentricity $= \frac{M}{P}$ (in.)

The concept of "e", the eccentricity of the vertical load, must be described in order to explain the use of the above soil pressure equation. The case of a column with both axial load and moment may be thought of in another way as shown in Figure 7-9.

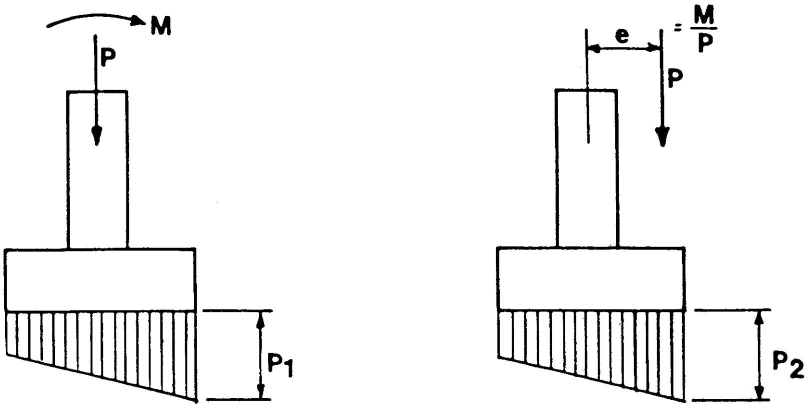


FIGURE 7-9

The condition of a column subjected to axial load plus moment can be thought of as equivalent to a column with an "off-center" or "eccentric" load. If the eccentricity is equal to M/P, the soil pressures will be identical (i.e., $P_1 = P_2$ in Figure 13).

The only difference in selecting the size of a footing subject to an axial load plus bending, from the design for axial load only, is that the effect of "e" must be included. The (4) step procedure presented previously in this chapter is used except that the footing area is selected from the following equations after "e" is calculated from M/P.

$$A_f = \frac{P}{P_{allow}} \left(1 + \frac{6e}{L}\right) \qquad \text{for } e \leq \frac{L}{6} \qquad (7.4)$$

and:

$$A_f = \frac{P}{3\ P_{allow}} \left(\frac{4L}{L - 2e}\right) \qquad \text{for } e > \frac{L}{6} \qquad (7.5)$$

NOTE: The use of equations (7.4) or (7.5) involves a trial and error approach.

A special point that should be mentioned is the value of the allowable soil pressure (P_{allow}) used in the design of footings subject to axial load plus moment. Since the soil pressure under the footing is non-uniform, many engineers will use a slightly higher allowable soil pressure than when axial load exists without moment. The philosophy is that a small region on one side of a footing that has a slightly higher soil pressure should not require a large increase in footing size. Under such a non-uniform soil pressure, if the footing is overloaded to the extent that the pressure gets quite large in a localized area (potentially large enough to develop a localized bearing capacity failure), other less highly stressed areas will have increased pressures and "take up the slack". This approach has been used in developing the tables in this manual.

The previous equations are to be used for bending about one axis of the column. When bending exists about both axes (biaxial bending) a further modification must be made. Fortunately this is quite easy to accomplish except for Case D.

The bending moment about the X-X axis would be M_x (M_y about the y-y axis). This would result in two eccentricities e_x and e_y. The effect of the bending about the second axis is simply added on to the bending about one axis. The equation for A_f would be:

$$A_f = \frac{P}{P_{allow}} \left(1 \pm \frac{6e_x}{Lx} \pm \frac{6e_y}{Ly}\right) \text{ for } e_x < \frac{L_x}{6} \quad (7.6)$$

$$\text{and } e_y < \frac{L_y}{6}$$

The soil pressure variation would be as shown in Figure 7-10.

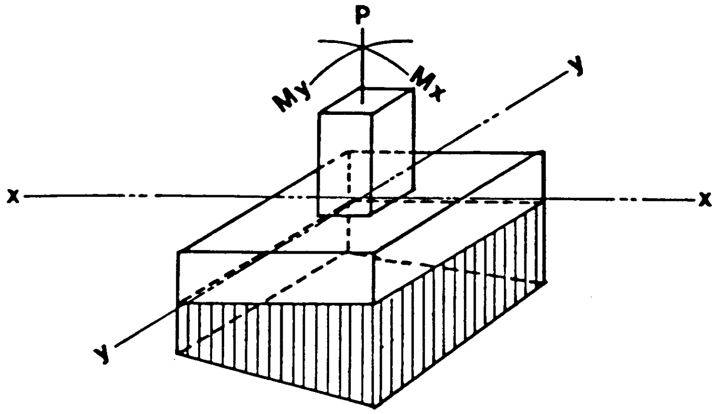


FIGURE 7-10
SOIL PRESSURES - BIAXIAL BENDING

If one or both of the eccentricities for the biaxial bending case are greater than the respective L/6 dimension, the footing will have an area of zero soil pressure. Such a problem is complex, requires a trial and error solution and will not be treated in this manual.

Eccentrically Constructed Footings

There is one class of footing that has not previously been described and is encountered quite often in BUTLER building structures. This is referred to as an "eccentrically constructed footing". We have already examined the case where a footing is subjected to a moment (from the column) and a resulting non-uniform soil pressure exists. This was depicted as shown below in Figure 7-11 (a) and (b). Figure 7-11 (c) shows an eccentrically constructed footing. This is a footing in which the column or pier is built "off-center". There are a number of reasons why this might be done. Certainly one should try to construct the footing in such a way that a uniform soil pressure results but there are times when this is not possible. For example, a property line, existing sewer or water pipe or existing building may preclude placing the column in the middle of the footing. The designer may be "forced" to construct the footing with an eccentrically applied load. It should be emphasized that it does not matter whether an eccentricity exists because of moment from a column or because the column is located eccentrically.

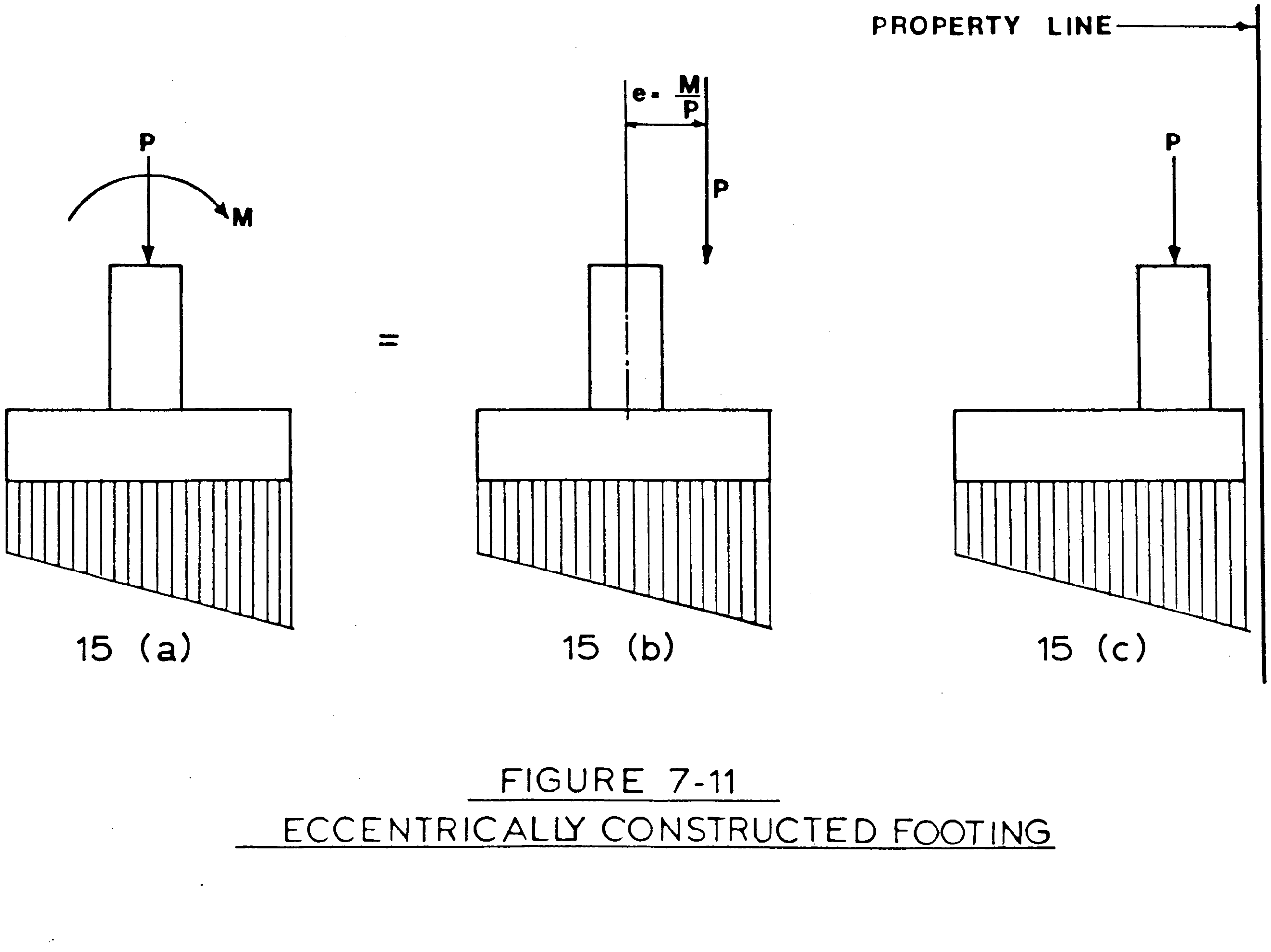


FIGURE 7-11
ECCENTRICALLY CONSTRUCTED FOOTING

There is an interesting design possibility relative to eccentrically loaded footings. If a column is subject to a moment (M) which is not reversible (e.g. the moment always acts clockwise) a uniform soil pressure can be achieved if the column is placed eccentrically on the footing by a distance equal to M/P. See (Figure 7-12). This procedure may be the most economical solution when horizontal column thrusts cannot be removed by tension ties or "hairpin" rods.

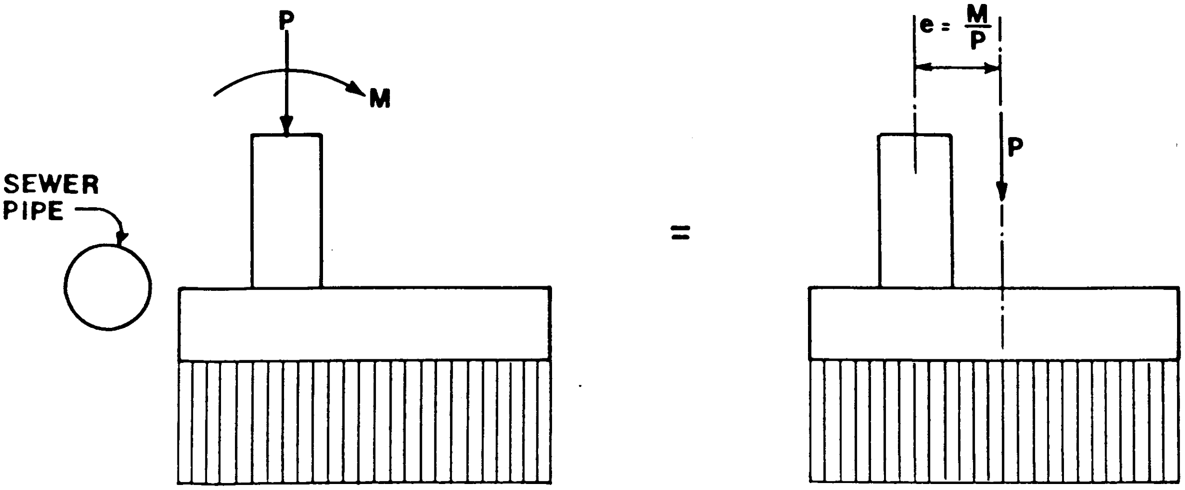


FIGURE 7-12
ECCENTRICALLY LOADED-ECCENTRICALLY CONSTRUCTED FOOTING

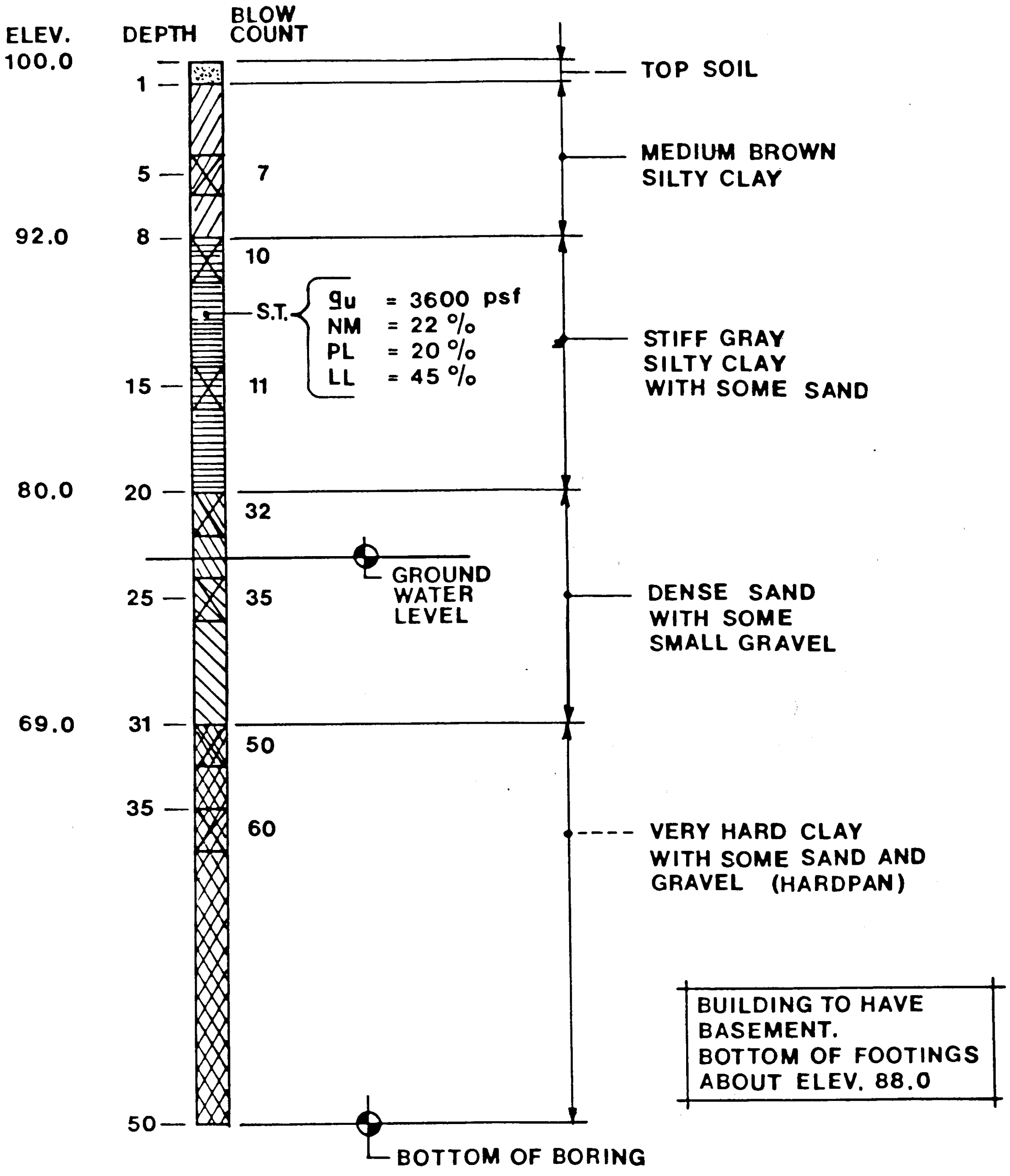
Example

Select the size footing for the following conditions:

Column Load = 20^k

Bending Moment (x-x axis) = $1000^{"-k}$

Pertinent Soil Data shown on next page



PERTINANT SOIL DATA FOR EXAMPLE

(1) Determine allowable soil pressure

Footings will be founded in the STIFF GRAY CLAY at about Elev. 88.0.

(a) From Blow Count

$N = 10$

From Table 3-1 (Chapter 3)

$P_{allow} = 3000$ psf (By linear interpolation)

(b) From Lab Data

$q_u = 3600$ psf

$P_{allow} = 3600$ psf (Chapter 4)

Use: $P_{allow} = 3000$ psf

$P_{allow} = 3000(1.25)^* = 3750$ psf

(The larger value may be used since Table 3-1 is conservative and the Lab Data is more reliable. Also the moisture content is about at the plastic limit. This means little or no settlement. Also the sand stratum below has provided an excellent drainage layer for the clay. Settlement should be minimal. Also the fact that it is a silty clay with traces of sand indicates glacial activity and pre-consolidation. The 3000 psf value is used in this example for ease of comparison with the load tables. Judgements as to use of the higher value are best left to a qualified soils engineer.)

(2) Determine Footing Size

Estimate the footing weight

Try: 8'-0" x 5'-0" x 1'-6"

Weight = 9000 lbs. Total Axial Load = 29,000 lbs.

$e = \frac{M}{P} = \frac{1000}{29} = 34.5$ in. $= 2.87$ ft.

Assume $e > \frac{L}{6}$ (use Eq. (7.5))

(*) Allowable increase when temporary non-uniform soil pressure exists.

Using L = 8'-0":

$$A_f = \frac{29}{3(3.75)} \left(\frac{4(8)}{8-2(2.87)}\right) = 36.5 \text{ sq.ft.}$$

Width = 36.5 ÷ 8 = 4.56 say 5'-0"

Use: <u>8'-0" x 5'-0"</u> This is the same as the assumed size.

If no moment exists (or if moments were incorrectly ignored) the footing area would be:

$$A_f = \frac{29}{3} = 9.66 \text{ sq.ft.}$$

requiring a footing 3'-6" x 3'-6" in size. Use of such a footing would certainly result in a failure of some type if the 1000$''^{-k}$ moment actually existed.

Footings Subjected to Uplift

There is a special class of problem wherein the structural configuration in a building is such that some of the columns under certain loading conditions are actually subjected to an upward load. In such cases it is necessary to "hold down" the column. This can be accomplished in several ways.

1. If the uplift is small it may only be necessary to anchor the column into a footing which is heavier than the anticipated uplift. A minimum factor of safety of 1.5 is recommended if the uplift force is due to a wind.

2. If the uplift is much larger than the weight of a "reasonable" footing (say 10^k) an alternate approach is used. In order for a footing to be "lifted up", the soil on top of the footing must also be raised. Therefore, by lowering the footing a sufficient amount, a substantial increase in uplift resistance is developed.

Figure 7-13 illustrates the behavior of a footing subjected to an uplift load.

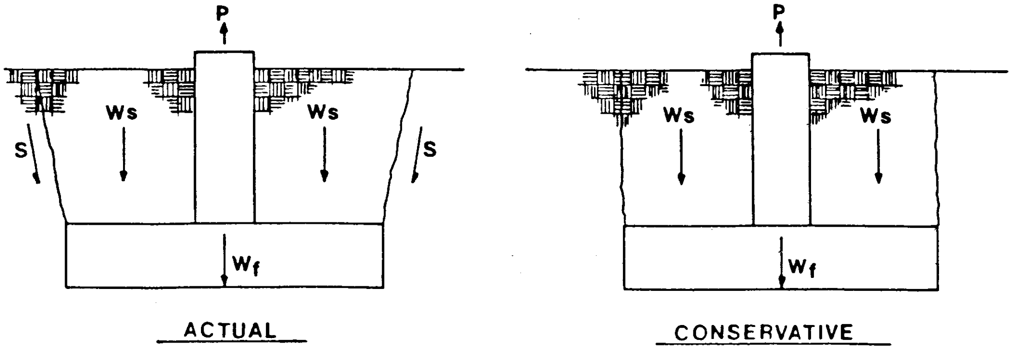


FIGURE 7-13
FOOTING SUBJECT TO UPLIFT

The actual resistance to uplift comes from three sources. In order to move up, the columns must:

1. Lift the footing weight (W_f)
2. Lift the soil above the footing (W_s)
3. Shear the soil around the perimeter of the soil volume actually raised. The shearing resistance is a function of the depth of the footing and the type of soil.

A conservative approach which is often used by engineers is to ignore the shearing resistance of the soil and to ignore the fact that the failure plane will be inclined from the vertical. Figure 7-13 illustrates the actual and conservative approaches for this design problem. Since in the development of this manual it was not possible to establish a specific depth of a footing, the footing tables for the zero moment case were developed such that uplift forces will be resisted only by the footing weight. It will generally be economical in actual design conditions to drop the footing a sufficient distance such that the weight of soil on top of the footing can be used in resisting uplift. Thus P_{max} (uplift) should not exceed 2/3 (W_f) to provide a factor of safety against uplift of 1.5.

Overturning

A common condition in the foundations encountered in Butler building structures occurs when a large moment is applied to a footing which has a small (or even upward) axial load. It is entirely possible that an improperly designed footing could "tip over" under such a loading. The mechanism of overturning is illustrated in Figure 7-14.

There are two ways in which a footing can be designed to resist the tendency to tip (including a proper factor of safety). One is to simply make the footing heavy enough so that tipping cannot occur.

Another method, which will result in smaller footings, is to include the weight of soil and/or floor slab construction above the footing. Clearly, a footing will be much more difficult to tip if there is four or five feet of soil on top of it. Unfortunately, the designer cannot always be sure that the anticipated overburden will actually be there. It has been the experience of the authors in a number of buildings that the entire structure (roof, walls, etc.) was completed yet the backfilling had not been accomplished. (In one case, a plumber's strike precluded all underground plumbing installations.)

Rather than require large increases in footing thickness to insure stability when there "may" be several feet of earth above a footing, the tables in this manual have been developed without including extra footing weight for stability. In all cases wherein a proper factor of safety against overturning does not exist, a value is listed in the tables in the column labeled "Overburden". This is the weight in kips per square foot which is required (in addition to footing weight) to prevent overturning. The "overburden" can be soil, floor slab, extra footing concrete or any combination thereof.

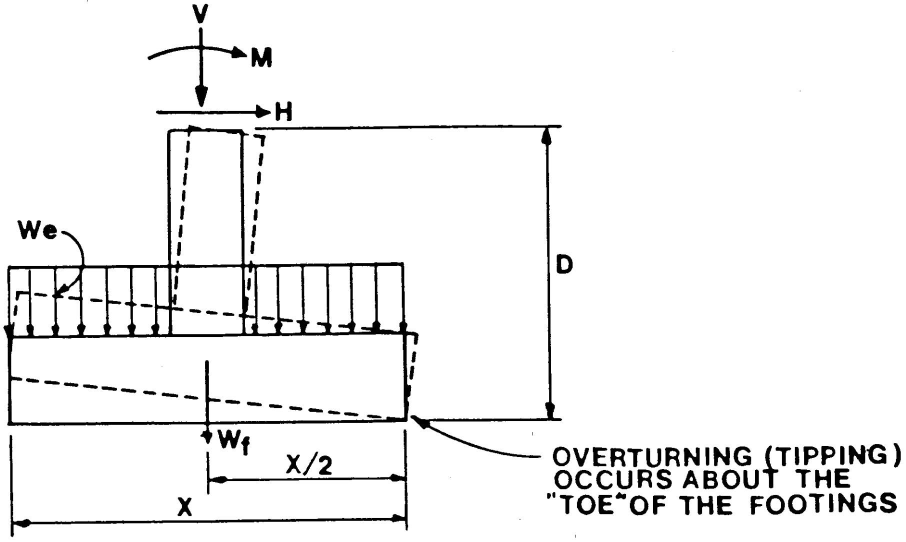


FIGURE 7-14

For hand calculations the equation which may be used to calculate the required "overburden" is:

$$W_e = \frac{1}{(X)(Y)} \left[\frac{4\ M_o}{X} - 4.05\ V_c - V \right] \qquad (7.7)$$

where:
W_e = Overburden (ksf)
X,Y = Footing dimensions (feet)
M_o = Overturning Moment (M + H x D) (ft.-kips)
V_c = Volume of Concrete in Footing (cu.yds.)
V = Vertical Column Load (kips) (+ is down)

Inherent in this equation is a factor of safety of 2.0.

It is important to point out that when overburden is included in calculations, the weight of soil (surcharge) at the level of the base of the footing may be deducted from the total bearing pressure for comparison with allowable bearing pressure. Allowable bearing values are based on the net pressure applied by the footing in addition to the pressure already existing at that depth due to the weight of earth.

2. Mat or Raft Foundations

Occasionally when soils are of low bearing capacity and extend to great depths it is neither practical nor economical to use either caissons or piles. In such cases a raft foundation may be feasible. A raft foundation is simply a large concrete slab which supports several building columns. In most structures all columns and walls in a building would be supported on a single mat. A special case of a raft supporting only two columns is called a combined footing. The raft (and combined footing) will generally have very low soil pressures. A raft may also be used when individual spread footings get so large that they "almost touch".

When a building has a basement and a raft foundation another special condition may exist. This is referred to as a "floating foundation". This term is used for the following reasons. A building which has a basement will have had ten or more feet of excavation. This ten feet of soil could weigh 1000-1300 pounds per square foot. If a building is placed on a mat, the soil pressures from the mat can be as much as 1000-1300 pounds per square foot and the soil will have no more pressure than it did prior to the excavation. It is thus possible, with several levels below grade, to excavate soil which will exactly equal the weight of the building placed on the site. The building literally "floats" on the soil. (Of course, the soil can withstand extra pressure due to its own shear strength.) The reader will recall from Chapter 2 that the "allowable soil pressure" given by the equations are net pressures over and above the weight of the soil overburden.

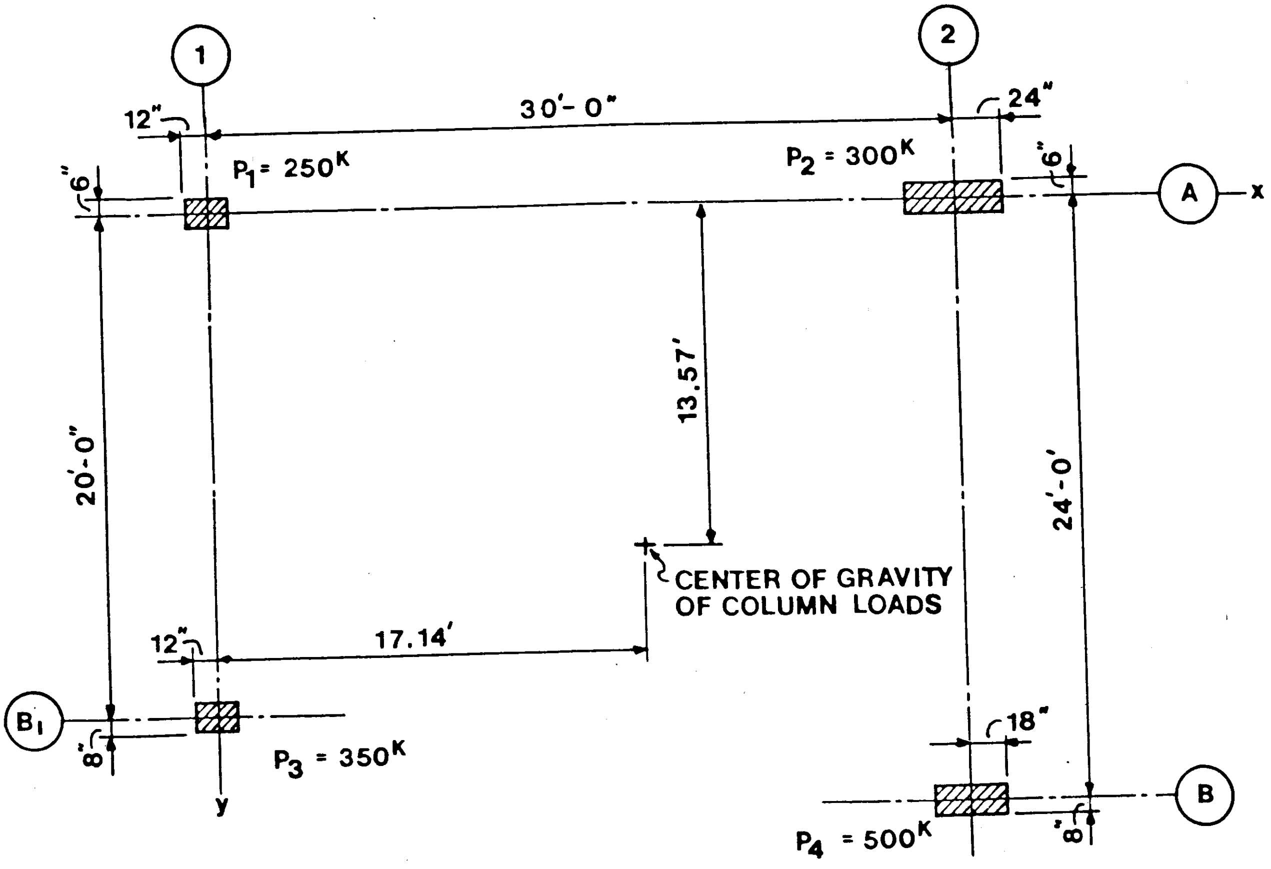
A mat foundation may be thought of as a large spread footing. The required size of the mat (area) is determined by adding all column loads and dividing by the net allowable soil pressure. Normally, the general intent of the design is to develop a uniform soil pressure under the mat. This is accomplished by the following simple procedure:

(1) Find the location of the center of gravity of all column loads.

(2) Position the mat in such a way so as to locate the center of gravity of the mat coincidental with the center of gravity of the column loads.

The soil pressure under the mat will be uniform.

Example - Mat Foundation - Allowable Soil Pressure = 1500 psf.



Find Center of Gravity of Column Loads

Sum of Moments about line ①

M ① = 300(30) + 500(30) = 9000 + 15000 = 24000

$$\bar{X} = \frac{24000}{300+500+250+350} = \frac{24000}{1400} = 17.14 \text{ feet from } ①$$

Sum of Moments about line Ⓐ

M Ⓐ = 350(20) + 500(24) = 7000 + 12000 = 19000

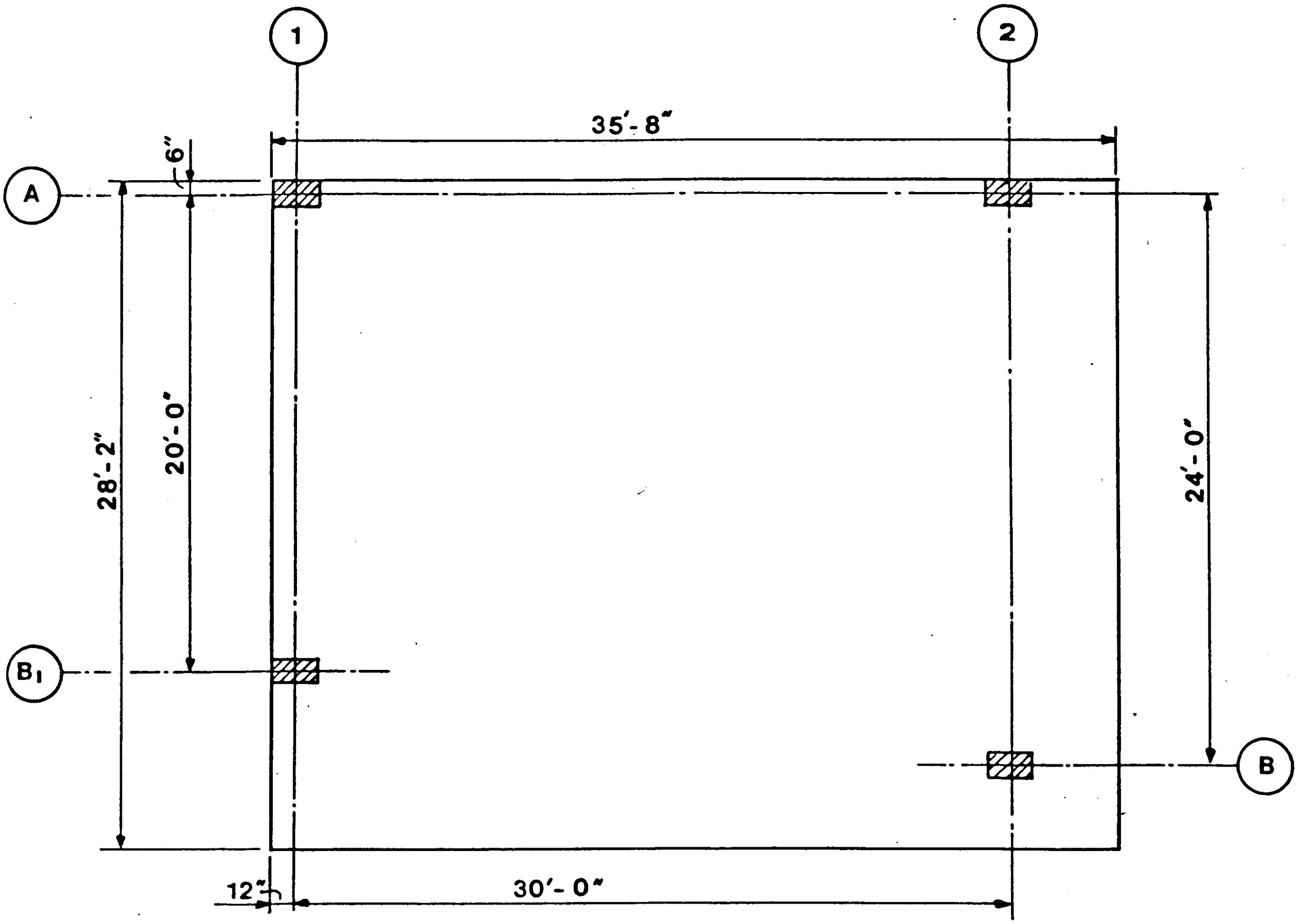
$$\bar{Y} = \frac{19000}{1400} = 13.57 \text{ feet from } Ⓐ$$

Find Area of Mat based on Soil Pressure

$$A_{mat} = \frac{1,400,000 \text{ lb.}}{1500 \text{ psf}} = 933 \text{ square feet}$$

A_{mat} (to support columns) = 30 x 24 = 720 square feet.
Thus the mat must have 933 sq.ft.

The other consideration is that the centroid of the mat be located at the centroid of the column loads. The mat must thus be at least 2 x (17.14 + .67) or 35.66 feet in the (X) direction and 2 x (13.57 + .50) or 28.14 feet in the (Y) direction. This would provide an area of 1003.47sq.ft. which is more than is necessary to keep the soil pressure below 1500 psf. The final mat configuration is shown in the Figure below.



MAT CONFIGURATION

3. Drilled Piers or Caissons (SEE PAGE 136 FOR EXAMPLE)

A drilled pier or caisson may be looked on as a spread footing placed deep underground. These caissons are constructed using augers which can drill holes to six or more feet in diameter and with bottom bells widened to 15 feet diameter. (Not all contractors can construct the large sizes. A check should be made locally to determine equipment available.) The holes are filled with concrete (and some reinforcing).

Caissons are used when upper soil strata are soft and/or highly compressible (or organic) and are too thick to justify removal and replacement with compacted fill. Also there are times when column loads are so large that a "relatively good" upper level soil (P_{allow} = 3000-4000 psf) will necessitate such large spread footings (20'-0" x 20'-0" or more), that it will often be more economical to use a caisson which extends to a deeper, higher quality stratum. Decisions to use caissons, based on the economics of foundation construction, should be made only by an experienced foundation engineer.

Caissons are ideally suited for use in cohesive soils. Such soils will "stand" vertically, enabling the caisson rig to rapidly drill and bell. In sandy soils the holes will tend to collapse. In order to prevent such collapse, the holes must be "cased" with a liner pipe or casing. This process works but is costly and has one serious drawback. The liners are generally too costly to be left in place and they are withdrawn as concrete is being placed. If the liner is withdrawn too rapidly there is a chance that the soils will collapse into the hole resulting in a caisson with soil pockets (or worse a caisson with several feet of soil where concrete should be.) Such problems have happened in a number of major buildings in this country. Careful field inspection is required to insure that this does not occur.

Caissons have high bearing capacity. Figure 2-2 (Chapter 2) illustrates the tremendous benefit a foundation receives from being placed deep in the ground. The bearing capacity is large due to the depth or "surcharge effect". In Chapter 4 the relations for ultimate bearing capacity of clay soils were described. For normal depth footings the bearing capacity factor (N_c) was given as 6.0 and the allowable soil pressure resulted in being equal to q_u. For deep* foundations this bearing capacity factor increases from 6.0 to 9.0. and the allowable soil pressure takes corresponding increase. Therefore, for deep caissons founded on clay:

$$P_{allow} = 1.5\ q_u \tag{7.8}$$

In some soils it is not possible to bell the caisson bottom. A belled caisson is looked upon by most building officials as simply a deep footing. This will be true as long as the caisson bearing capacity is derived from the underlying soils. A "straight shaft caisson" without a bell will often have substantial load carrying capacity due to friction along the shaft. In this instance the caisson is behaving more like a cast-in-place concrete friction pile. Building officials may require load tests for such cases. The authors have designed several projects with friction caissons one of which was load tested in order to gain building code approval.

Caissons can be founded in sands as well as clays. The equations given in Chapter 3 may be used to establish the allowable soil pressure. One major problem which occurs with caissons founded in sand is the presence of ground water. In clay soils there is relatively little water due to the impermeability of the clay. In free draining sands, water will readily fill the caisson hole, making drilling and placing concrete difficult. If a liner is used and the water table outside the liner is high, there are two other potential problems. One is the collapse of the liner. This has happened on at least one major project and received widespread publicity. The second is the danger of a "blowout". This happens when the soil at the bottom of the liner is blown out (up) from the water pressure below.

(*) For purposes of this manual a "deep" caisson is defined as having a depth equal to 2.0 or more times the bell diameter.

In summary, caissons are designed similar to spread footings, have high bearing capacity due to depth effects and have a number of potential construction problems. It is the feeling of the authors that caissons are an economical and desirable foundation system requiring, however, careful field inspection.

Laterally Loaded Caissons

There is one special use of caissons which may occur with certain types of BUTLER building structures in which the caisson is subjected to a substantial lateral (horizontal) load. This may be combined with moments and vertical loads. This use of a caisson warrants a separate discussion. Figure 7-15 depicts this situation.

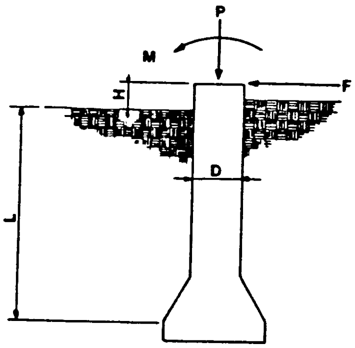


FIGURE 7-15
LATERALLY LOADED CAISSON

The design problem is to select a caisson diamer (D) and an embedment length (L) which are of adequate size such that the caisson does not move horizontally. Obviously the soil pressure against the side of the caisson shaft is of paramount importance. This pressure is the "passive pressure" a soil develops to resist being moved by an object pushing into the soil. Following is an approximate procedure which may be used to design such a laterally loaded caisson. (See Figure 7-15 for definitions of terms.)

(1) Use Table 7-1 to establish soil properties. Based on a knowledge of soil type and blow count, the passive pressure (P_p) and coefficient of subgrade reaction (K) may be established.

Table 7-1 - Soil Properties for Laterally Loaded Caissons

Soil	Description	N,**Blows/ft.	P_p*, ksf	K*,kcf
Clay	Very Soft	<2	<0.3	<15
Clay	Soft	2-4	0.3-0.6	15-30
Clay	Medium	4-8	0.6-1.2	30-60
Clay	Stiff	8-15	1.2-2.4	60-120
Clay	Very Stiff	15-30	2.4-4.8	120-240
Clay	Hard	>30	>4.8	>240
Sand	Very Loose	<5	<0.6	<10
Sand	Loose	5-10	0.6-1.2	10-20
Sand	Medium	10-30	1.2-2.4	20-60
Sand	Dense	30-50	2.4-4.8	60-120
Sand	Very Dense	>50	>4.8	>120

(*) Use 60% of these values if ground water above bottom of pier.
(**) N = Number of blows per foot using standard split spoon sampler.

(2) Assume a caisson diameter (D). (feet)

(3) Solve equation 7.9 for L. This is a quadratic equation which may be solved using the quadratic formula or trial and error. (L is in feet)

(4) Solve equation 7.10 for Δ (the lateral movement of the caisson at the ground line). This should be limited to 0.25" for important structures and 0.50 for less important structures. (Δ is in inches).*

(5) Once you are satisfied with L, D and Δ the caisson reinforcement may be selected. The caisson is a vertical cantilever beam subjected to the total moment $M = M_e + F \times H$. If L is too long or Δ is too large, a larger K must be used and the design process repeated.

$$P_p DL^2 - 2.13FL - 3.2 (F \times H + M_e) = 0 \qquad (7.9)^{**}$$

$$\Delta = \frac{216F}{KDL^2} \left[\frac{1.33H}{L} + 1 \right] \qquad (7.10)^{**}$$

Example

Given: $M = 78.0^{ft.-k} = (F \times H + M_e)$

$F = 4^k$

$H = 7.0$ ft.

$M_e = 50^{ft.-k}$

N = 8 blows

Soil = Medium Clay

Use: $P_p = 1.2$ kcf

K = 60 ksf

Try: D = 2'-0"

(*) The authors of this manual cannot take responsibility relative to the permissible amount of horizontal movement which a given building can tolerate. The values listed are general and may be too large for some conditions.

(**) The equations 7.9 and 7.10 are developed with appropriate numerical coefficients to give a solution for Δ in inches while all other units are feet and kips.

From Eq. 7.9

$$1.2(2)\ (L^2) - 2.13\ (4)\ (L) - 3.2(78) = 0$$

$$L = 12.1 \text{ feet}$$

From Eq. 7.10

$$\Delta = \frac{216(4)}{60(2)(12)^2} \left[\frac{1.33(7)}{12} + 1\right]$$

Δ = .089 inches (OK for most structures)

4. Pile Foundations

Piles are commonly used when spread footings and caissons are either inappropriate or more expensive. Piles are considered as a foundation system when the soils, in which normal spread footings would be placed, are too soft or too compressible to support the footings. There is no simple rule which can be stated relative to the economy of piles versus caissons. In many instances, bids are taken on both systems. This is particularly true when use of caissons would require casing, adding to the expense of that system.

There are several different types of piles in common use. These include:

Timber
Steel H Piles
Steel pipe filled with concrete
Cast-in-place concrete
Precast concrete

Each of these types have specific application in a wide variety of uses. Timber piles are the most common and generally the least expensive. They do, however, have limited load capacity and life. Recent studies have shown that old timber piles in certain areas of the country are showing signs of rotting. Of particular importance are areas of varying water table level and pollution of the ground water. When higher loads are required, several other types are suitable. The specific choice will depend upon soil conditions, economics and availability. Another study of the National Bureau of Standards shows that Steel H Piles suffered no corrosion after many years, except in corrosive soils.

Piles are classified not only by the materials of which they are made but also by the method in which they develop load-carrying capability. Piles are classified as end bearing or friction piles. End bearing piles are those that are driven through soft materials and develop load capacity by bearing on a hard, dense stratum or by a short penetration into such a stratum. Friction piles develop their load capacity by friction with the soil, developed along the length of the pile. The frictional resistance, in large measure, comes from the displacement of the soil as the pile is driven. This displacement is accompanied by increased densification of the soil around the pile. In reality, most piles develop their capacity by a combination of both friction and end bearing.

This manual does not present a comprehensive explanation of pile behavior. There are, however, certain basic considerations relative to pile foundations, that are important to all engineers and contractors.

(1) Piles are commonly designated as 20 Ton, 30 Ton, etc. This capacity is rated by the lower of two values.

  (a) The structural capacity of the pile material (e.g. wood, steel, etc.). Determining the structural capacity of a pile based on the structural limitation of the pile itself may be easily accomplished by use of available tables (e.g. Ref. 1).

  (b) The capacity of the driven pile as limited by the soil strength. This limitation relates to the combination of end bearing and friction between soil and pile. Determining the capacity of a pile as limited by the soil is not a simple nor accurate procedure. Most soil engineers do have methods available to make calculations for pile capacity based on soil properties obtained from borings and lab tests. Most engineers recognize the limits of such a theoretical estimate.

(2) One method in common use for determining pile capacity is the use of one of the pile driving formulae. The basis for this method is that a given pile hammer driving piles of constant size and length into the same soil will require the same energy to accomplish the driving. The number of blows of the hammer required to drive the pile the last 12 inches is recorded. Most pile driving formulae predict pile capacity on the basis of penetration and pile hammer energy characteristics. The most widely used of these formulae is the oldest. It is the Engineering-News Formula (often incorrectly called the Engineering News-Record Formula). Tests conducted by the Michigan Highway Department in which many pile driving formulae were studied and compared with the results of load tests on the piles, showed that the factor proposed by the Michigan Highway Department is the preferred pile driving formula. It is essential to emphasize that the pile driving formula is at best an approximate method. It can be used effectively in conjunction with load tests. If pile capacity is based only on the pile driving formula any design should be extremely conservative and used for low rise, lightly loaded structures.

(3) A Pile Load Test is the most accurate commonly used method for establishing the load carrying capacity of a single pile. There is a standard accepted procedure for load testing a pile. It generally involves loading the pile by jacking against a heavy dead weight on a platform above the pile. The load is maintained for a period of time during which the settlement is measured. The load is then removed and the "rebound" of the pile is noted. A satisfactory pile test is one in which the pile satisfactorily carries the test load without exceeding settlement and rebound limits. Most codes require load tests which conform to ASTM Procedures (Designation D1194).

It is essential to recognize a major factor relative to the value of the pile load test. This factor is what is called "group effect". Piles are almost never used singly but rather in groups. Unfortunately the capacity of a group of piles, for example six piles, is not equal to six times the capacity of one pile. The driving of a pile affects the soil around a previously driven pile and therefore affects its capacity. Therefore, there is some limit on the value of a load test of a single pile. Unfortunately it is too expensive and impractical to attempt to load test a group of piles. The magnitude of loads required in the test is tremendous.

The design of a pile cap is accomplished in the same general manner as spread footing. Pile caps can also be subject to moments and shears. For the "axial-load-only" case there are a number of handbooks available for pile cap design. Determination of the number of piles is made by simply dividing the column load by the capacity of one pile.

$$N = \frac{P}{P_C} \tag{7.11}$$

N = Number of piles required

P = Column Load

P_C = Capacity of one pile

A commonly used handbook for design of pile caps <u>subjected to axial loads</u> is the CRSI Design Handbook. The handbook gives complete designs for various column loads and pile capacities. This includes complete reinforcing requirements.

For cases in which columns have a large base moment which is transferred into the foundation the condition may be considered similar to an eccentrically loaded spread footing. Figure 7-16 illustrates the basic similarity between the two cases.

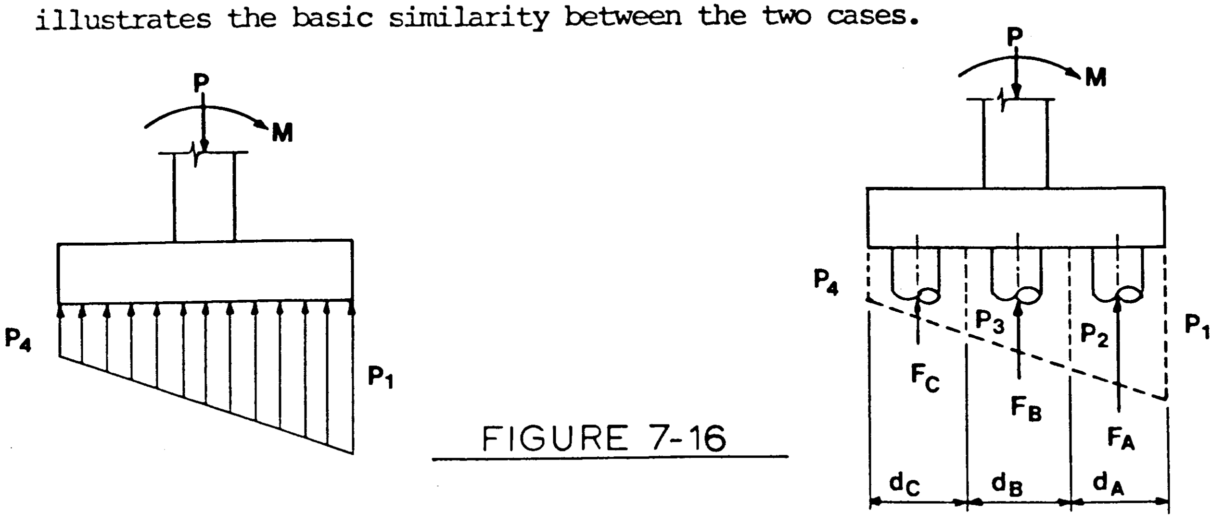


FIGURE 7-16

The "fictitious" soil pressures can be computed as described previously in this chapter. The force in any pile may be computed as follows:

For piles spaced (into the paper) at a spacing "S":

$$F_A = \frac{P_1 + P_2}{2} \quad (S) \quad (d_A) \qquad (7.12)$$

$$F_B = \frac{P_2 + P_3}{2} \quad (S) \quad (d_B) \qquad (7.13)$$

$$F_C = \frac{P_3 + P_4}{2} \quad (S) \quad (d_C) \qquad (7.14)$$

For piles subjected to very large moments, it may be desirable to space the piles more closely in the rows subjected to higher "fictitious" soil pressures in order to have all piles carry the same load. It is important to note that moments are often reversible and it may be necessary to use the closer spacing of piles on both outside rows to provide sufficient capacity.

SYSTEMS SUPPORTING SIGNIFICANT HORIZONTAL FORCES

Horizontal Resistance

In addition to the previously described aspects for selecting the size of a footing so as not to overstress the soil in vertical bearing, there is another consideration which may affect the size of a footing. In certain columns, particularly in rigid frame buildings, there will exist a substantial horizontal force, usually directed outward and tending to cause sliding as well as overturning. This force can be resisted by use of one of the following methods:

1. Tension Ties
2. "Hairpin" Rods
3. Horizontal Soil Resistance

1. Tension Ties - A rod may be connected from a column (or pier) to the column (or pier) on the opposite side of the building, thus balancing the horizontal forces. (See Figure 7-17). The size of the required tension rod may be easily determined as follows:

$$A_r = \frac{H}{F_t} \qquad (7.13)$$

where:

A_r = Required Cross-sectional area of the rod. (sq.in.)

H = Horizontal Force (lbs.)

F_t = Allowable Stress in rod (p.s.i.)

$= 0.6\ F_y$

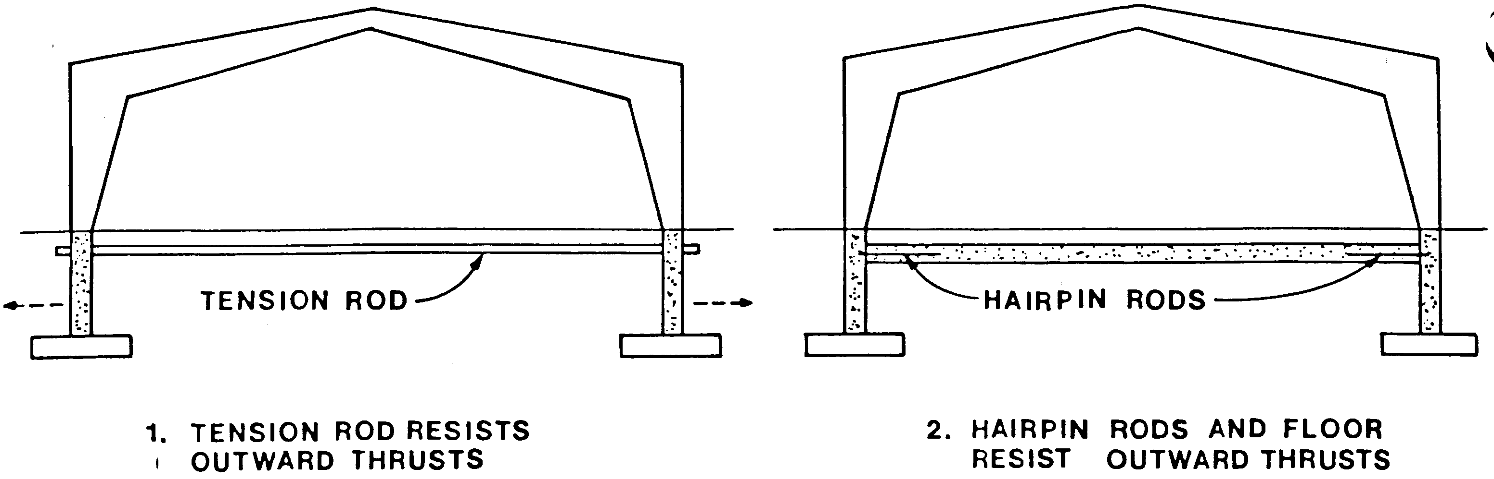


FIGURE 7-17
TENSION TIE RESISTS HORIZONTAL FORCES

2. Hairpin Rods - Another method of resisting horizontal forces involves use of a bent rebar ("hairpin") which is cast into the slab-on-grade. The slab-on-grade, if properly reinforced, can provide the required resistance to the horizontal shear force. The force is transferred from column to tie rod or bent rebar, to the concrete (through bond with the rebar) and finally into the mesh in the slab which acts as the final tensile element. Figure 7-18 illustrates the use of the spread tie for resisting horizontal thrusts. It is, of course, possible to use a combination of "across ties" and "spread ties" to resist the total horizontal thrusts.

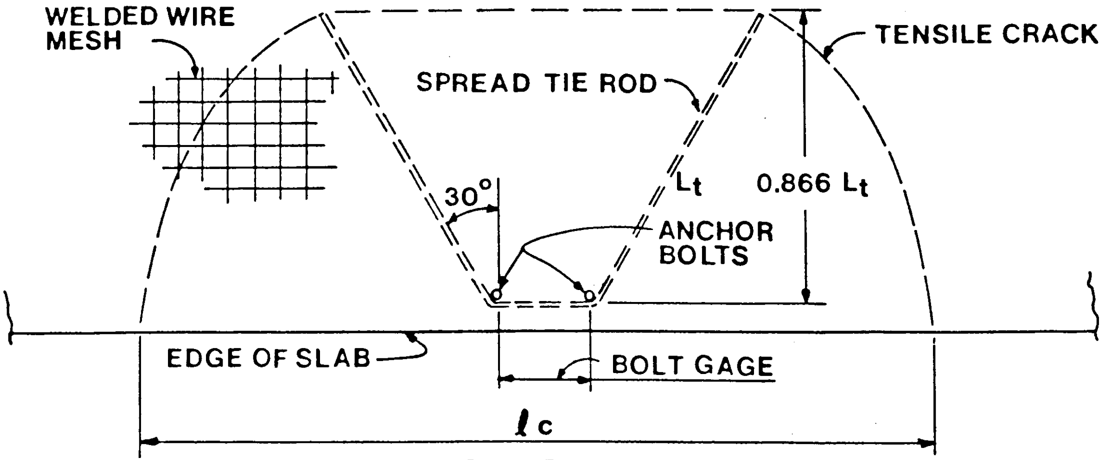


FIGURE 7-18
SPREAD TIE FOR RESISTING HORIZONTAL THRUSTS

To adequately resist the horizontal thrusts, the spread tie rod must extend into the slab a sufficient distance that the length of the "failure tensile crack" will have enough reinforcing mesh crossing it such that a proper factor of safety is developed.

If the angle of the crack from the end of the ties is 45 degrees to the edge of the slab and if the bolt gage is assumed as zero (conservative), then the projected length of the tensile crack is

$$l_c = 2(0.5)\ L_t + 2(.866\ L_t) \qquad (7.15)$$

$$= L_t + 1.732L_t = 2.732\ L_t$$

For 6x6 - 10/10 mesh the steel cross-sectional area is 0.029 in^2/foot. Using an allowable stress of 20000 psi for the mesh, the total tensile force resisting the opening of the "tensile crack" (including a factor of safety) is:

$$F_t = 0.029\ (20000)\ \ (2.732)\ L_t = 1584\ L_t$$

Thus if the horizontal force is 12000#, the required length (L_t) of the spread tie is 12000 / 1584 = 7.57 feet. The following table gives the value of the tensile capacity for various sizes of ties and mesh, using an allowable stress of 20,000 psi.

TABLE 7-2

Spread Tie Size	Max. Capacity (kips)	MIN. LENGTH, L_t (ft.) for VARIOUS SLAB REINF.					
		6x6-10/10	6x6-8/8	6x6-6/6	6x6-4/4	4x4-4/4	#4@12"
#4	6.9^k	4.37'	3.09'	2.19'	1.59'	1.06'	1.00'
#5	10.7^k	6.78'	4.79'	3.39'	2.46'	1.64'	1.25'
#6	15.2^k	---	6.80'	4.81'	3.49'	2.32'	1.60'
#7	20.8^k	---	---	6.56'	4.76'	3.17'	2.19'
#8	27.4^k	---	---	---	6.26'	4.17'	2.88'

In order for the slab to provide adequate horizontal tensile resistance, the slab reinforcement must either be continuous across the building to meet an equal and opposite force applied by an opposing column, or must be continuous over a large enough floor area so that friction of the slab against the subgrade provides sufficient resistance with an adequate factor of safety against sliding. If a vapor barrier is used below the slab, its adverse effect on the coefficient of subgrade friction should be considered. For example, using a coefficient of friction of 0.5 (with no vapor barrier) and a safety factor of 2, the weight of the slab area able to be depended on for resistance should be four times the horizontal force.

3. Horizontal Soil Resistance

In certain structures it may not be feasible to provide these tension ties or hairpin rods. The only means by which the horizontal forces can be resisted to prevent sliding is by either friction between footing and soil, "horizontal passive pressure" or a combination of the two. (Retaining walls must commonly provide resistance to sliding and use this method to do so.) A minimum factor of safety of 2.0* against sliding is recommended. Friction between footing and soil is the most logical method of preventing sliding. The maximum (ultimate) friction force between footing and soil may be calculated from the following equation.

$$F_{max} = \mu N \qquad \text{(Eq. 7.7)}$$

where: F_{max} = Maximum Friction Force (at failure)

N = Total Normal Force
(Column load plus weight of footing which exists under the same conditions causing the horizontal force to be resisted)

μ = coefficient of friction = 0.5
(0.5 is a conservative value for μ)

When the friction force is insufficient to resist the total horizontal force (with a proper factor of safety) it may be necessary to utilize the horizontal passive resistance of the soil against vertical faces of the foundation. If passive pressure against the edge of the footing is inadequate or undependable it may be necessary to add a shear block. A shear block is nothing more than a depression on the bottom of a footing as shown in Figure 7-19.

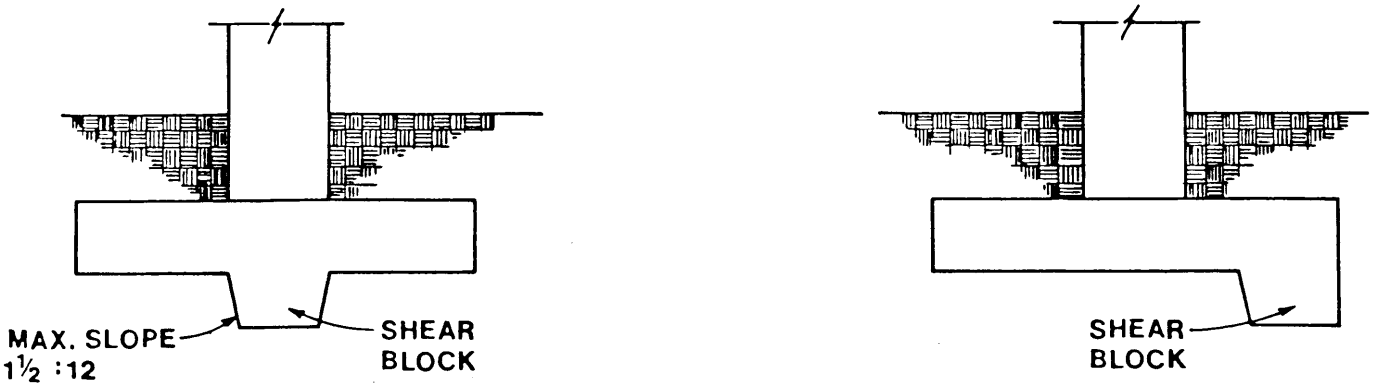


FIGURE 7-19

Concrete surfaces against which passive pressure is to be developed must be placed in undisturbed virgin soil. If the shear block cannot be constructed at the steep 1-1/2:12 slope it is then necessary to deepen the footing to provide the necessary passive pressure.

(*) For wind and/or earthquake the F.S. reduces to 1.5.

Figure 7-20 illustrates the manner in which this passive pressure is developed by a shear block.

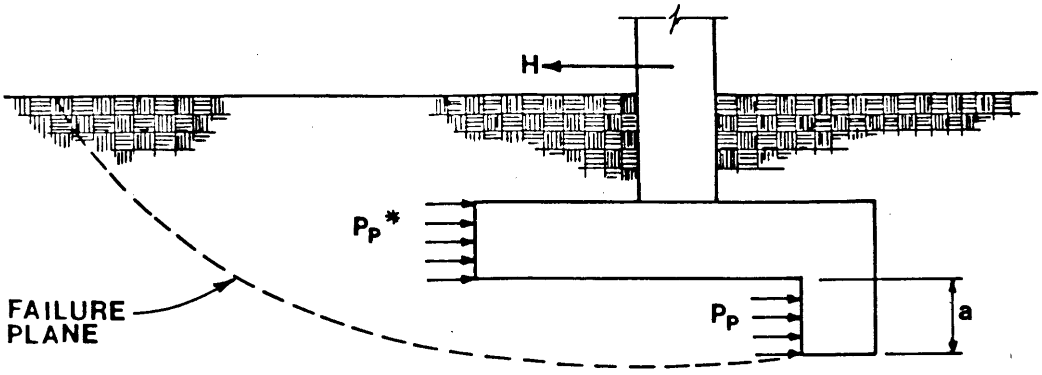


FIGURE 7-20

(*) This passive pressure may be used only when the footing is poured into natural ground without forming.

With the horizontal force directed to the left there is a tendency for the footing to slide in that direction. Passive pressure forces (P_p) resist this movement. In much the same mechanism as occurs in the bearing capacity failure (Chapter 2), the footing with a shear block can slide only when the soil fails along the "failure plane" shown. The amount of resistance which the soil will develop and the exact length and extent of the failure plane will depend on the same soil properties, c, ϕ and density which are found in the bearing capacity equations. Clearly the total resistance which can be developed is also heavily dependent on the depth "a" of the shear block.

The sizing of the shear block is a relatively complex problem involving a knowledge of earth pressure theory and is beyond the scope of this manual. What must be emphasized is that there are times when sliding cannot be resisted by friction alone and passive pressure must be used. An experienced soil engineer should be consulted for the design.

When passive pressure and friction are used in combination to resist horizontal forces, conservative allowable pressures (or slightly higher factors of safety) are suggested.

CONSIDERATIONS IN CHOOSING METHOD FOR RESISTING HORIZONTAL FORCE

Essential features:
- Adequate capacity for safety
- Must be in place by the time loads are applied
- Permanent
- Must not allow excessive movement of the column base

Important factors:
- As economical as possible
- Not an obstacle to changes within the building. (e.g. tie rods cut due to future pits)

The amount of movement which can be tolerated at the base of the column is difficult to evaluate. Standard design calculations for the steel superstructure usually presume zero horizontal movement, and limits are not specified. Since perfect rigidity is impossible, it is fortunate that a small amount of movement can always be allowed. Something of the order of 1/2 inch would seem reasonable. Generally, the larger the horizontal force and the greater the ratio of the horizontal force to the vertical force, the more important it is to consider the amount of movement.

1. Tension Ties

Typically, ties are only effective in tension and to the degree that forces are equal and opposite from both ends. If horizontal thrust can reverse directions or become unbalanced, some other system must be provided for those conditions.

If ties are used, the building owner must be made aware of them and the fact that they are absolutely essential to the safety of the structure. They may constitute an obstacle to future work below floor level, such as installation of pits or trenches. Consideration should be given to their protection against corrosion or damage.

An important disadvantage of the use of tension ties is the detailing problem and cost associated with end-connections and splices. Many types of tie elements have been used or proposed, such as standard rebar, special bars (e.g. "Dywidag thread bar"), threaded round rods, angles, as well as wire rope, cable, or strands. Typically, adequate connections are the biggest problem and cost.

The use of ordinary rebar as cross-ties by anchoring them into the upper part of the pier and splicing by laps encased in concrete is an attractive method because of its simplicity and economy. However, ACI 318-83 could be interpreted as prohibiting splices of this type, because it requires that splices in "tension tie members" be made with full welded splices or full mechanical connections which are staggered and capable of developing 125 percent of the specified yield strength of the bar. Mechanical connections generally are special proprietary sleeve devices and are quite expensive. Welding of ordinary grade 60 rebar is difficult and should be used with caution. Welding should conform to AWS D1.4-79. Unless the actual chemistry of the bars is taken into account, the welding procedures for a carbon equivalent exceeding 0.75 percent should be followed. Consideration should also be given to the possible vulnerability to fatigue or brittle fracture and potential weakening of the heat-affected zone due to welding.

It is the authors' opinion that reliable lap splicing of rebars in tension can be achieved with proper attention to design and construction. Research* has shown that lap splices enclosed in sufficient stirrups to resist longitudinal splitting of concrete along the bars have sufficient strength and ductility even under repeated loading.

(*) "The Behavior of Lapped Splices in Reinforced Concrete Beams Subjected to Repeated Loads", by Fagundo, Gergely and White; Report 79-7, Cornell University Dept. of Structural Engineering, Ithaca, N.Y., December 1979

Although this type of detail is not currently reflected in ACI 318, this should not necessarily preclude its use. First of all, it is debatable whether a section of concrete used to encase steel ties constitutes a "reinforced concrete member" and therefore legally falls under code requirements for this material. Secondly, it appears that one of the main reasons that ACI Committee 318 has not included provisions in the Code which would recognize the beneficial effect of stirrups or ties around lap splices is a desire to avoid making the Code "too complicated".

If tension lap splices are used, the following procedures are recommended:

Tension ties not larger than #10 (preferable smaller), with yield strength not over 60,000 psi and working stress not over 24,000 psi.

Lap length = 36 diameters or normal development length (see middle column of Appendix D), whichever is greater.

Not over 50% of bars spliced at one location, with splices staggered a distance at least equal to splice length

Bars spaced at least 6 diameters apart, with concrete cover at least 3 diameters to center of bar.

Concrete strength at least 3000 psi, preferably 4000.

Closed stirrups or transverse ties around outside of all bars, spaced equally over length of splice with spacing, $s = 20A_{tr}/d_b$, where:

A_{tr} = area of one leg of stirrup

d_b = diameter of main bars

Suggested details and capacities are illustrated on the following pages.

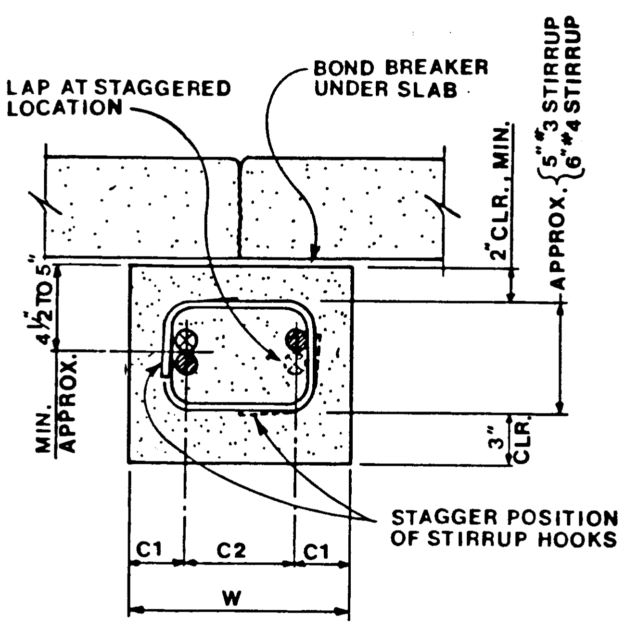
$$\sigma = \frac{P}{A} \pm \frac{M}{S}$$

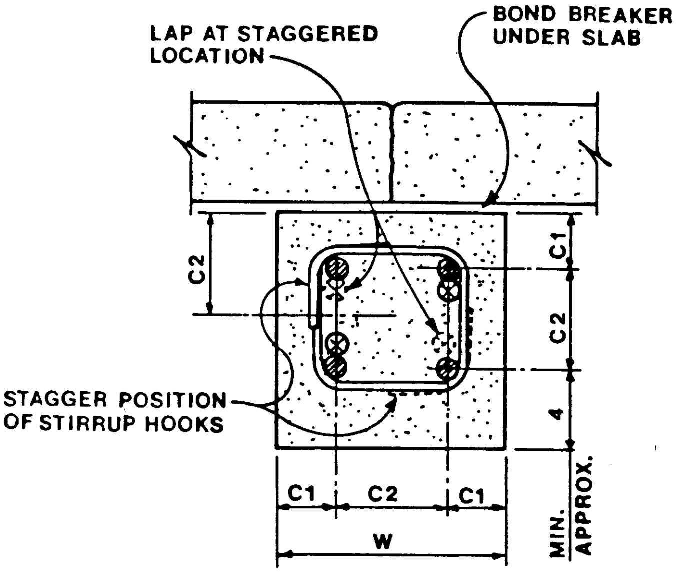
$$\sigma - \frac{P}{A} = \frac{M}{S}$$

$$\left(\sigma - \frac{P}{A}\right) S = M$$

$$\therefore S = \frac{M}{\sigma - P/A}$$

TABLE 7-3--REBAR TENSION-TIE SPLICES



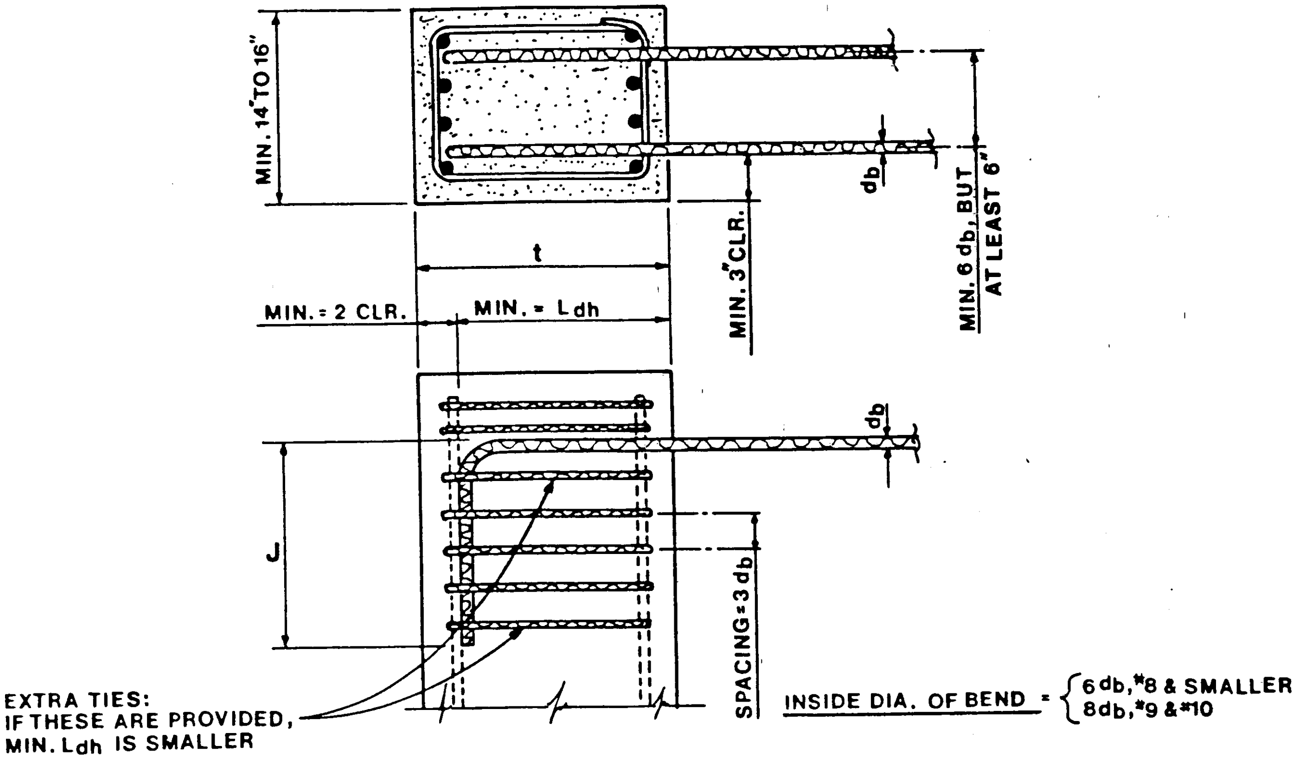


C1 = MIN. 3 BAR DIA., BUT AT LEAST 3"
C2 = MIN. 6 BAR DIA., BUT AT LEAST 6"

BAR SIZE	LAP LENGTH	CLOSED STIRRUPS		MIN. CONC. WIDTH, W	ALLOW. TENSION AT 24 KSI	
		SIZE	NO.& SPACING		2 BARS	4 BARS
#5	18"	#3	5 @ 3½"	12"	14.9K	29.8K
#6	24"	#3	8 @ 3"	12"	21.1K	42.2K
#7	32"	#4	6 @ 5¼"	12"	28.8K	57.6K
#8	36"	#4	8 @ 4½"	12"	37.9K	75.8K
#9	44"	#4	11 @ 4"	14"	48.0K	96.0K
#10	56"	#4	16 @ 3½"	16"	61.0K	122.0K

TABLE 7-4

MIN. HOOKED-BAR ANCHORAGE IN PIERS FOR REBAR TENSION-TIES



INSIDE DIA. OF BEND = {6db, #8 & SMALLER; 8db, #9 & #10}

EXTRA TIES: IF THESE ARE PROVIDED, MIN. Ldh IS SMALLER (SEE TABLE)

CONCRETE STRENGTH, f'_c = 3000 psi

TENSION-TIE BAR SIZE	J	NO EXTRA TIES		WITH EXTRA TIES		
		MIN. DIMENSIONS		MIN. DIMENSIONS		EXTRA TIES
		Ldh	t	Ldh	t	
#6	12"	11.5"	14"	9.2"	12"	5 @ 2¼"
#7	14"	13.4"	16"	10.7"	13"	5 @ 2⅝"
#8	16"	15.3"	18"	12.3"	15"	5 @ 3"
#9	19"	17.3"	20"	13.8"	16"	6 @ 3¼"
#10	21.5"	19.5"	22"	15.6"	18"	6 @ 3¾"

2. "Hairpin" Rods in Slab

The use of this system should probably be limited to forces no greater than the tensile capacity of a #7 or #8 bar (roughly 20 to 30 kips maximum). Adequate slab reinforcement is essential.

Being tied to the slab, this system is capable of resisting forces in compression as well as in tension. However, the slab must be in place before erection proceeds to the point where significant loads are applied to the frame, unless temporary means are provided to resist thrusts.

Since the slab is essential to the safety of the superstructure, the owner should be made aware of its importance. Future removal of areas of the slab should be prohibited.

If the slab is to serve as part of a tension-tie system, the tensile forces induced in the slab may tend to produce cracks and to some degree affect the performance of the slab-on-grade in supporting direct loads. This means that floor and subgrade quality are probably more important than ever. It may be desirable to provide a slightly thicker slab if substantial tensile forces are to be transmitted into the slab. (See Chapter on "Slabs-on-Grade".)

In order for the slab-on-grade to function effectively as a tension tie it is essential that the slab not settle excessively to the extent that the necessary tension cannot be developed. It is the opinion of the authors that if the slab-on-grade is to be used as the tension element that no chances can be taken on whether or not the slab "might" settle. It simply must not settle excessively. This means no soft compressible or organic soils may exist below the slab.

3. Horizontal Soil Resistance

In some cases the present or possible future interior layout (pits, foundations, etc.,) may preclude other methods of resistance than the soil against the foundation. Comparison of cost may also show that in some cases this method is cheaper than installing long cross-ties.

Careful design is required, with due attention to all possible load combinations and potential failure modes (e.g. overturning as well as sliding). Soil properties used should be conservative with an ample factor of safety.

The determination of the amount of movement to be expected is extremely difficult. Where horizontal forces are large the effect of horizontal movement should be evaluated cautiously, especially where tipping may be involved.

CHAPTER VIII - STRUCTURAL DESIGN OF FOUNDATIONS

The structural design of foundations requires considerable knowledge of reinforced concrete design theory. It is not possible to include, nor is it the intent of this manual to present all necessary theory to enable the reader to design concrete structural elements. On the contrary, the manual is intended to provide design tables, including all dimensions and reinforcement, for commonly encountered foundation systems used in Butler Buildings. This chapter will give a qualitative discussion of foundation structural design.

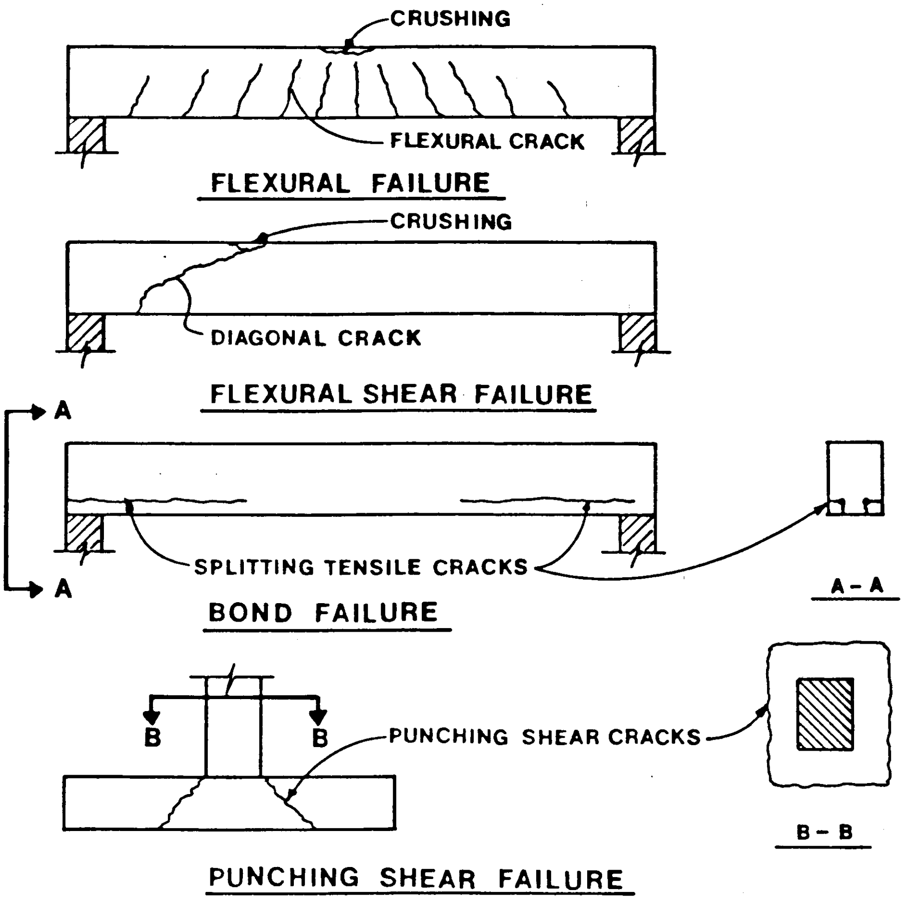
Reinforced concrete members may be classified by the manner in which they would fail if overloaded. Engineers have learned that they can accurately predict the failure loads for concrete members. This includes the following principal modes of failure:

(1) Flexure (bending) - A bending failure begins with extensive cracking in the tensile region of the member. Cracks extend deeper and deeper into the member (as the steel reinforcing stretches) until the compression zone becomes so small that the concrete actually crushes. (See Figure 8-1). The flexural strength of a beam depends on the concrete strength, beam size, and the amount, strength and location of reinforcement. The reinforcement amount is kept low in order to have the reinforcement yield prior to concrete crushing to give ample warning of a failure.

(2) Flexural Shear - A flexural shear failure is actually a tension failure. In the end regions of a beam where high shearing forces exist (usually at the ends), it is possible to develop diagonal cracks (See Figure 8-1). These diagonal cracks can cause a catastrophic failure which occurs without warning. Vertical reinforcement in beams (called stirrups) is used to "cross" potential diagonal cracks and prevent a catastrophic collapse. The shear strength of a beam depends on concrete strength, beam size, flexural reinforcement, amount and location of stirrups and type and position of loading. (It is possible to have a member without stirrups. In such cases shear stresses must be kept very low to avoid the catastrophic shear failure).

(3) Bond and Anchorage - It is fundamental to the behavior of any reinforced concrete member that the bars be anchored and bonded to the concrete. The deformations on the bars are intended to improve the bond. It is possible to compute the necessary distance required to fully "anchor" a bar so that it will not pull out of the concrete. If a member should experience a bond failure, which means the bar will have "slipped", there will be an accompanying tensile splitting of the concrete. In order for a bar (with deformations) to slip, the "hole must get larger" in order for the deformations to "slide past". A bond failure is shown in Figure 8-1. The bond strength depends upon bar size, concrete strength and the stress in the reinforcing bar which is to be anchored.

(4) Punching Shear - This failure is likely any time there is a concentrated load on a slab element. (This is especially critical in footings where the column can "punch through" if the footing is not thick enough.) A punching shear failure is depicted in Figure 8-1. The punching shear strength of a slab depends upon concrete strength, slab thickness and the size (perimeter) of the column. Concrete is roughly twice as strong in punching shear as compared to flexural shear.



FLEXURAL FAILURE

FLEXURAL SHEAR FAILURE

BOND FAILURE

PUNCHING SHEAR FAILURE

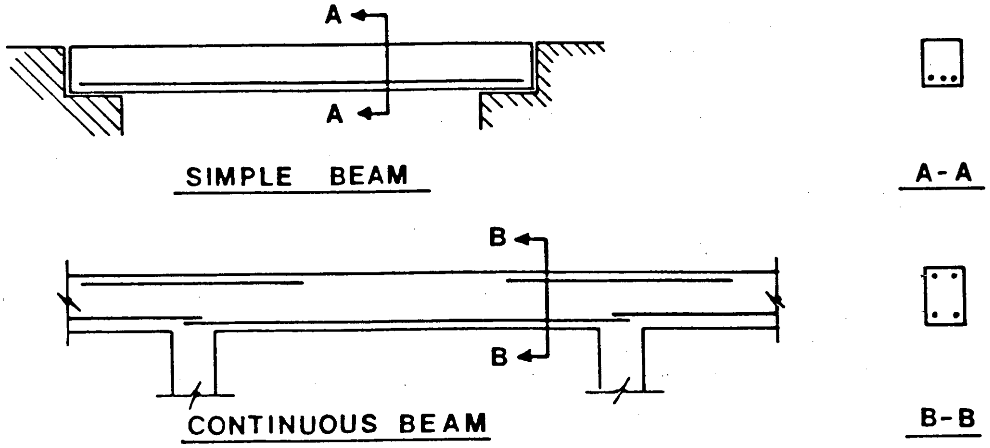
FIGURE 8-1

Design Procedure

The basic premise in the design of any reinforced concrete member, be it a column, beam, wall or footing, is that concrete is weak in tension and strong in compression. Concrete will have ultimate compression strengths in the range of 2500-8000 pounds per square inch (psi) while stresses of 300 to 700 psi in tension will cause concrete to crack.

Figure 8-2 illustrates some typical concrete structural elements and the location of reinforcing bars to resist the tension stresses that result.

The basic concept of "concrete carrying no tension" is important in one major way. The design of concrete flexural members (with the exception of prestressed concrete) is made with the full expectation that flexural cracking will occur. Such cracks could extend 50 to 75% through the member without any harm or reduction in capacity.



SIMPLE BEAM

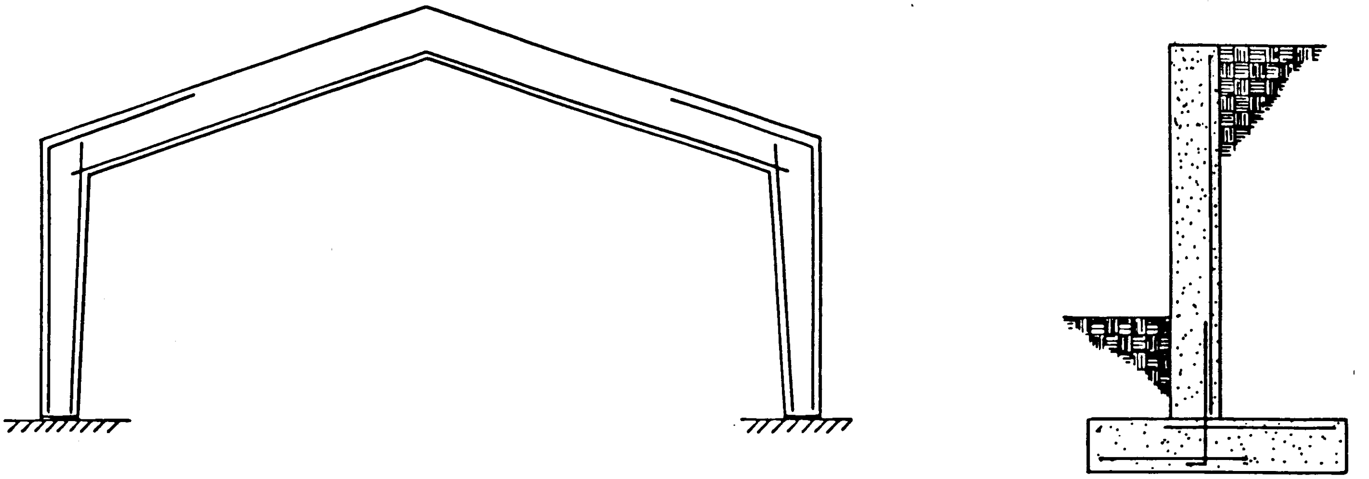
A-A

CONTINUOUS BEAM

B-B

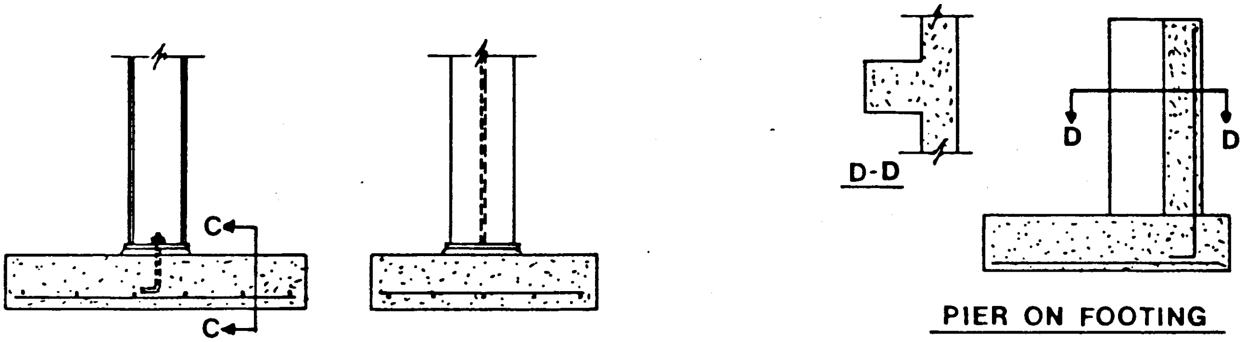
FIGURE 8-2

TYPICAL FLEXURAL REINFORCEMENT PATTERNS



RIGID FRAME

RETAINING WALL



SPREAD FOOTING

C-C

D-D

PIER ON FOOTING

FIGURE 8-2 (cont'd.)

TYPICAL FLEXURAL REINFORCEMENT PATTERNS

The ultimate required capacity is calculated for a member. This is found by using the loads which the member must support every day (working loads) and multiplying by a suitable factor of safety. The design is then made by selecting a member of sufficient size and reinforcement that has an ultimate strength equal to the ultimate required capacity (including the safety factor).

Material Properties

Reinforcing - Reinforcing bars are made from steels which are generally classified as mild steel and exhibit a "yield point" similar to that of rolled steel shapes. The proper method of designating reinforcement is as follows:

> ASTM-A615 - Grade XX. The "XX" is the yield point of the steel (e.g. 40,000 psi is Grade 40)

Concrete - Concrete is a mixture of inorganic aggregates, cement and water. In order to specify a concrete it is common practice to define the minimum cement content (e.g. 5 bags per cubic yard) the maximum size aggregate permitted (e.g. 2 inch) and any special admixtures such as an air-entraining agent (for resistance to freeze/thaw deterioration). There are a number of types of cement (e.g. High early strength, Low Heat of Hydration, etc.) so that the type of cement should be specified. Unless specifically requested to the contrary, Type I ordinary Portland Cement would be provided. Generally it is preferable from the engineer's point of view to specify concrete from a "performance" point of view. This means that the required 28 day strength of the concrete (fc') will be given (e.g. 3000 psi). Along with this the previously stated material characteristics would be given. The concrete supplier would be obligated to provide a mix design which meets these requirements and be liable for the consequences if the requirements are not met.

In some areas, engineers are also specifying a maximum shrinkage as a standard which must be met by the concrete. Excess shrinkage causes cracking and deflection and lawsuits. In most parts of the country, however, if you provide adequate strength, the concrete is acceptable.

Design of Footings

In the structural design of spread footing the following procedure is normally followed.

Given: Allowable Soil Pressure
Column Load and Moment
Base Shear

Find: Footing Size (L and W)
Footing Thickness
Footing Reinforcing
Special Design Features

(1) Select Footing Size

The size of the footing is found using procedures given in Chapter 7. The minimum suggested footing size is 2'-6"x2'-6".

(2) Select Footing Thickness

There are four factors that may govern the thickness of a spread footing. These are listed below along with the commonly used means of "handling the problem":

(a) Punching Shear - Make the footing thick enough or the column (or pier) large enough so that the column does not "punch" through. The critical section for punching shear is at a distance d/2 from the "face" of the column. (See Figure 8-3) b_0 = shear perimeter = 2(2d + x + y)

(b) Flexural Shear - Make the footing thick enough that a flexural shear (diagonal tension failure) does not occur. The critical section at which this type of diagonal tension failure will occur is located at a distance "d" from the "face" of the column. (See Figure 8-3)

(c) Bending - Make the footing thick enough and with adequate reinforcing to resist bending. The critical section is at the "face" of the column (or pier).

(d) Bond - Make the footing thick enough to adequately develop the bars in the column through proper bond. (This obviously applies to concrete columns or piers on a footing).

The footing thickness must be such that the "worst" of the above (4) requirements is met. Generally the footing thickness will not be controlled by bending. Bending strength can be increased with use of additional reinforcing while keeping the footing relatively "thin". However, concrete shear stresses are low and thus punching shear is often a more severe requirement.

Minimum thickness of footings should be 10" based on the experience of the authors.

(3) Select Reinforcing

Once the footing thickness is established the amount of reinforcing must be determined. This is done using standard procedures for design of a reinforced concrete slab. The design equations yield the required area of reinforcing steel per foot of footing width. A bar size and spacing which provides at least that minimum area is used. Clearly there are many possible choices (i.e. small bars closely spaced or large bars at a greater spacing.)

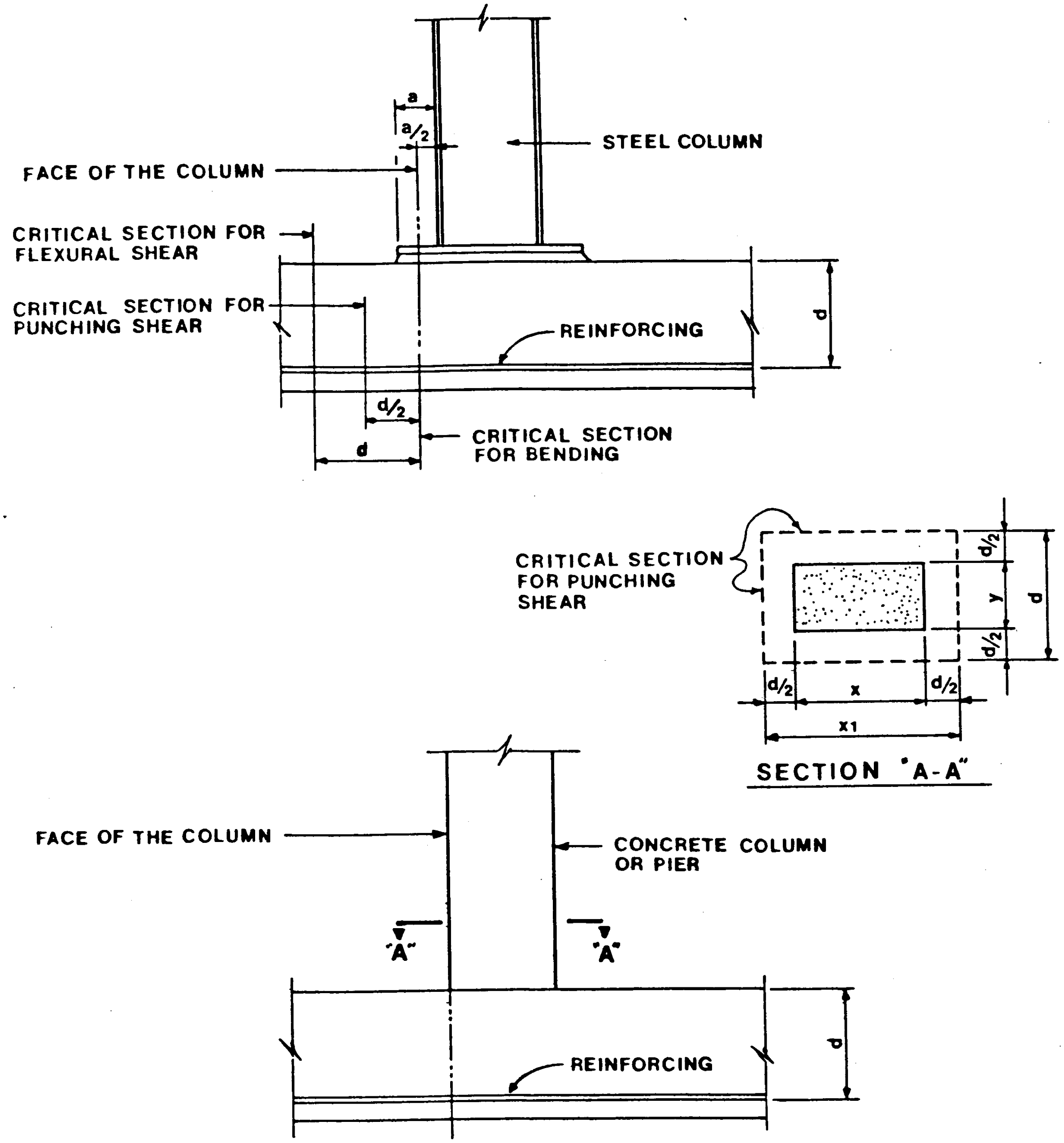


FIGURE 8-3

LOCATIONS OF CRITICAL SECTIONS

There are a number of practical cases in which footings are designed without reinforcing. In such cases the tensile strength of the concrete is counted upon to resist flexural stresses. The most common example of this is for a wall footing. Normally the width and thickness of such footings are of dimensions that concrete flexural tension stresses are well below allowable limits. ACI 318.1 permits a tensile stress corresponding to a working-load value of about 100 psi.

It is also appropriate to add, at this stage, that it is common practice to put two or more longitudinal rebars in wall footings, especially where masonry walls are used. Such bars do not add to the flexural strength of the wall footing but do add to the resistance against temperature and shrinkage cracking as well as enable the footing to bridge soft spots in the soil.

Minimum reinforcement in footings is not clearly defined value and various textbooks give different opinions as to the specific value. It is the opinion of the authors that a minimum percentage of .18 percent of concrete area should be used when reinforcement is required. The logic for selecting this value among the several published recommendations is beyond the scope of this manual.

(4) Select Special Design Features

This may include adding such features as a shear block to prevent sliding or using a "pedestal footing" to save concrete when footing dimensions and thickness get quite large. A "pedestal footing" is depicted in Figure 8-4. Pedestal footings are relatively expensive due to the form work involved in building the pedestal.

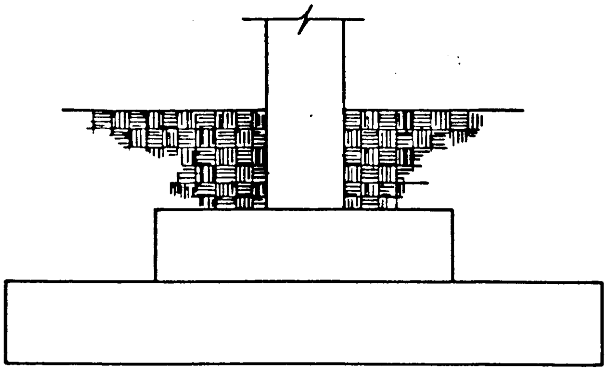


FIGURE 8-4

PEDESTAL FOOTING

Certainly the best method of learning the design procedure is to follow through a worked out example. As stated previously, this manual cannot hope to teach reinforced concrete design. Therefore, the various equations used in the design example will be given without proof or detailed explanation.

Design Example

Design a spread footing for the following conditions:

(a) Column Load (P) = 20^k (DL = 10^k, LL = 10^k - wind)

(b) Bending moment = $1000^{"k}$ (x-x axis) (wind)

(c) Allowable soil pressure
- 3000 psf
- 3750 psf with moment

(d) A W8x31 col. is to be used on a 12" x 16" pier

(e) Concrete strength of ftg. (fc' = 3000 psi)

(f) Footing rebars (F_y = 60,000 psi)

(1) Select Footing Size - (See example Chap. 7)

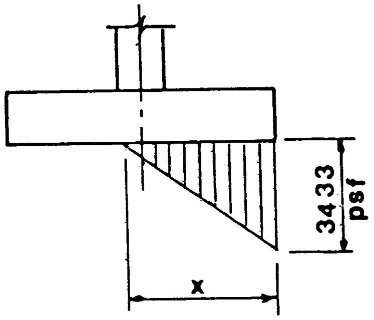
Use: 8'-0" x 5'-0" x 1'-6" ftg.
Ftg. wt. = (8x5x1.5)(.15) = 9.0^k
Area = 40 sq.ft.

Calculate Soil Pressure: (Using Eq. 7.3)

$$\text{Pressure} = \frac{P}{3A_f} \cdot \frac{4L}{L-2e}$$

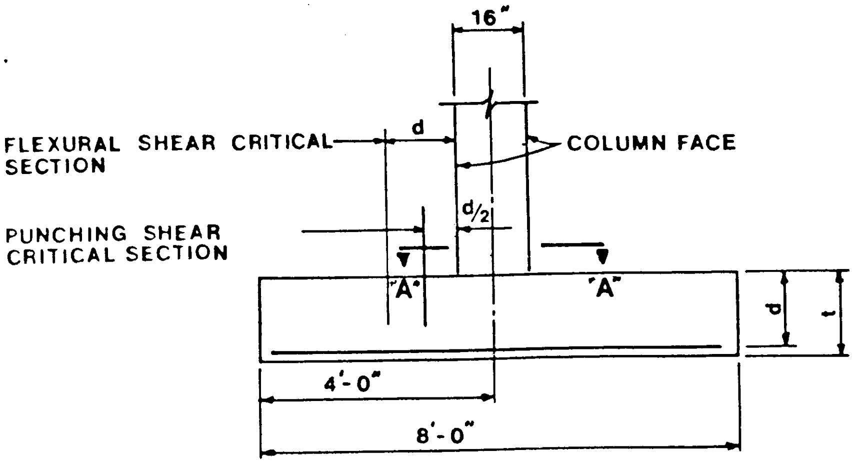
$$= \frac{29000}{3x40} \cdot \frac{4x8}{8-2x\frac{1000}{12x29}} = 3433 \text{ psf}$$

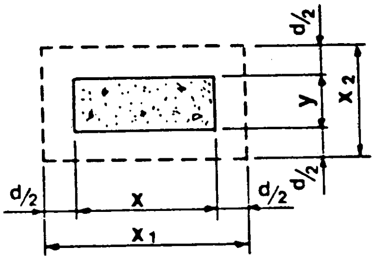
Solve for x (See sketch)
29000 = 1/2 (3433)(5)(x)
x = 3.38'



Check overturning:
M_o=0.75(1000)=$750^{"k}$
M_r=(10+.75x10+9)(4)(12)=$1272^{"k}$
F.S.=1272/750=1.70 O.K.

(2) Select Footing Thickness





SECTION "A-A"

CHECK PUNCHING SHEAR

Ultimate shear strength of the concrete (per ACI 318-83)

$$\phi\ V_c = \phi \times 4\sqrt{fc'}\ b_od = \phi \times 219\ b_od$$

Punching Shear Failure Perimeter:

$$b_o = 2(2d + x + y) = 2(2d + 16 + 12)$$

For "d" assumed to be 14.5", $b_o = 114"$

Ultimate Load to Ftg:

$$P_u = 1.4(10) + 1.7(10) = 31^k$$

Note: Ftg. wt. does not affect punching shear

Ultimate Punching Shear:

Soil pressure due to column load only
= 20,000/40 = 500 psf

$$V_u = 31 - 0.5(X_1)(X_2) = 31 - \frac{0.5(30.5)(28.5)}{144} = 27.98^k$$

Calculate Depth Required:

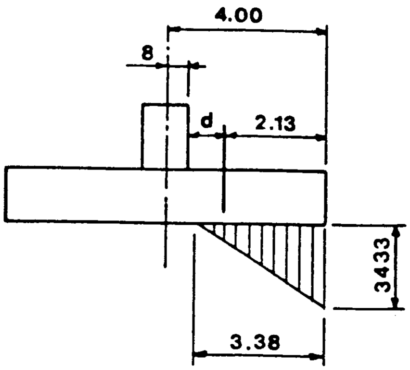
$$d = \frac{V_u}{\phi x 219 b_o} = \frac{27980}{.85(219)(114)} = \underline{\underline{1.32"}}$$ (clearly this will not control)

CHECK FLEXURAL SHEAR

Ultimate shear strength of conc. (per ACI 318-83)

$$\phi\ V_c = \phi \times 2\sqrt{fc'}\ b_wd = \phi \times 109\ b_wd$$

Ultimate Flexural Shearing Force



d = 14.5"= 1.21'

Find Soil Pressure at critical section:

$$\frac{3433}{3.38}(3.38 - 2.13) = 1270 \text{ psf}$$

Total Shear Force (Working Load)

$$= \left(\frac{3433 + 1270}{2}\right) 5 = 17273\#$$

Ultimate shearing force (assuming all load to be live load)

$$V_u = 1.7(11758) - 1.7(2.13)5(150) = 17273\#$$

Depth required:

$$d = \frac{V_u}{\phi x 109 b_w} = \frac{17273}{.85(109)(5x12)} = 3.11"$$ (Flexural shear will not control)

<u>CHECK BENDING</u>

Calculate moment at col. face. Use entire stress block (3.38 length extends slightly past col. face)

Moment = Moment due to stress block - Downward force due to conc.

$$M = 29000 \times \frac{2}{3}(3.38) - \frac{150 \frac{(18")}{(12")}(4-.67)^2}{2}(5) = 59.1'^{k}$$

Ultimate Moment:

$$M_u = 1.7\ (59.1) = 100.5^{lk}$$

Select reinf. for d = 14.5"

$$M_u = \frac{100.5}{5} = 20.1'^{k}/' \text{ of ftg.}$$

Using the ACI code equations for bending:

$$M_u = 0.9\ f_y\ A_s \left(d-\frac{a}{2}\right) \text{where } a = \frac{f_y A_s}{.85 f c' b} = \frac{60000 A_s}{.85(3000)(12)} = \underline{\underline{1.96 A_s}}$$

Thus: $20.1x12 = 0.9(60)As\ (14.5 - \frac{196A_s}{2})$

$$241.2 = 783As - 52.92\ A_s^2$$

$$A_s = 0.31 \text{ sq.in/ft.}$$

<u>Minimum Steel</u> = .0018 (t)(12) = .0018(18)(12) = <u>0.39 sq.in/ft.</u> Controls

Use 5 - #6 bars E.W. (Each way): Require 15.4" develop length (see Appendix D (48"-8") provided, therefore, O.K.

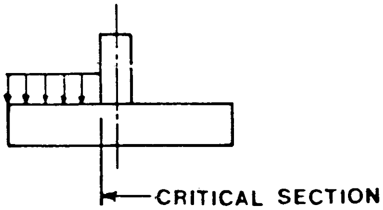
<u>CHECK IF TENSILE STEEL IS REQD. AT FOOTING TOP:</u>

Assume overburden 2'-6" @ 110 PCF

$$M_u = 1.7\ \frac{(4-.67)^2}{2}\ (2.5 \times \underset{\uparrow \text{soil}}{.110} + \frac{18"}{12} \times \underset{\uparrow \text{conc.}}{.150}) = 4.71'k/'$$

$$f_c = \frac{Mc}{I} = \frac{4.71(12)(9)}{\frac{1}{12}(12)(18)^3} = 87 \text{ psi}$$

$$f_r \text{(Allow conc. stress)} = 5\phi\sqrt{fc'}$$
$$= 5(.65)\sqrt{3000}$$
$$= 178 \text{ psi}$$



<u>No top reinf. reqd.</u>

LOADING COMBINATIONS

The preceding example was designed for a vertical axial load only and was shown primarily to acquaint the reader with the design procedure. (Chapter XII has a number of sample problems commonly encountered in Butler Building Structures.) The example included only Dead plus Live Load as the loading condition. The footings in buildings can, of course, be subject to loads from wind, earth pressure and seismic forces as well. Design for foundations is treated the same as other structural elements with respect to combinations of loads. For example, it is not likely that a building will be subject to full dead load plus full live load plus full wind load all acting at the same time. Even if this should occur, the short duration and constantly changing direction of the wind mean that this load would not exist for extensive periods of time. As a result, Building Codes (AISC, ACI, UBC, SBC, etc.) permit stresses to increase above normal levels if we include certain combinations of loadings. An increase in allowable stresses is permitted when the design is made using the working stress method (33-1/3 percent). In the case of a design based on the ultimate strength method, the permitted "temporary overload" is accommodated by reducing the factor of safety (lower load factors).

Also there are many ways in which live load can come onto a structure. The live load (such as snow or people) may load the entire area of a floor or may load alternate areas. Often loading alternate areas (checkerboard loading) will create higher bending moments and may be the most severe loading condition even though less total load is on the structure. A lightly loaded column with a large moment may require a larger footing than a column with a heavy axial load but no bending moment.

CHAPTER IX - PIERS AND GRADE BEAMS

There are two important elements in the building foundation system that should be included in this manual even though they are reinforced concrete elements and not a part of the basic Butler Building. Since this manual was developed to familiarize engineers and contractors with the basic aspects of soil and foundation engineering, it is logical to include a discussion of pier and grade beam design since these elements are often an integral part of the foundation system.

Piers

In the general sense, a pier is a reinforced concrete "column element" which transfers load from the column to the footing. This "column element" must transfer the axial load, bending moments and shears (which result from horizontal forces in the columns). In this sense a pier is a highly complex element, subject to up to three loading conditions. Figure 9-1 illustrates the basic loading elements in pier design.

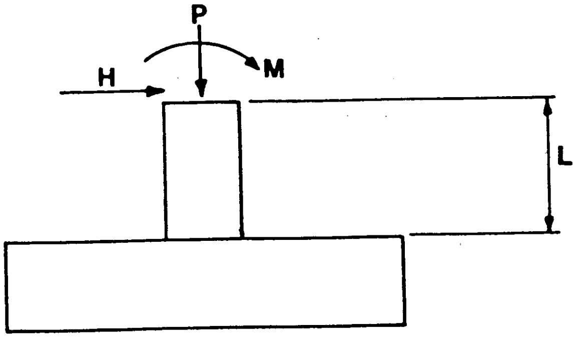


FIGURE 9-1

The pier must be designed for moments (if they exist)

$$M_T = M + (H) \times (L) \qquad (9.1)$$

and an axial load P. As with footings, a column subjected to an axial load plus bending can be thought of as having an axial load acting at an eccentricity, "e" equal to M_T/P.

In order to design a pier it is necessary to understand the behavior of the reinforced concrete column. A reinforced concrete column is one of the most complex structural elements that must be designed. The intent of developing this chapter is to make sure that the user is cognizant of the importance and complexity of the pier as a structural member.

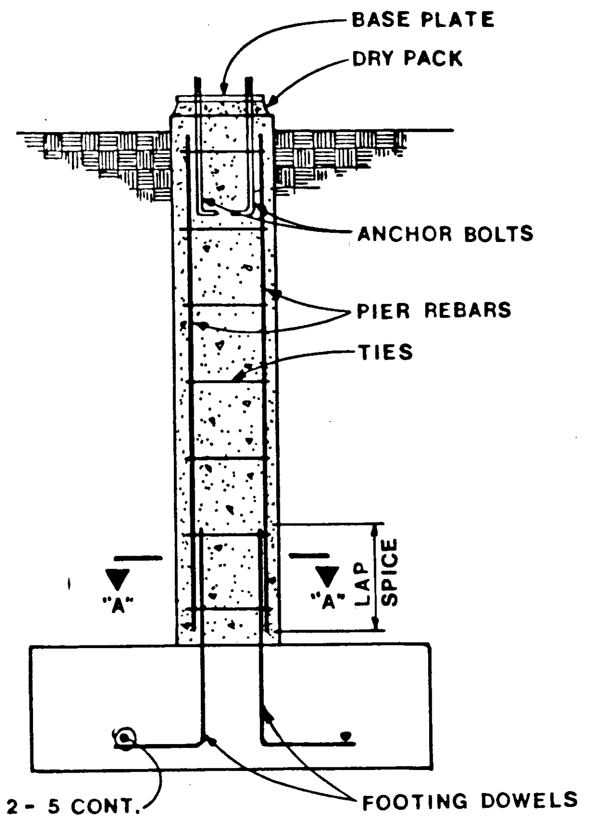
Since the pier is a reinforced concrete column subjected to axial load plus bending, it may be possible to utilize various handbooks to select pier size and reinforcement. The CRSI Handbook, for example, has tables wherein the size and reinforcement can be determined for a given axial load plus moment. Using these tables would involve a "search" procedure and there are many possible solutions to any one design problem. (Large pier - small reinforcement, Small pier - large reinforcement).

In general the pier size will be dictated by the size of the column base plate and provision of adequate "side" concrete cover on the anchor bolts and pier rebars. A minimum size pier is typically 12"x12". Only in rare cases would the size of the pier need to be larger than the above to satisfy structural requirements. The ACI Building Code would normally require minimum vertical reinforcement in a pier of not less than 1/2 percent of the gross cross-sectional area of the pier. Horizontal ties (usually #3 rebars) would be used to hold the vertical pier reinforcement in place, to provide a horizontal tie to prevent buckling of the vertical rebars under the column load and to act as web reinforcement in the event that large shearing forces exist in a pier subject to horizontal loads.* It should be obvious how important the ties really are.

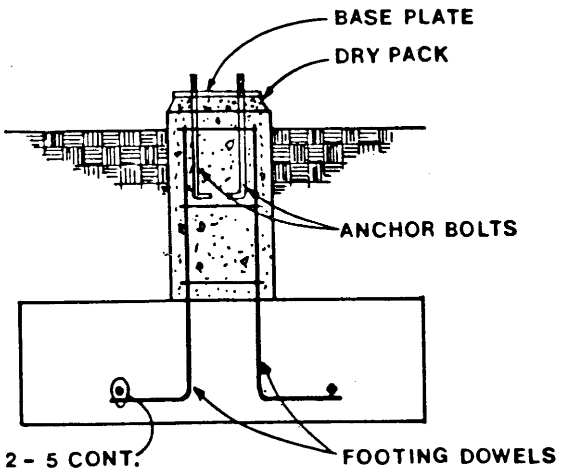
It is also important to emphasize the fact that the pier often becomes a highly congested reinforced concrete element. There could be, at a given cross-section, anchor bolts, pier rebars, footing dowels and horizontal ties. This area of concrete, as stated previously, can be highly stressed. It may thus be necessary to increase the size of a pier (larger than required structurally) to simply avoid congestion and to enable the placement of concrete. Elevations of piers are shown in Figure 9.2.

There may be separate pier rebars spliced with footing dowels in tall piers. Footing dowels may be used as pier reinforcement until they become so long so as to become unwieldly when projecting out of the footing. There is no "magic dimension" which is an upper limit on dowel extension but anything above 6'-0" does, in the opinion of the authors, become "too long". Sometimes the pier will be constructed as part of a wall or grade beam system as shown in Figure 9-3. In this case the design is handled in the same manner as with an isolated pier, with the wall simply being ignored in selecting pier reinforcement.

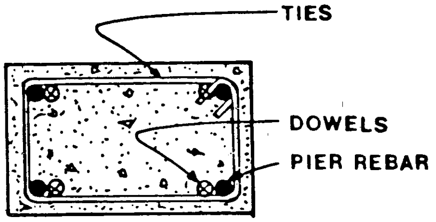
(*) When ties are used as web-reinforcement (stirrups) due to existence of high shearing forces, the spacing of ties must be selected on the basis of a separate design. ACI Code spacing requirements for ties will not be adequate for the high shear condition.



PIER WITH VERTICAL REINFORCING LAPPED WITH DOWELS FROM FTG.

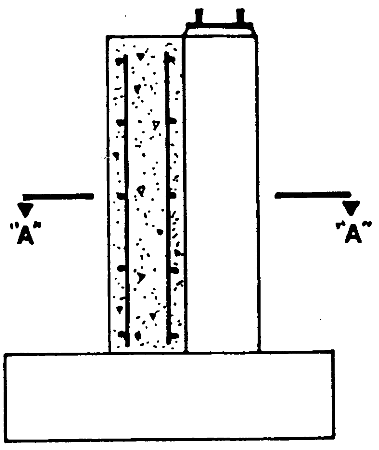


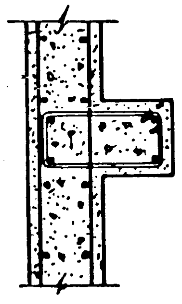
PIER WITH ONE-PIECE VERTICAL REINFORCING (DOWELS) EXTENDING FROM FTG.



SECTION "A-A"

FIGURE 9-2



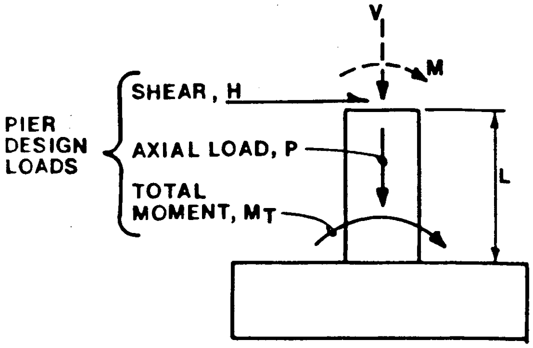


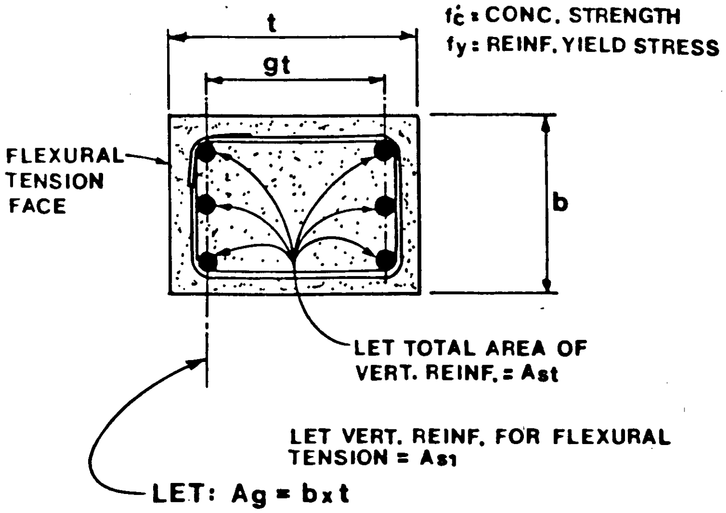
SECTION "A-A"

FIGURE 9-3

PIER AND GRADE BEAM

SUGGESTED PROCEDURE FOR DESIGNING PIER REINFORCEMENT





NOTE: Bending moment only in plane parallel to "t" dimension of pier section.

(1) Load Adjustments (for each load conditon; axial load in kips)

(a) If loading includes wind, multiply loads by 3/4.

(b) If $P>0.1\ A_g$, check slenderness:

Let k = 2 if pier is free to deflect laterally at top
k = 1 if held against deflection at top

If $kxL<6.6t \sqrt{\frac{A_g}{P}}$, neglect adjustment for slenderness

Otherwise: Let $R = 1 - \frac{P}{400A_g} \left(\frac{kL}{t}\right)^2$

Multiply design moment, M_t by $\left(\frac{1}{R}\right)$

(2) Calculate Required Area of Vertical Reinforcement

(a) Using Charts in ACI Special Publication SP-7

1. Multiply working loads by the appropriate load factors per Section 9.2 of ACI 318. Let factored loads = P_u and M_u.
2. Calculate: $m = \frac{f_y}{0.85\ fc'}$

$$K = \frac{P_u}{fc'\ A_g}$$

$$Ke/t = \frac{M_u}{fc' A_g (t)}$$

3. From appropriate chart in SP-7, read required $p_t m$
4. Calculate $A_{st} = \frac{p_t m}{m} \times b \times t$
5. Check minimum steel:
   Min. A_{st} = 1%(b)(t), unless calculations are repeated based on A_g = 1/2(b)(t), in which case min. A_{st}=1/2%(b)(t).

(b) Vertical Reinforcement by Approximate Working Stress Method

$$\text{Let} \begin{cases} \text{eccentricity,} \quad e = M_T/P \\ K = \dfrac{P}{fc'\,A_g} \\ \text{Allow. steel tension,} \ f_s = 0.4\,f_y \end{cases}$$

1. If $K \leq 0.18$:

   If $e/t \leq 0.2$, minimum steel is o.k.

   If $e/t > 0.2$:

   Tension Steel, $$A_s' = \frac{\dfrac{M_t}{gt} - 0.2P}{f_s\,(1-1.25K)}$$

   (Steel is usually placed symmetrically,)
   (so that $A_{st} = 2xA_s'$)

2. If $K > 0.18$"

   If $e/t \leq 0.1$, $A_{st} = \dfrac{P-0.21\,fc'\,A_g}{0.85\,f_s}$

   If $e/t > 0.1$:

   Let $P_o = P + 4.5\,\dfrac{M_t}{t}$

   $$A_{st} = \frac{\dfrac{M_t(P_o-.18fc'Ag)}{(P_o-P)} - .027\,fc'\,A_g}{0.27\,f_s}$$

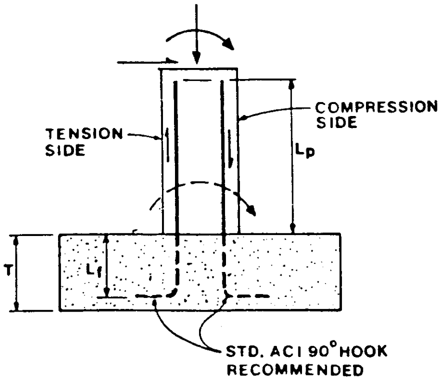
   But not less than $\dfrac{P-0.21\,fc'\,A_g}{0.85\,f_s}$

3. Check Minimum Steel:

   If $A_{st} < 1\%(b)(t)$ and $K > 0.18$, repeat calculations using $A_g = 1/2(b)(t)$
   Then minimum steel is $1/2\%(b)(t)$

(3) Select Vertical Bar Size and Number

Bar size must be small enough to allow development by bond of the required stress at any critical section. (This may include anchor-bolt tension at a section near the end of the bolt, as well as maximum bar stress at the location of maximum moment.) See Appendix C for tabulation of reinforcing bar areas.



Symmetrical arrangement of bars is recommended even if moment is not reversible, to avoid confusion in the field.

Required degree of bar development at a given section must be achieved from both ends of the bar. Critical section is usually at the top of the footing, except for fixed base endwall posts of significant uplift conditions, where lap with anchor-bolts may be critical.

1. <u>Compression Development</u>
   This will seldom be critical, since the load of the column is applied by a base plate which must be large enough not to overstress the pier in bearing.

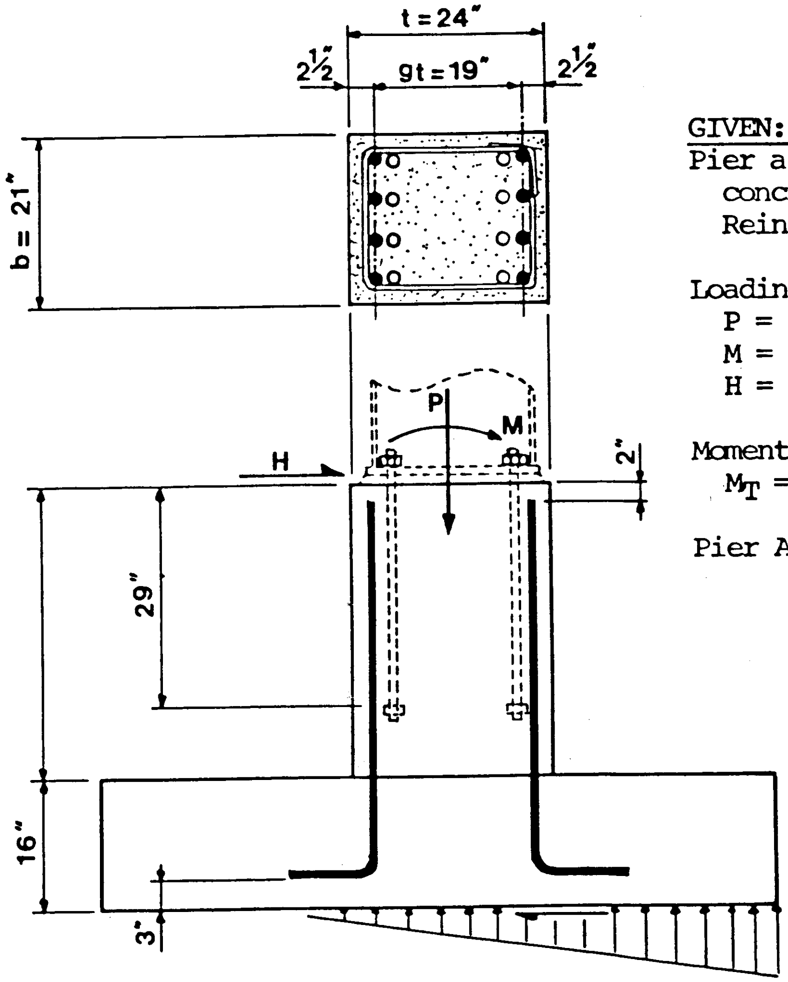
   However, for full compression development with grade 60 bars and 3000 psi concrete, straight embedment of 21.9 bar diameters would be required (with no credit for hooks).

2. <u>Tension Development</u>
   Minimum lengths for full development, with f_y=60,000 psi; fc'=3000psi

BAR SIZE		#5	#6	#7	#8	#9	#10	#11
STRAIGHT BAR IN PIER	Lp	15.0"	19.2"	26.3"	34.6"	43.8"	55.6"	68.4"
	APPROX. MIN. PIER *	17"	21"	28"	37"	46"	58"	70"
STD. 90° HOOK IN FOOTING	L_f	9.6"	11.5"	13.4"	15.3"	17.3"	19.5"	21.6"
	APPROX. MIN. T *	12"	14"	16"	18"	20"	22"	24"

* ASSUMING CRITICAL SECTION AT TOP OF FOOTING

PIER DESIGN EXAMPLE



GIVEN:

Pier as shown, with
concrete fc'=3000 psi = 3 ksi
Reinforcement f_y=60 ksi

Loading, including wind:
$P = 20^k$
M = 1244 in-k @ Top/Pier
$H = 8^k$

Moment at bottom of pier,
$M_T = 1244 + 8 \times 36 = 1532$ in-k

Pier Area, $A_g = 21 \times 24 = 504$ in.^{2}

SOLUTION:

(1) Load Adjustments

(a) Since wind is included, multiply loads by 3/4

Design working loads: $P = 20 \times 3/4 = 15^k$
$M_T = 1532 \times 3/4 = 1149$ in-k
$H = 8 \times 3/4 = 6^k$

(b) Slenderness

$$\frac{P}{A_g} = \frac{15}{504} = 0.03, < .10$$ -- Slenderness need not be checked

(2) Calculate Required Area of Vertical Reinforcement

By Approximate Working Stress Method:

$$e/t = \frac{M_T}{P(t)} = \frac{1149}{15x24} = 3.192$$

$$K = \frac{P}{fc'A_g} = \frac{15}{3x504} = 0.00992$$

$$f_s = 0.4\ f_y = 0.4x60\ ksi = 24\ ksi$$

Since $K<0.18$ and $e/t>0.2$,

Tension Steel, $A_s' = \frac{M/gt - 0.2P}{f_s(1.125K)}$

$$= \frac{1149/19-0.2x15}{24(1-1.25x.00992)} = 2.425\ in.^2$$

With symmetrical arrangement,

$$A_{st} = 2xA_s' = 4.85\ in.^2$$

Check minimum percentage:

$$1/2\%xA_g = .005\ x\ 504 = 2.52\ in.^2,\ <4.85$$

Alternate calculation using ACI publication SP-7:

$$P_u = 1.7\ x\ 15 = 25.5^k$$

$$M_u = 1.7\ x\ 1149 = 1953\ in\text{-}k$$

$$M = \frac{f_y}{0.85\ fc'} = \frac{60}{0.85x3} = 23.53$$

$$K = \frac{P_u}{fc'\ A_g} = \frac{25.5}{3x504} = .016865$$

$$K^e/t = .016865\ x\ 3.192 = .0538$$

From chart #87 in ACI SP-7, $p_t m = 0.19$

$$P_t = P_t\ m/m = \frac{0.19}{23.53} = .0081$$

$$A_{st} = p_t\ A_g = .0081\ x\ 504 = 4.08\ in.^2$$

Since a grade beam is generally continuous over the tops of footings, pile caps, or caissons, there will be some areas of tension on the top of the grade beam (near footings) and other areas of tension on the bottom (midway between footings). For this reason it is common practice to reinforce grade beams with continuous rebars, top and bottom as shown in Figure 9-4.

For heavy exterior wall loads and a shallow grade beam, vertical web reinforcement may be needed to resist shearing forces. In general a designer would try to make the grade beam deep enough (or wide enough) such that web reinforcement (stirrups) would not be required.

There is one special condition which occurs relative to grade beam construction, which deserves to be mentioned in this manual, primarily due to the wide usage and economy of the method. This relates to use of a shallow grade beam which is poured as a part of the floor slab construction as shown in Figure 9-5. Use of a thickened edge poured as part of the floor slab is common, particularly in warmer climates where frost depth is minimal. In such cases this thickened edge may be designed to serve as a grade beam.

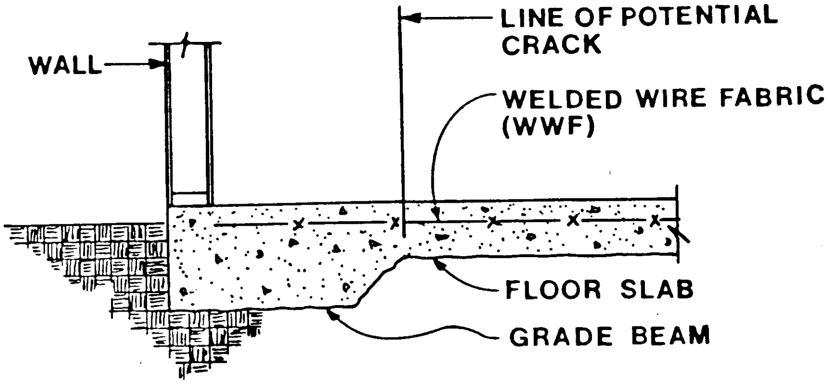
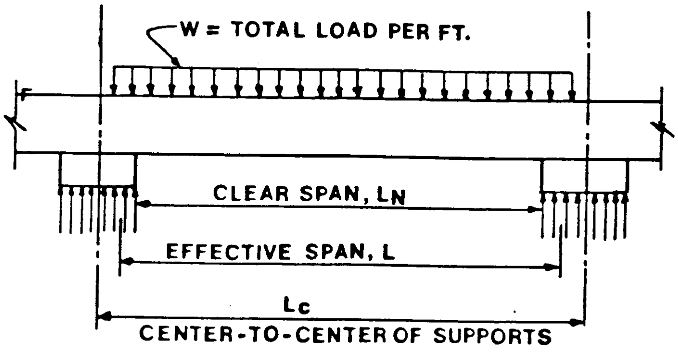
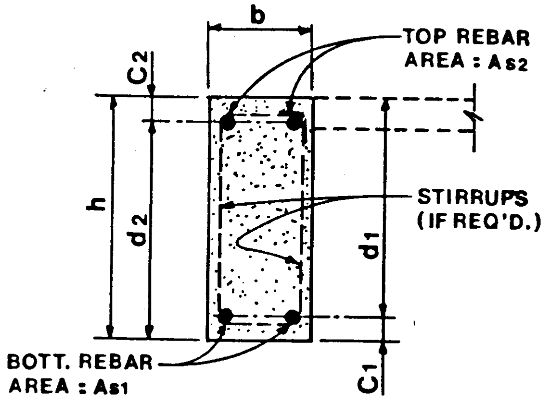


FIGURE 9-5

SUGGESTED PROCEDURE FOR DESIGNING GRADE BEAM REINFORCEMENT



ELEVATION



SECTION

NOTE: Load is assumed to be in vertical direction

(1) Calculate Maximum Moments and Shears

Effective span, $L = L_N + h$, but not $> L_C$
(Conservatively, L may always be taken as L_C, center-to-center)

(a) Elastic Analysis may be used to calculate moments and shears. Discussion of this process is beyond the scope of this manual.

(b) Approximate Method (for uniformly distributed loads) (When beam is continuous for two or more spans, this method should only be used if: spans are approximately equal so that the longer of the two adjacent spans is not more than 20% greater than the shorter one, and if live load does not exceed 3 times dead load.)

Positive moment near midspan $= W(L)^2/11$ for end span
$= W(L)^2/16$ for interior span
$= W(L)^2/8$ for single span

Negative moment at support
over which beam is continuous $= W(L_{av})^2/9$ for 2 spans
$= W(L_{av})^2/11$ for more than 2 spans
(L_{av} = average of L values for the adjacent spans)

Shear at support $= WL/2$

(3) Select Vertical Bars

Try 6-#8 bars (= 6x0.79 = 4.74 in.^{2})
or 8-#7 bars (= 8x0.60 = 4.80)

For tension development of bars with standard 90 hook, minimum footing thickness is about 18" for #8 and 16" for #7 (see Table on p.84). Therefore use smaller than #8.

Lap of vertical bar with anchor-bolt = 29"-2" = 27".

Minimum straight development length for #7 = 26.3"
Use 8 - #7 vertical bars

(4) Select Horizontal Ties

d = t-2 1/2" = 21.5"
Shear capacity without shear reinforcement

$$= .060\ bd \left(1 + \frac{4P}{A_g}\right)$$

$$= .060x21x21.5 \left(1 + \frac{4x15}{504}\right) = 30.3^k,\ >6$$

Therefore, shear reinforcement is not required.

Minimum ties = #3, spaced @ 16 vert.-bar diameters
= 16x7/8" = 14" max. o.c.

Spacing from top: 2@2", 2@12"

Grade Beams

A grade beam is a reinforced concrete member spanning between column footings. It is constructed at or below "grade" and usually serves to support exterior wall construction of a building. A wall footing and short wall section could be used in place of a grade beam. Figure 9-4 illustrates a grade beam and wall section for comparison. A grade beam would normally be used when soils are poor and all loads are carried on pile or caisson caps at column locations.

PIER DESIGN EXAMPLE

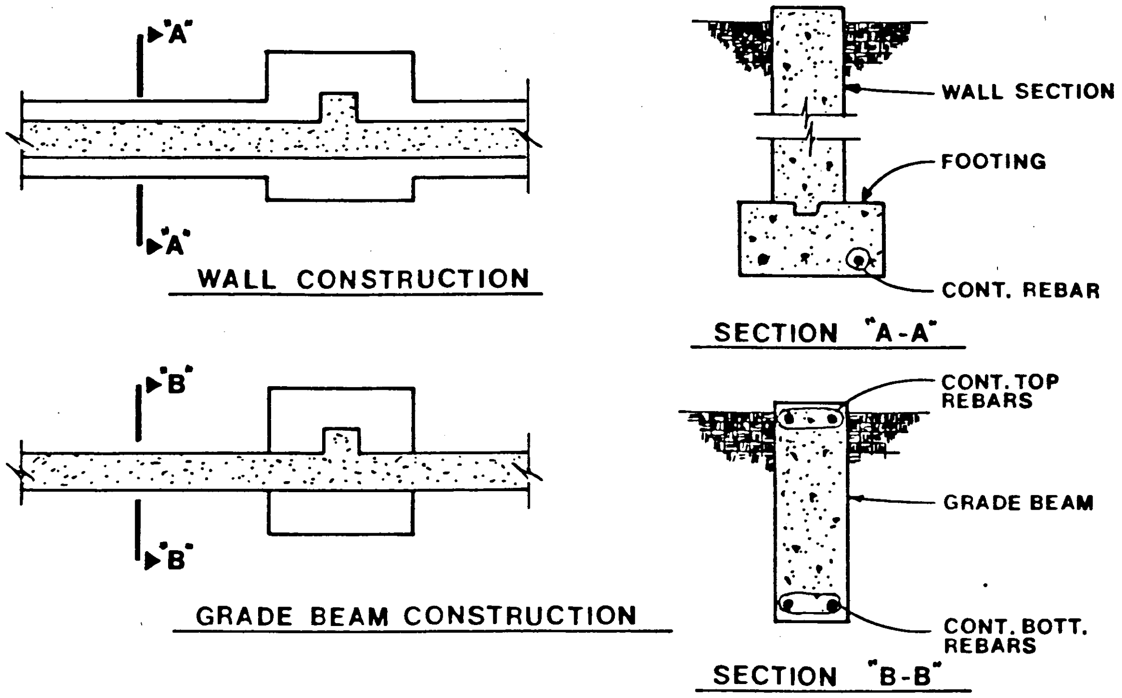


FIGURE 9-4
GRADE BEAM CONSTRUCTION

If the exterior wall of a structure is "heavy", such as in masonry construction, the load on the grade beam will be large and a deep beam with considerable reinforcement may be required. A grade beam should be deep enough to extend below frost depth.* Since the loads on a grade beam are <u>not</u> transmitted downward into the soil, soil conditions under a grade beam are not of major concern. In the northern areas where frost depth is commonly 4'-0" or more the grade beam is deep enough "automatically" such that minimal reinforcement will be needed to enable the grade beam to carry considerable loadings.

(*) In some cases a grade beam of a depth less than that required to extend below the depth of frost penetration may be used, provided that a compressible material (insulation) or a material that will decay is placed below the grade beam. In these cases frost forces would be presented from acting on the underside of the grade beam.

(2) Longitudinal Bars

(a) Area required for Bending Moments

$$As = \frac{M \cdot 12 \cdot 1000}{fs \cdot j \cdot d}$$ where

$As = As_1$ or $As2$, sq.in.

M = Moment, foot-kips

fs = 0.5xfy(yield str.,psi)

$d = d_1$ or d_2

$j \simeq 0.9$

$$\text{Flexural minimum reinforcement} = \frac{200 \cdot b\ d}{fy(psi)}$$

If As is less than this, increase the area to the lesser of 4/3xAs or the flexural minimum.

(b) Minimum Continuous Reinforcement for Shrinkage and Temperature

Provide a total area of continuous reinforcement not less than 0.0025·b·h, divided approximately equally top and bottom. (Any splices should be at supports for bottom bars and near midspan for top bars.)

(c) Distribution of Bars

It is assumed that there will usually be negligible exposure of grade beams above grade, so that bars may all be placed near the top and bottom faces.

If this is not true beware of lateral pressures against the beam, and also investigate minimum amounts and distribution of reinforcement as a "wall" (see Chapter 14 of ACI 318.83).

(3) Check Whether Shear (Stirrup) Reinforcement is Required

Maximum allowable shear without shear (web) reinforcement,

$Vc = 1.1 \sqrt{fc'}\ b\ d$, where fc'=concrete strength, psi

$d = d_2$(near support)

Let X, dist. from support to critical section = the smaller of d or 0.15L.

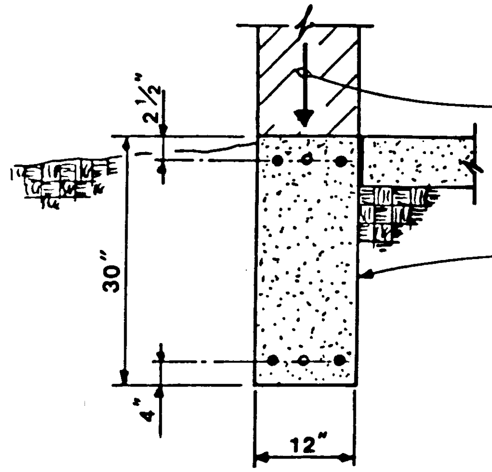
Then critical shear = W (L/2-X)

If critical shear exceeds Vc, provide stirrups at spacing S,

$$S = \text{smallest of:} \begin{cases} d/2 \\ 24 \text{ inches} \\ Av \cdot fs \cdot d/(V-Vc) \text{ with} \\ Av \cdot fs/(25\ b) \end{cases} \begin{cases} fs=0.5fy \\ Av=\text{total area of legs for each stirrup} \\ V=\text{shear at given location} \end{cases}$$

when required at any section, continue to provide stirrups out to where V = Vc/2

GRADE BEAM DESIGN EXAMPLE



GIVEN:

GRADE BEAM AS SHOWN, WITH CONCRETE f'_c = 3000psi, REINFORCING f_y = 60,000psi

SUPERIMPOSED LOAD = ENDWALL = 1.00 ^{k}/ft. DL
0.50 ^{k}/ft. LL
SIDEWALL = 0.88 ^{k}/ft. DL
0.0 ^{k}/ft. LL

GRADE BEAM WEIGHT = $\frac{12 \times 30}{144} \times 0.15 = 0.375$ ^{k}/ft.

SPANS: CONTINUOUS OVER MORE THAN TWO EQUAL SPANS FOR BOTH ENDWALL AND SIDEWALL. SUPPORTING PILE-CAPS 5'-0" WIDE AT 30'-0" O.C. FOR ENDWALL, 25'-0" FOR SIDEWALL.

$f_s = 0.5\, f_y = 30,000$ psi

SOLUTION

(1) Maximum Moments and Critical Shears

Since spans are equal, loads are uniformly distributed, and ratios of live load to dead load are low, the approximate method is applicable.

For endwall: Effective span, $L = 30'-5'+\frac{30''}{12} = 27.5'$

$W = 1.00 + 0.50 + 0.375 = 1.875$ ^{k}/ft

Positive moment = $1.875(27.5)^2 \begin{cases} 1/11 = 128.9 \text{ ft-k, end span} \\ 1/16 = 88.6\text{, interior span} \end{cases}$

Negative moment = $1.875(27.5)^2/11 = 128.9$ ft-k, interior supt.

Distance from effective support point to location of critical shear, $X=d=(30-2.5)/12 = 2.29'$

Critical shear $= W(L/2-X) = 1.875 \left(\frac{27.5}{2} - 2.29\right) = 21.49^k$

For Sidewall: Effective Span $= 25'-5'+\frac{30''}{12} = 22.5'$

$W = 0.88 + 0.375 = 1.255$ ^{k}/Pt.

Max.moments = $1.255\ (22.5)^2 \begin{cases} 1/11=57.8 \text{ ft-k, positive in end span \& negative @ int. supt.} \\ 1/16=39.7\text{, positive in int.span} \end{cases}$

Critical shear $= 1.255 \left(\frac{22.5}{2} - 2.29\right) = 11.24^k$

(2) Longitudinal Bars

Flexural minimum reinforcement $= \frac{200}{f_y} b\ d$

$$= \frac{200}{60,000} .12 \left\{\begin{array}{l}30-2.5\\30-4\end{array}\right.$$

$$= \left\{\begin{array}{l}1.10\text{in.}^2\text{, top}\\1.04 \qquad \text{, bottom}\end{array}\right.$$

Min. shrinkage and temperature reinforcement

$= 0.0025\ bh = 0.0025x12x30 = 0.90$ in.^{2}

Area required for bending moments:

$$A_s \approx \frac{M\cdot 12\cdot 1000}{f_s\cdot 0.9\ d} = \frac{M\cdot 12,000}{30,000\cdot 0.9\left\{\begin{array}{l}27.5\\26\end{array}\right.} = \left\{\begin{array}{l}0.01616M\text{, top}\\0.01709M\text{, bottom}\end{array}\right.$$

For endwall:

$$\text{Bottom } A_{s1} = 0.01709 \left\{\begin{array}{l}128.9 = 2.20\text{ in.}^2\text{, end span}\\88.6 \ = 1.51 \qquad \text{, interior span}\end{array}\right.$$

Top A_{s2}=0.01616x128.9 = 2.08 in.^{2}, interior support

Suggested bar selection:

$$\text{Bottom} = \left\{\begin{array}{lcl}\text{2-\#8 continuous} & = & 1.58\text{ in.}^2\\ \text{1-\#7 end spans} & = & \underline{0.60}\\ & & 2.18\ (\approx 2.20)\end{array}\right.$$

Top = 2-#8 continuous
1-#7 partial-length @ each interior support

For Sidewall

$$\text{Bottom } A_{s1} = 0.01709 \left\{\begin{array}{l}57.8 = 0.99\text{ in.}^2\text{, end} < \text{flexural min.}\\39.7 = 0.68 \qquad \text{, int.}\end{array}\right.$$

$$\text{Use} \left\{\begin{array}{l}\text{flexural min.} = 1.04\text{ in2, end span}\\4/3\text{x}0.68 \qquad = 0.91\text{ in}^2\text{, int. span}\end{array}\right.$$

Top A_{s2} = 0.01616x57.8 = 0.93 in.^{2}, <flexural min.
Use flexural min. = 1.10 in.^{2} Top

Suggested bar selections:

2-#7 top and bottom continuous

or
- 2-#6 top and bottom continuous
- +1-#5 bottom in end spans
- +1-#5 top (partial length)@ each interior support

(3) <u>Check Whether Shear Reinforcement is Required</u>
Maximum shear without web reinforcement,

$$V_c = 1.1 \sqrt{fc'}\ bd = 1.1 \sqrt{3000} \text{ x12x27.5} = 19{,}880\#$$

<u>For Endwall</u>
Critical shear exceeds V_c -- provide stirrups

Using #3 with 2 vertical legs, A_v=2x0.11 = 0.22 in^2/stirrup

Spacing:

$$d/2 \approx 13"$$

$$\frac{A_v x f_s x d}{(V-V_c)} = \frac{0.22x30{,}000x27.5}{(21{,}490-19{,}880)} = 112.7"$$

$$\frac{A_v x f_s}{25b} = \frac{0.22x30{,}000}{25x12} = 22"$$

Use 13" o.c.

Location where stirrups may be discontinued
(where V = $V_c/2$):
Distance from midspan toward support

$$= \frac{V_c/2}{W} = \frac{19{,}880/2}{1.875x1000} = 5.30'$$

Distance over which stirrups are required, each side of support centerline = 30.5-5.30 = 9.70'
Say 9 spaces @ 13" = 117" = 9.75'

<u>For Sidewall:</u>
Critical shear less than V_c -- no stirrups required.

CHAPTER X - COLUMN BASE ANCHORAGE

Columns are provided with base plates and anchor bolts to transmit the design forces into the supporting pier or footing. The anchor bolts also serve during erection to position and help stabilize the column. Even when no design tension or shearing forces exist after erection, anchor bolts of some minimum size are provided (See Chapter XIV).

Except where arbitrary minimum anchor bolts are used, the size and number of bolts is determined by the tensile capacity required, based on the area of the bolts in tension times the allowable tensile stress. For each loading combination, all of the three possible load components (axial load, moment, and shear — see Figure 10-1) which exist may influence the bolt area required.

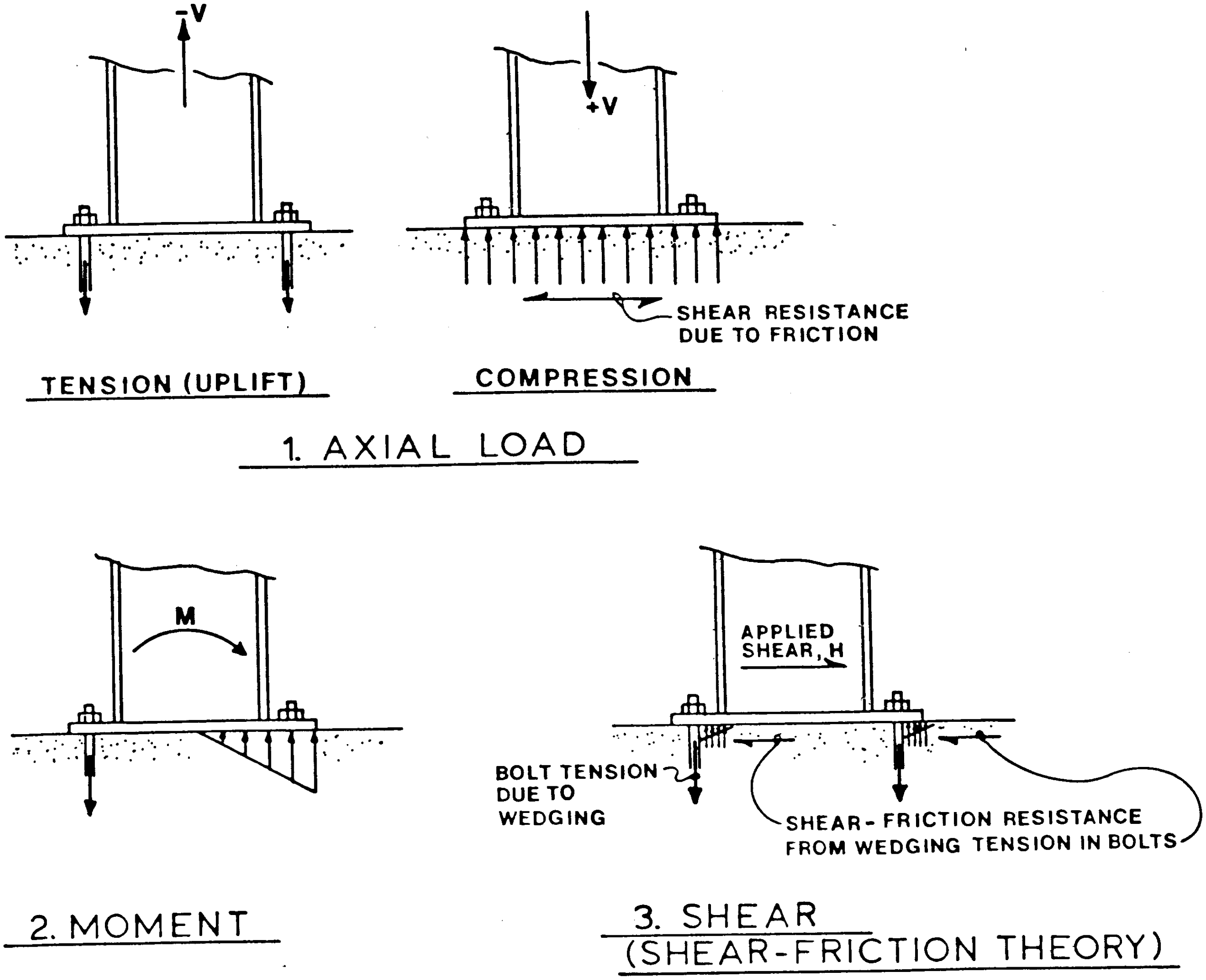


FIGURE 10-1

LOADS WHICH INFLUENCE REQUIRED ANCHOR BOLT AREA

Bolt tension due to axial uplift force is easily calculated. Axial comprесion produces no bolt force directly but if acting simultaneously with moment and shear it may reduce the flexural tension and it may provide frictional shear resistance which reduces the bolt tension required for shear according to the "shear-friction" theory. Bolt tension required for moment may be calculated in a manner similar to the calculation of tensile reinforcement in a reinforced concrete section equivalent to the contact area of the base plate. Shear resistance is calculated using the shear-friction theory*, which assumes that, as the base tends to be slid over the concrete surface by a shearing force, the horizontal bearing pressure of the bolt shank at the top of the concrete will form a concrete wedge under the plate. Translation of this wedge under the shearing force cannot occur without upward thrust which induces tension in the bolt and a resulting clamping force which produces a frictional shear resistance. Thus, using an appropriate coefficient of shear-friction, the tensile area required to resist shear by this mechanism may be calculated. The bolt area provided must equal the greater of the amounts calculated for axial load plus moment and for axial load plus shear.

With the size and number of anchor bolts determined, their embedment in the concrete should be designed so that the full tensile value of the bolts can be developed without failure of the concrete, to insure a ductile rather than a brittle failure mode. It is good practice to provide for full development of all anchor bolts, even those which constitute an arbitrary minimum.

The recommendations and design procedures on the following pages are based primarily on Appendix B (Steel Embedments) of ACI 349-80, "Requirements for Nuclear Safety Related Concrete Structures" and its commentary. The reader is advised to refer to this standard and become familiar with its general provisions before attempting the design of column base anchorage.

For proper development of an anchor bolt in tension it must be bonded or anchored sufficiently not to slip out of the concrete and it must extend deep enough so that a tensile failure cone does not develop (See Figure 10-2).

(*) References:

(1) ACI 318.77 & 83, Section 11.7 (and Commentary)
(2) PCI Design Handbook, 2nd Edition (1978), part 5.6
(3) ACI 349.80 ("Nuclear Safety Related Concrete Structures") Appendix B (and Commentary)
(4) "Design of Headed Anchor Bolts" by Shipp and Haninger, AISC Engineering Journal, 2nd Quarter, 1983

Resistance to slipping out of the concrete can be achieved by providing a head or a nut at the bottom. Heavy heads or nuts are suggested by the authors, although ACI 349 requires only the area of a standard hex head or nut for complete mechanical anchorage. "J"-bolts with 90 hooks have been commonly used as anchor bolts, but they are considered to be less effective in resisting slip and are not recognized by ACI 349.

With the bolt mechanically anchored into the concrete by a head or nut, the critical failure mechanism is the pullout of a cone of concrete which fails in tension at approximately 45 degrees (See Figure 10-2). If the full cone can develop without falling outside the edge of the concrete or intersecting the cone around another bolt, the ultimate strength is the projected area of the cone minus the area of the head, multiplied by the ultimate tensile stress of the concrete. This stress is taken as $4\phi\sqrt{fc'}$, in which $\phi = 0.65$ unless the head is beyond the far-face reinforcement, in which case $\phi = 0.85$.

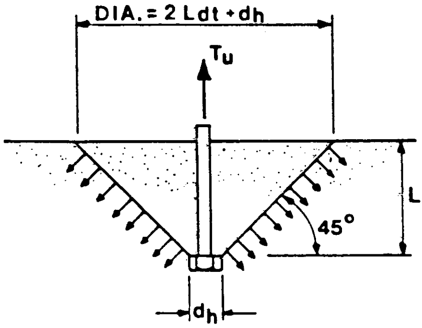


FIGURE 10-2
CONCRETE TENSILE FAILURE CONE

In order to assure ductile behavior by avoiding concrete failure, the ultimate tensile force, T_u, for which the pullout-cone strength is checked should be the minimum specified <u>tensile</u> (not yield) strength times the tensile-stress area of the bolt.

Anchor bolts are usually spaced too closely for the full failure cone to develop around each bolt without overlap. This must be reflected in calculating the net projected area of the failure surface. Also, where the bolt is near an edge (such as usually is the case in piers) the cone may intersect the edge of the concrete so that its effective area is restricted. TVA civil design standard DS-C6.1 requires that embedment length never be less than that required to develop 1.25 times the bolt tensile capacity if no edges were present, and that for restricted areas such as piers the lap of bolts with any necessary reinforcement be at least that same minimum length.

To avoid lateral failures, certain minimum edge distances are required, especially where shear forces are applied toward the free edge. In that case the distance must not be less than

$\sqrt{\frac{f_{ut}}{7.5\sqrt{fc'}}}$ times the bolt diameter, f_{ut} is the minimum unit tensile strength of the bolt (12 diameters for A307 bolts or A36 threaded rods in 3000 psi concrete), unless special lateral reinforcement is provided. In any event, the edge distance (or side cover) should not be less than $\sqrt{\frac{f_{ut}}{56\sqrt{fc'}}}$ times the bolt diameter (which is 36.6% of the above value, or 4.4 diameters for A307 bolts or A36 threaded rods in 3000 psi concrete) to prevent lateral bursting at the anchor head.

Where the tensile strength of the concrete does not suffice to develop the tensile strength of the bolts, reinforcement must be provided. Reinforcement must be located and oriented to intercept potential cracking planes, and must be developed on both sides of the potential crack. In the case where shear force is applied toward a free edge with insufficient edge distance, the potential failure plane is assumed to be at 45 degrees from where the bolt enters the concrete downward and toward the free edge. Two examples of reinforcement across failure planes are shown in the sketches below.

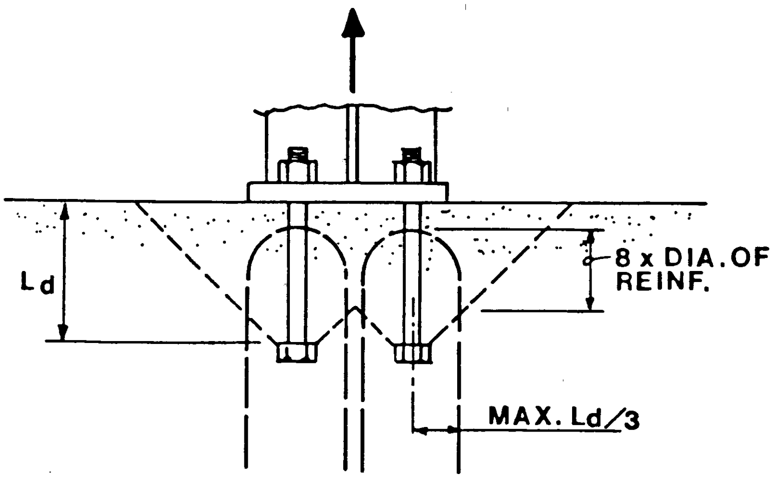


FIGURE 10-3
EXAMPLE OF VERT. REINFORCEMENT

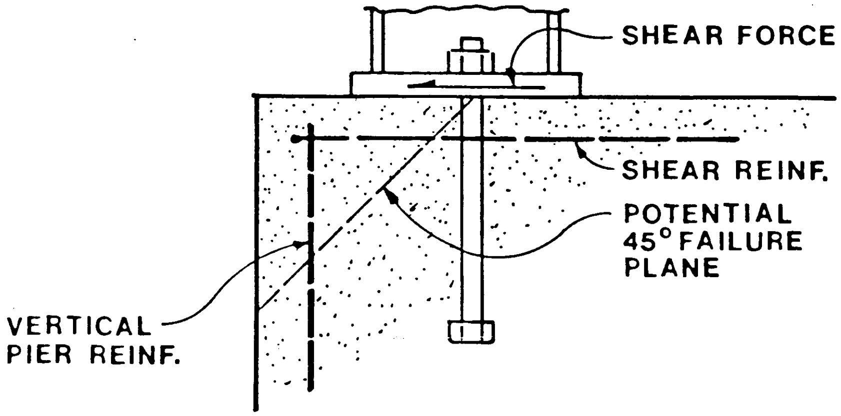


FIGURE 10-4
EXAMPLE OF REINF. FOR SHEAR NEAR EDGE

With adequate shear-friction bolting, "shear keys" ("shear bars", "shear lugs", "thrust bars") are not required. If they are used, they should be considered effective only when located in a concrete compression zone, and should be designed for the full shear force rather than relying partly on shear-friction and partly on a shear key. For shear keys bearing in the direction of a free edge, the strength of the concrete should be checked assuming a potential crack from the bottom of the bearing surface of the key downward at 45 degrees toward the free edge of the concrete, assuming a uniform ultimate tensile stress of $4\ \phi \sqrt{f_c'}$ with $\phi = 0.85$

Conservatively, the required bearing area of the key could be determined using the normal value for concrete bearing where the bearing area extends to the edge of the concrete (approx. $0.60\ f_c'$ ultimate). This will usually result in quite a large required area. It seems likely that due to confinement of the concrete under the base plate a larger value might be justified, perhaps as much as double the above value (equal to the upper bound for bearing with the plate held back from the edge of the concrete). However, the authors know of no research on this subject upon which to base a definitive allowable value.

Anchor bolts should be well tightened to at least a "snug tight" condition, defined as a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench. Where vibration may occur, the bolts should be preloaded by an additional 2/3-turn of the nut if possible, or locked in some other manner. If preloaded the concrete should have attained nearly its design strength.

Examples of anchor-bolt embedment design are given on the following pages.

EXAMPLE NO. 1

Given:
Column base to be anchored to 12-inch-thick footing,
Using (2)-3/4" φ bolts at 5-1/2" o.c., head area = 1.35 sq.in.
Tensile strength of bolts = 20,050 lb. each (per ASTM A307)
Concrete fc' = 3000 psi:

Solution: Develop full tensile value of bolts, 2x20,050# = 40,100#
Required tensile stress area of concrete $= \dfrac{40,100}{4\phi\ \sqrt{3000}} = \begin{cases} 281.6 \text{ in.}^2 & \phi=0.65 \\ 215.3 & ,\phi=0.85 \end{cases}$

(φ = 0.65 unless head is below bottom reinf.)

Equiv. radius of head $= \sqrt{\dfrac{1.35}{\pi}} = 0.66"$

Guessing that the portion of the projected area between the bolts is 95% of a full rectangle:

$$\text{Area} \simeq \pi\ (\text{Ld}+0.66)^2 + 95\%\text{x}2\text{x}5.5(\text{Ld}+0.66) - 2\text{x}1.35$$
$$\simeq \pi\ \text{Ld}^2 + 14.6\ \text{Ld} + 5.6$$

Assuming head is not below bottom reinf. (φ = 0.65),

$$\pi\,\text{Ld}^2 + 14.6\ \text{Ld} + 5.6 \simeq 281.6$$

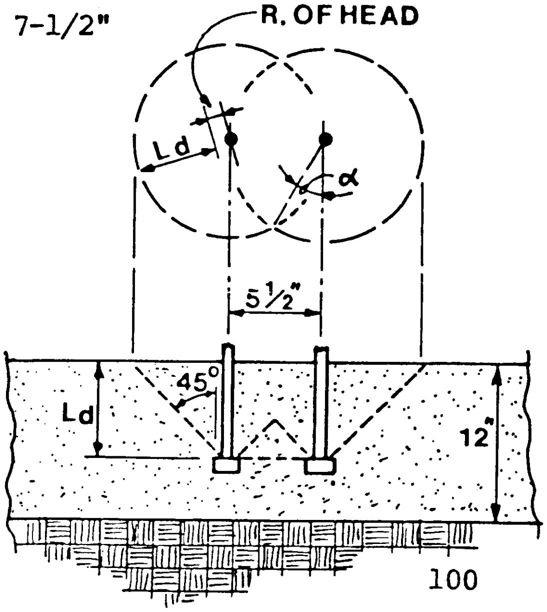
Solving: Ld ≃ 7.33" — Try Ld = 7-1/4"

Check area provided:
Radius of circles = 7.25 + 0.66" = 7.91"

$$\text{Angle } \alpha = \text{Arc Sine } \frac{5.5}{2\text{x}7.91} = 20.34°$$

$$\text{Tensile Area} = \left(1 + \frac{4\text{x}20.34°}{360}\right) \pi(7.91)^2 + \frac{5.5\text{x}7.91}{2} \text{ cotan } (20.34°) - 2\text{x}1.35$$
$$= 274.7 \text{ in.}^2 \text{ -- slightly low}$$

Use Ld = 7-1/2"



EXAMPLE NO. 2

Given:

Column base to be anchored to pier 18" wide x 24".

Loading: (without wind)

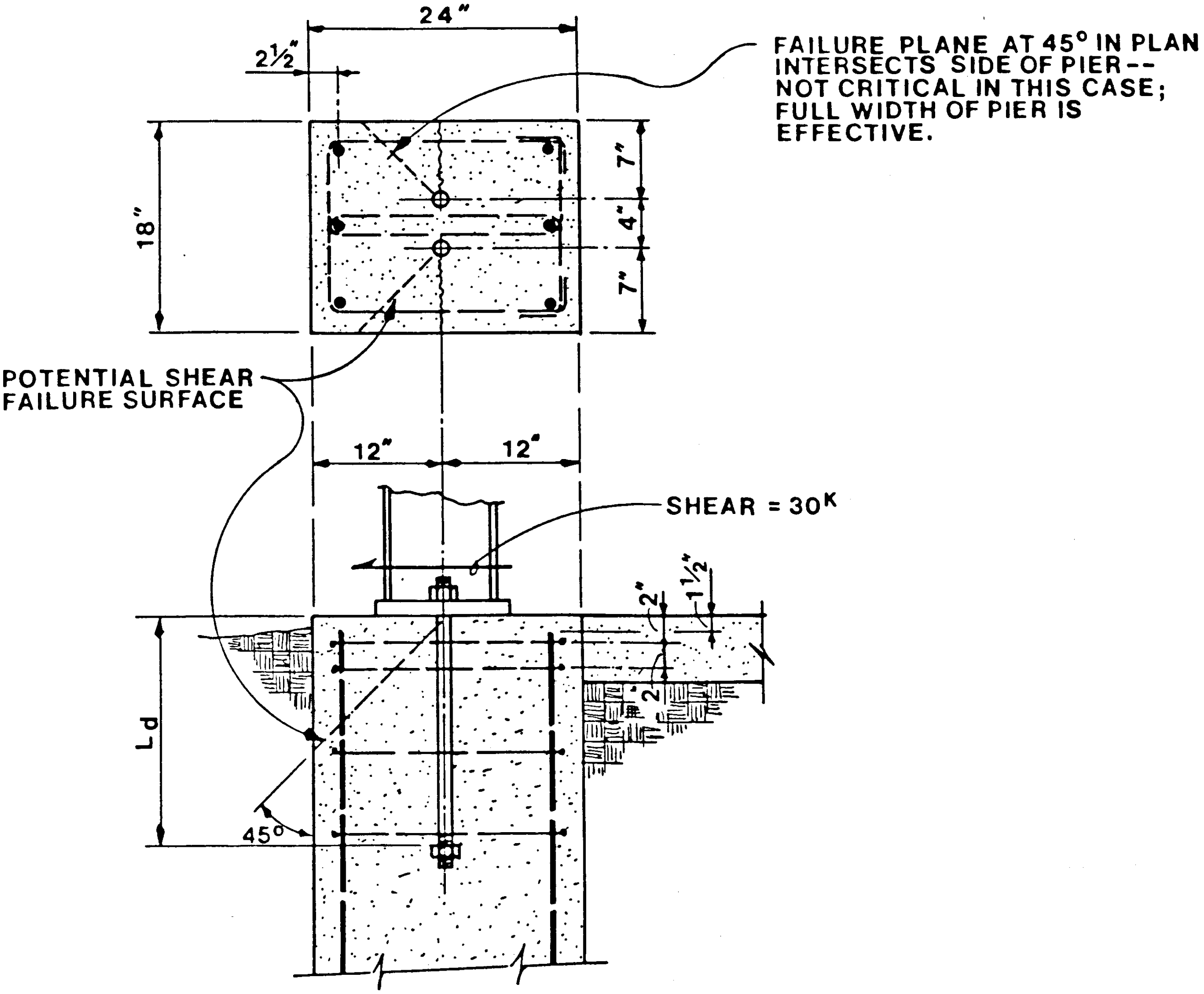
No uplift, no moment

Shear = 30^k, acting toward edge as shown

Bolts = (2)-1-3/8" ϕ A36 threaded rods (tensile area = 1.16 in.^{2}), with heavy hex nut at bottom (calculated nut area = 4.14 in.^{2}) (f_y = 36,000 psi and f_{ut} = 58,000 psi)

Concrete fc' = 3000 psi

For all rebars, f_y = 60,000 psi



SOLUTION:

Check edge-distance of bolts:

To avoid lateral failure in direction of shear,

$$\text{min. edge-dist.} = \sqrt{\frac{f_{ut}}{7.5\sqrt{fc'}}} \times \text{Diam.} = \sqrt{\frac{58{,}000}{7.5\sqrt{3000}}} \times \text{Diam}$$
$$= 11.88\ \text{Diam.} = 11.88 \times 1.375 = 16.34", >12"$$

Where there is no shear toward edge,
min. edge-dist. = 36.6% x 16.34" = 5.98", <7"

Therefore, edge distances are OK except for the side toward which shear acts, which must be checked for concrete tensile failure on 45° plane.

On 45° potential shear-failure plane:

Assuming load factor = 1.7 (as for Live Load),
Reqd. Ultimate shear capacity = $1.7 \times 30 = 51.0^k$

Ultimate capacity of concrete = $4\,\phi\sqrt{fc'} \times$ Projected Area

$$= 4 \times 0.85 \ \frac{\sqrt{3000}}{1000} \times 12" \times 18" = 40.22^k, <51.0$$

Therefore, reinforcement across this plane is required.

With 2 layers of horizontal ties, each with 4 legs crossing the plane, tie area per leg $= \dfrac{51.0^k}{8 \times \phi\ f_y} = \dfrac{51.0}{8 \times 0.9 \times 60} = 0.118\ \text{in.}2$

4 legs × 2 layers = 8? ?

Say <u>2 - #3 ties OK</u> (area = 0.11 in.^{2}/leg)
<u>@ top</u>, @ 2" o.c. as shown

Bolt Embedment:

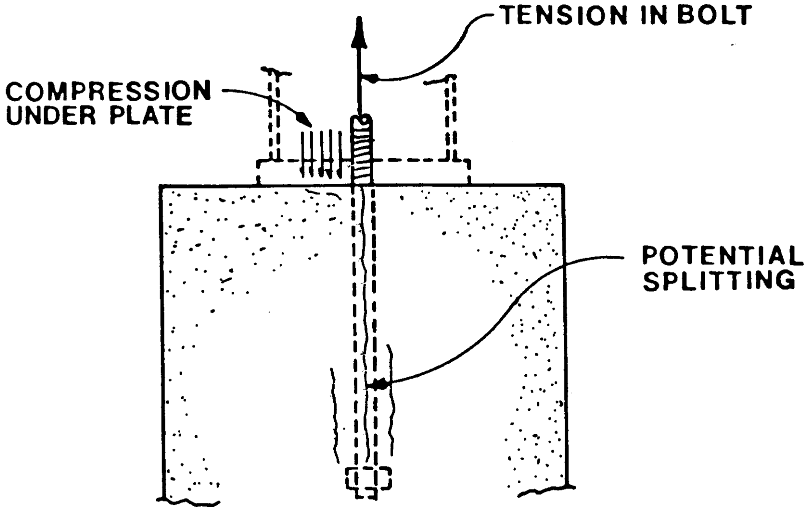
<u>Check minimum embedment length per TVA Standard DS-C6.1</u>
(Min. Ld is length required to prevent a 45° tensile-cone failure if no edges were present.)

Reqd. Projected Area of Cones
$$= \frac{1.25\ f_{ut}\ At}{4\,\phi\sqrt{fc'}} = \frac{1.25 \times 134{,}500}{4(0.65)\sqrt{3000}} = 1180.6\ \text{in}^2$$

Equivalent radius of nut = $\sqrt{4.14/}\ \pi = 1.15"$
Guessing that portion between bolts is 95% of a full rectangle,
Approx. projected area
$= \pi\ [(Ld+1.15)^2-2(1.15)^2]+95\% \times 4 \times 2(Ld+1.15)=1180.6$
or: $\pi\ (Ld)^2+14.826\ Ld+6.095 = 1180.6$
Solving: Ld = 17.12" -- say 18" minimumn

SELECT ACTUAL EMBEDMENT LENGTH -- CONSIDER LATERAL TIES

Since there is no uplift or moment, a 45 degree conical pullout failure cannot develop (except possibly for an extremely short bolt). Presumably, the bolt size has been determined by shear requirements, based on the shear-friction theory. Therefore, the potential failure mode governing embedment design is bond or anchorage failure, involving vertical splitting of the concrete around the bolt.



It may be assumed that if at least the minimum 18" embedment length were provided (as calculated above), that development of bolt tension is assured. However, since the area of surrounding concrete is limited, a more conservative approach might be desirable. The embedment length could be increased an arbitrary amount to increase the bonded area, or lateral ties might be provided around the bolts and across potential splitting cracks.

EXAMPLE NO. 3

Given: Moment-resisting column base to be anchored to 16" wide pier as shown below.
Bolt edge-distances in long direction to be kept near minimum.

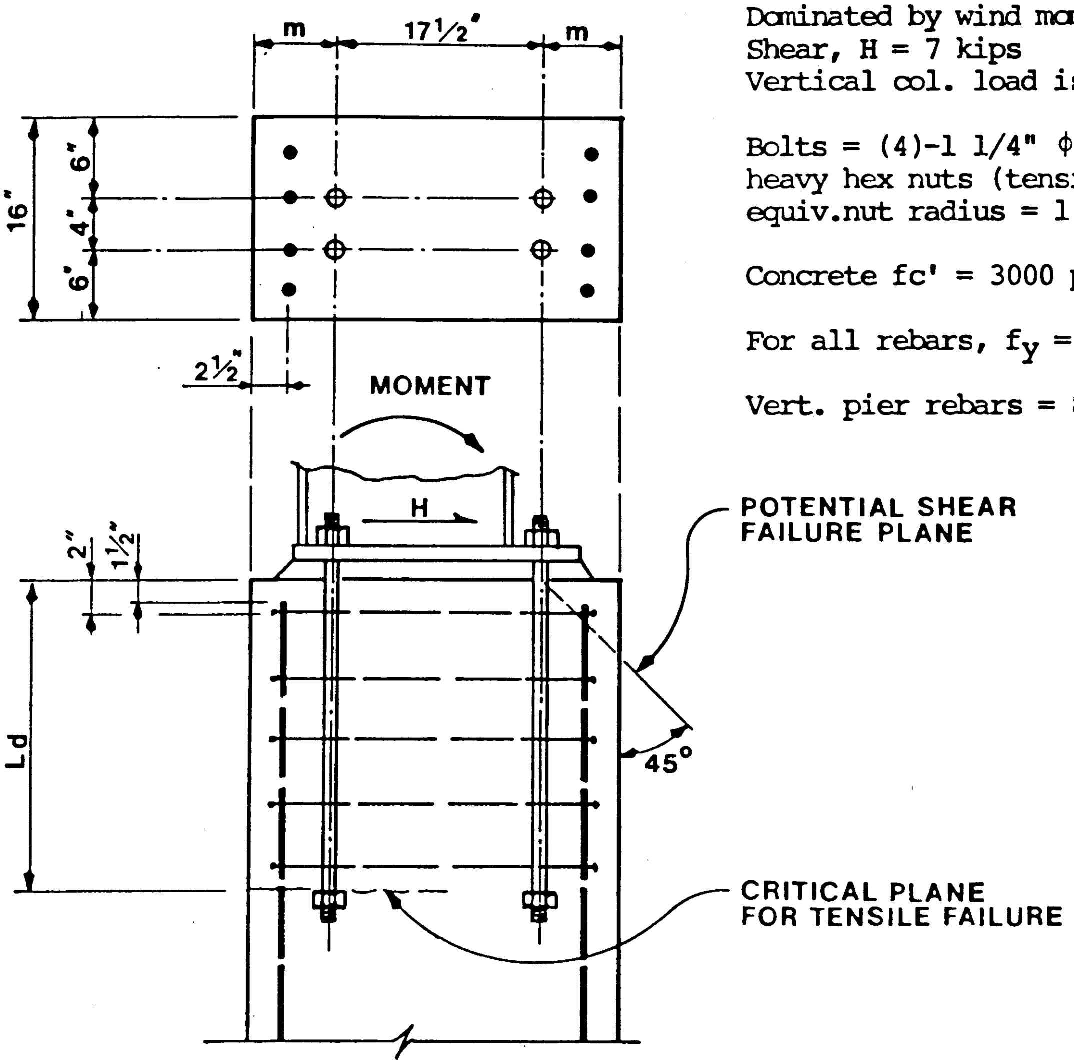
Critical Loading:
Dominated by wind moment
Shear, H = 7 kips
Vertical col. load is negligible

Bolts = (4)-1 1/4" ϕ A36, with heavy hex nuts (tensile area=0.969in.^{2} equiv.nut radius = 1.05")

Concrete fc' = 3000 psi

For all rebars, f_y = 60,000 psi

Vert. pier rebars = 8 - #7



SOLUTION:

Edge Distance of Bolts:

For A36 bolts and 3000 psi concrete,
min. edge distance = 4.4 diam. = 4.4x1.25 = 5.5"

Min. pier size = 17.5 + 2 x 5.5 = 28.5" -- use 30" pier

Then with bolts centered, m = 6 1/4"

Since this is less than 12 diameters, potential shear failure @ 45 degrees must be checked at edge.

Check 45° Potential Shear failure Plane:

Assuming load factor = 3/4 x 1.7,
reqd. ultimate shear capacity = 3/4x1.7x7 = 8.92^k

Ultimate capacity of concrete = $4\ \phi \sqrt{fc'}$ x Projected Area

$$= 4(0.85)\ \frac{\sqrt{3000}}{1000}\ 6.25(16) = 18.62^k$$

Reinforcement not required; however, as good practice, locate top ties close to top of pier.

Bolt Embedment:

Check min. embedment length per TVA Standard DS-C6.1:

For pair of bolts at 4" o.c. reqd. projected area of 45° tensile cones $= \frac{1.25\ f_{ut}\ A_t}{4\ \phi \sqrt{fc'}} = \frac{1.25x58000x2x0.969}{4x0.65\ \ 3000}$

$= 986.6$ in.^{2}

Area $\approx \pi\ (Ld+1.05)^2 + 4Ld = 986.6$

Solving: Ld = 16.1" = min. Lap with pier rebar

Fraction of development of pier rebars above critical plane for tensile failure $= \frac{f_{ut}\ A_t}{\phi f_y\ A_s} = \frac{58000x2x0.969}{0.9x60,000x4x0.6}$

$= 0.867$

Full development length for #7 = 26.3"

Ld = 0.867x26.3" + 1.5" = 24.3" min. -- say 25"

Ties:

With bolt edge-distances near minimum, consideration might be given to providing ties distributed over the embedment length to resist possible splitting along the bolts. (See Example No. 2)

CHAPTER XI - SLABS-ON-GRADE

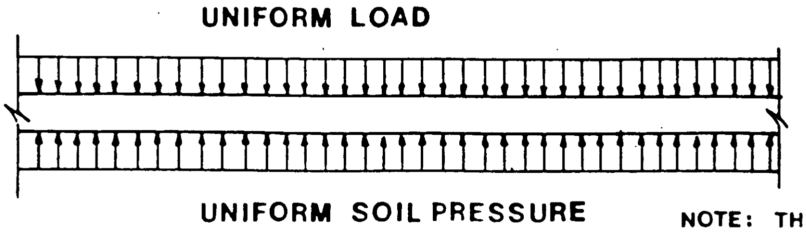
This chapter will deal with the design (selection of thickness and reinforcement) of slabs-on-grade subject to uniform, partial uniform and concentrated vertical loads.

It is important to note that if a slab-on-grade is resting on a uniform high quality soil and is loaded with a perfectly uniform load, the slab thickness can be some arbitrary minimum and no reinforcement would theoretically be needed. The reason is that a uniformly supported, uniformly loaded slab will not bend, hence no flexural stresses may be calculated. (See Figure 11-1) Therefore, statements such as "design a slab-on-grade for 2500 pounds per square foot" are by themselves meaningless.

However, a floor in a factory which will have heavy storage loadings (perhaps steel storage, heavy castings, etc.) will undoubtedly have localized concentrations of load and unloaded aisles. The simplest example of this is the use of dunnage of blocking to support equipment or materials, storage racks or wheel loads as shown in Figure 11-2. (The slab curvature shown is exaggerated.) This curvature (bending) will result in stresses in the slab for which reinforcement may be required. Commercial and industrial floors are commonly subjected to vehicle wheel loads, such as from lift trucks. Therefore, an industrial floor will really not be uniformly loaded but rather will have load concentrations as shown in the figure. The designer must carefully examine the service conditions of a slab-on-grade to determine whether or not concentrated loads and resulting bending will exist.

There are other reasons for reinforcing being placed in a slab-on-grade. Principal among these are temperature and shrinkage effects. The ACI Building Code requirements do not apply to slabs-on-grade, since these are not strictly structural slabs. A committee of ACI for Design of Slabs-On-Grade was formed in 1975. Clearly there are many instances of lightly loaded slabs on good soils wherein reinforcing may not be required. In such cases, the designer should provide closely spaced control joints or be prepared to accept random cracks due to shrinkage and crack-control reinforcement in all slabs-on-grade. Welded wire mesh is normally used for the slab reinforcement.

Slabs-on-grade will be affected by concrete shrinkage and temperature change. The concrete will want to change dimensionally and will be restrained from such change by the soil. The slab will also tend to warp or curl due to non-uniform drying shrinkage. The presence of reinforcing (mesh) will not prevent cracking of the slab, but will cause a distribution of hairline cracks which will generally not be noticeable.



NOTE: THE SLAB WILL NOT BEND UNDER THIS LOADING

FIGURE 11-1

UNIFORMLY LOADED SLAB ON GRADE

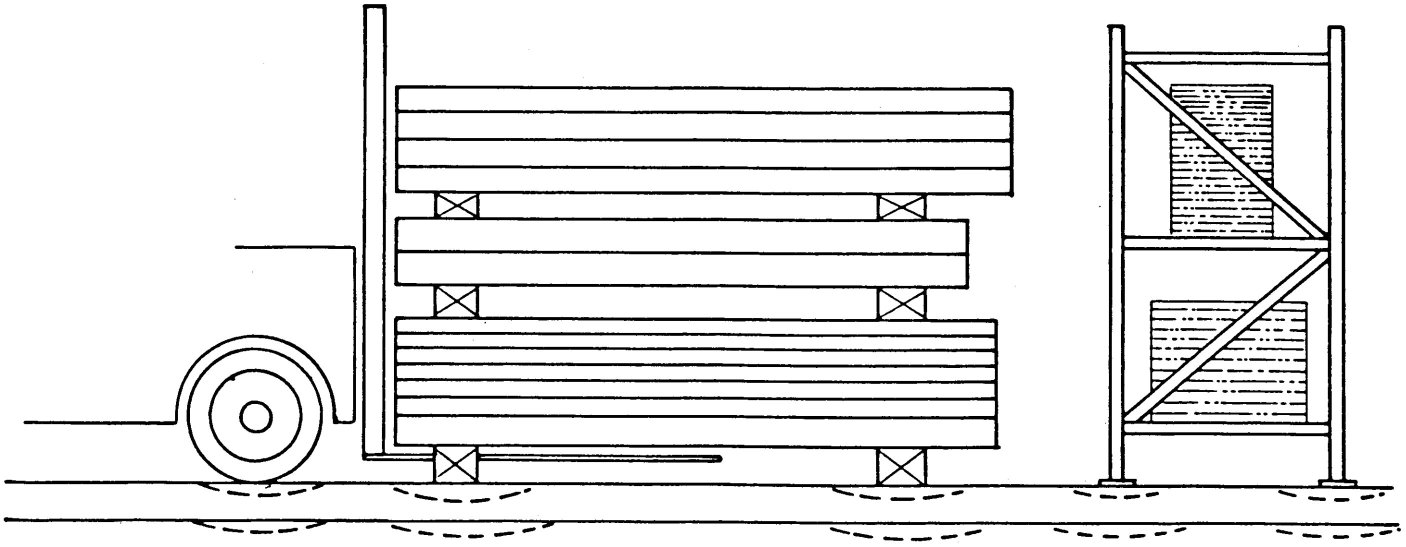
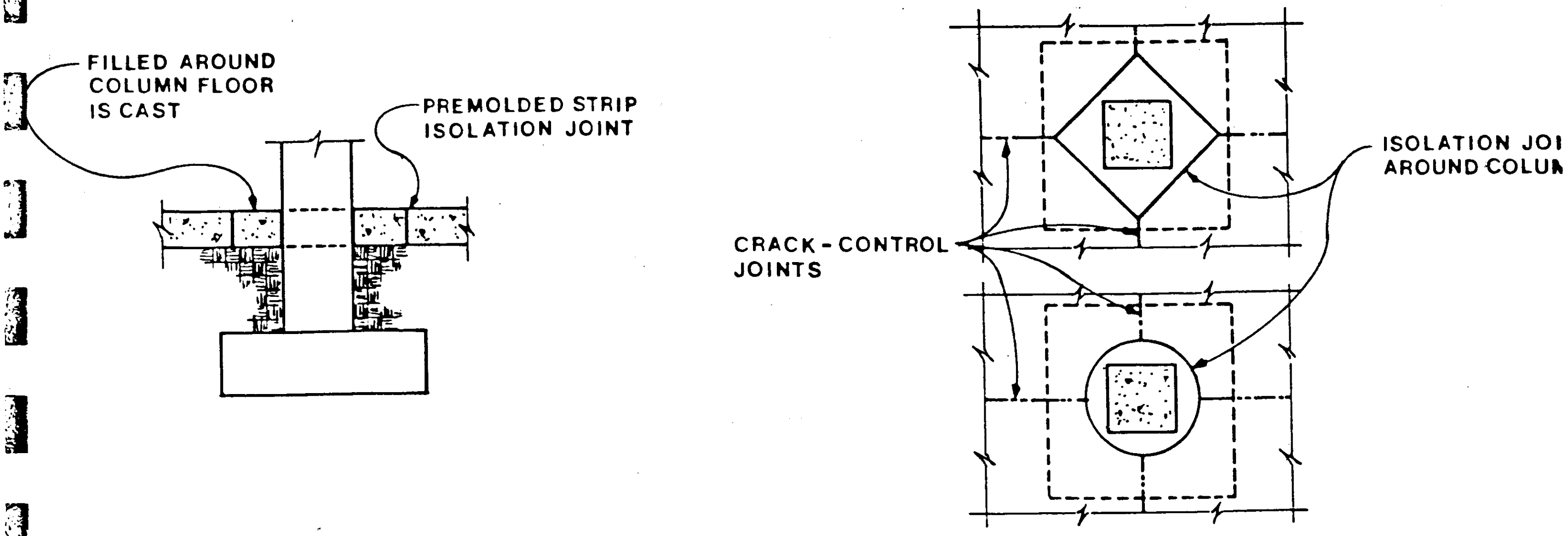


FIGURE 11-2

TYPICAL LOADS TO A SLAB ON GRADE

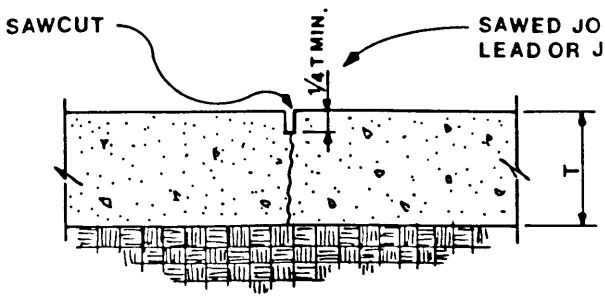
Designers have learned, however, that the presence of reinforcement will not guarantee a floor without observable cracking and that use of crack control joints is generally logical. The use of crack control joints is based on the logic that it is better (from an appearance point of view) to have a crack occur in a prepared straight line joint rather than to exist in a random, non-linear manner. The reader should note that the <u>crack</u> will be there in either case and that the joint simply defines its location and appearance. However, a crack-control or construction joint may also be designed to provide for load-transfer across the joint as well as to allow for slight horizontal movement to control crack formation. This may be important where heavy vehicle wheel loads occur. Load transfer devices usually consist of keys or smooth dowels debonded on one side of the joint.

Other types of joints besides crack-control joints which are used in floor construction are isolation joints (also called expansion joints) and construction joints. Isolation joints usually contain premolded "expansin felt", and are used to allow movement between the floor and other parts of the building such as walls, columns, and machinery bases. Construction joints are provided as stopping places at the edges of an area to be placed and finished at one time. Where construction joints occur; they also serve the purpose of crack control. Figure 11-4 gives typical details of floor joints.

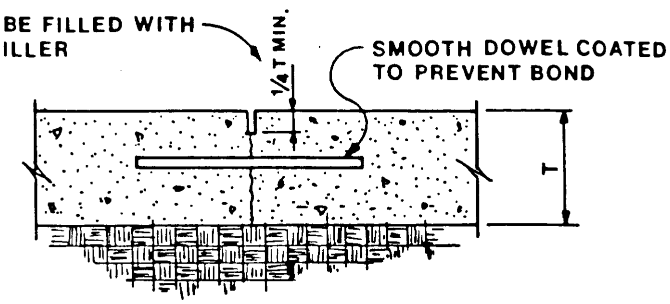


<u>FIGURE 11-3</u>

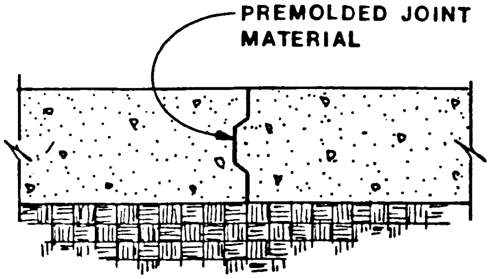
<u>JOINTS AT COLUMNS</u>



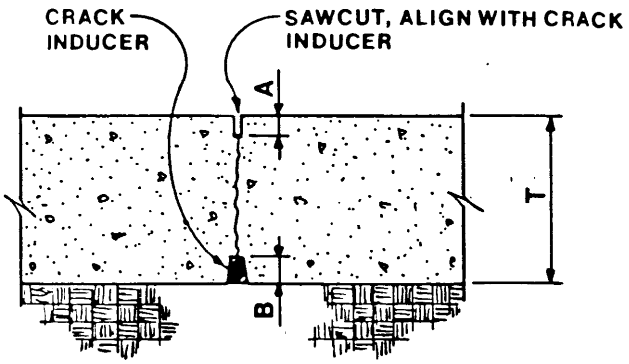
SAWED CONTROL JOINT



CONTROL JOINT WITH DOWELS



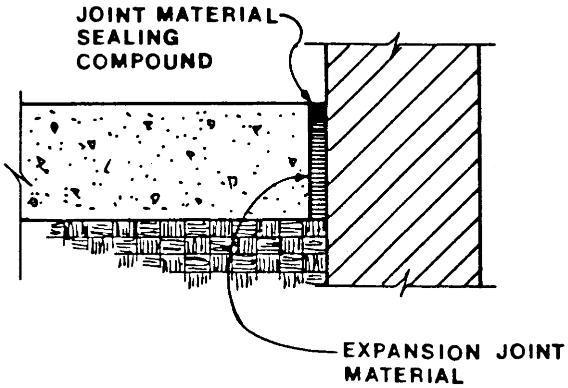
TONGUE AND GROOVE CONTROL JOINT



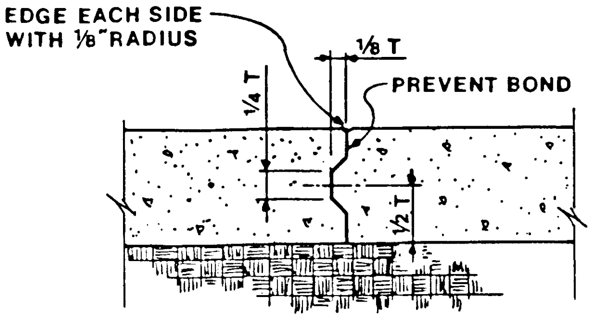
A + B : 1/4 T MIN.

CONTROL JOINT IN THICK FLOOR SLABS

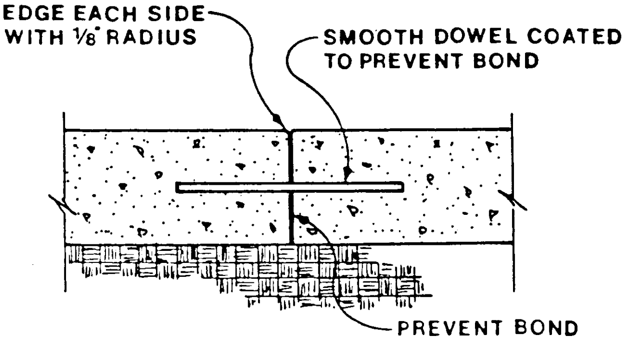
CRACK-CONTROL JOINTS



ISOLATION JOINT



TONGUE AND GROOVE CONSTRUCTION JOINT



BUTT-TYPE CONSTRUCTION JOINT WITH DOWELS

CONSTRUCTION JOINTS

FIGURE 11-4

Where joints are permitted, their design and spacing is very important in obtaining satisfactory floors with a minimum of cracking. Isolation joints should be provided at the perimeter of the floor and at any other elements that would restrain horizontal movement such as columns, pits, or machinery bases. Crack-control joints should be added to divide the floor into panels of a moderate size (typically in the range of 15 to 30 feet) which are nearly square and without re-entrant corners. (Figure 11-3 shows the layout of isolation and crack-control joints at a column.) The maximum recommended spacing between joints depends on the slab thickness, the mix and curing conditions of the concrete, the range of temperature variation in service, and the amount of distributed reinforcement. With close spacing of joints, it is feasible to provide a satisfactory slab with no reinforcement at all. With no reinforcement, the recommended joint spacing ranges from 24 times the slab thickness for 3/4-inch aggregate and more than 4-inch slump to 36 times the slab thickness for larger aggregate and slump less than 4 inches.

Grade-supported slabs are usually designed to depend on the flexural tension strength of the uncracked concrete section to resist bending rather than using the standard theory for reinforced concrete which usually provided only for crack control, and is usually of a smaller amount than the minimum required for a structural slab. Crack-control reinforcement should be placed in the upper portion of the slab, approximately 2 inches from the top.

The allowable flexural stress used in selecting slab thickness depends on the type of load and the consequences of failure. For vehicle traffic or storage of material directly on the floor where failure of the slab would not be catastrophic, a safety factor of two is usually applied to the flexural strength (modulus of rupture) of the concrete, resulting in a design stress typically in the range of 250 to 300 psi. Where safety considerations are important, such as with slabs supporting high storage racks, a higher safety factor and lower stresses (perhaps half of the above values) would be advisable. In the case of heavy concentrated loads, the slab should also be checked for resistance to punching shear failure.

The calculation of stresses in slabs-on-grade according to elastic theory is a complicated procedure which involves such variables as the modulus of elasticity and Poisson's ratio for the slab, its thickness, the compressibility of the soil (modulus of subgrade reaction), the magnitude of the load, size of the loaded area, and the proximity of any free edges. Equations developed by Westerguard for highway pavement design may be used to calculate stresses due to loads applied to a small area (assumed circular in shape) representing a single wheel or post load. An approximate determination of the slab thickness required to limit bending stress due to a concentrated load located away from any free edges or joints, may be made by using the following approximate formula:

$$t = \sqrt{\frac{2P}{f}}$$

, in which P = load
f = flexural stress
t = slab thickness

For additional information including tables and charts relating to the design of slabs-on-grade, the reader is referred to "Concrete Floors on Ground" by Ralph E. Spears (1978), published by the Portland Cement Association.

A common problem in conjunction with slab-on-grade design, relates to placing such slabs on low quality compressible and/or variable thickness soils. In general the compressibility of the soil is not a major consideration as far as the design of the slab is concerned, provided the support is uniform. The subgrade modulus would be affected but the worst that might happen is that a thicker or more heavily reinforced slab would be required.

The problem is that such slabs-on-grade will settle and may settle non-uniformly. Increasing the slab thickness or adding reinforcement will not solve this problem. All too often, designers become so concerned with the building foundations that the consideration of slab-on-grade settlements is overlooked.

There is no magic solution to this problem. If the compressible soils are shallow, they may be removed and replaced with a compacted engineered backfill. If the problem soils are of a considerable depth, then it may be necessary to replace the slab-on-grade with a structural slab. A structural slab could be supported by a number of different methods including:

(1) Caissons

(2) Piles

(3) Grade beams

(4) Foundation walls

The earth may be used as a "form" but the assumption is that it may not be counted upon to support floor loads and will eventually settle, leaving a gap under the slab. The structural slab will be considerably thicker and more heavily reinforced than the slabs-on-grade presented previously. Design procedures for these structural slabs are beyond the scope of this manual and designs should be made by an experienced structural engineer.

A final comment about slab-on-grade construction is in order. This manual is devoted to structural considerations. The authors recognize that wearing surface characteristics are essential to the proper performance of a slab. The details of curing, finishing and mix design, which can affect the wearing and other surface characteristics of a slab, are not included herein. The reader is referred to ACI Standard "Guide for Concrete Floor and Slab Construction". (ACI 302.1R-80.)

CHAPTER XII - FLOOR SLABS AS FOOTINGS

The use of a shallow "footing" poured as a part of the floor slab is common, particularly in warmer climates where frost depth is minimum. In such cases the major consideration is to have the "footing" founded below organic materials (top soil), below disturbed ground (cultivated, planted, tree root zones) and below any depths to which erosion from rainfall, roof or downspout runoff might extend. A crack will almost surely occur in the floor slab at the point where the "footing" starts (See Figure 12-1). Therefore, a crack-control joint is recommended at this location for exposed slabs.

The use of a shallow "footing" poured as a part of the floor slab (thickened slab) is a complex condition. There are some limitations to the use of such a system. Consider, for example, the footing shown in Figure 12-1. Assume the footing is subject to a reversible moment and a vertical downward column load.

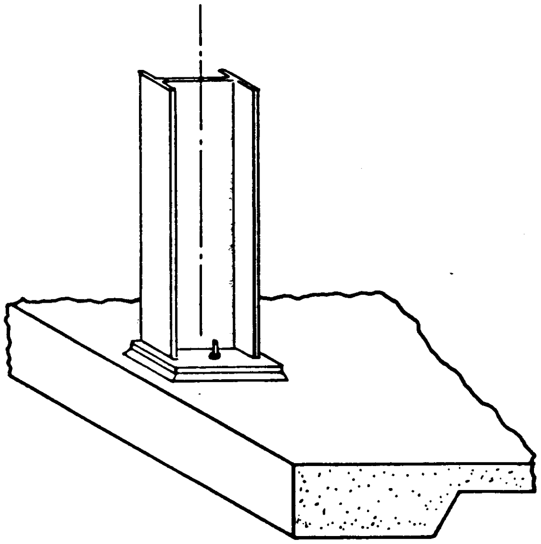


FIGURE 12-1
THICKENED SLAB EXTERIOR FOOTING

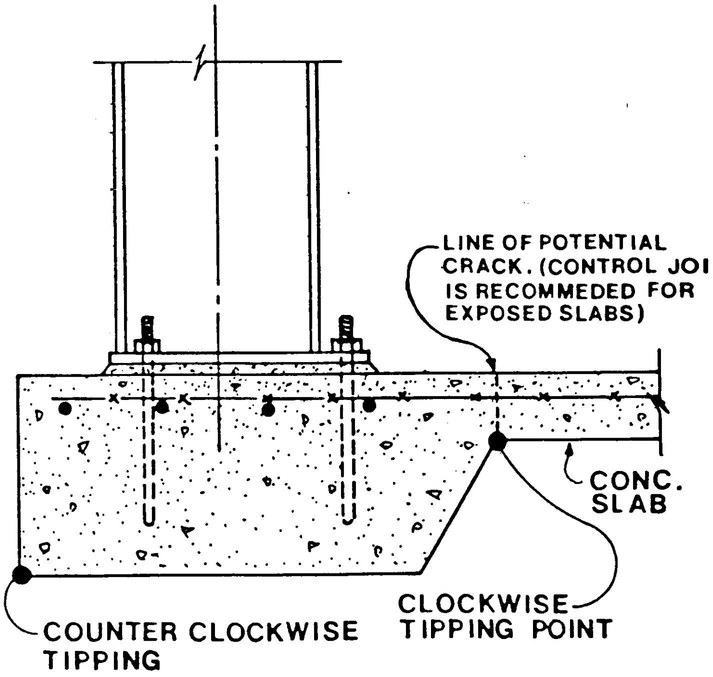


FIGURE 12-1

THICKENED SLAB EXTERIOR FOOTING

In the case of the footing design tables of Appendix B, the entire stability (overturning) and soil pressure analysis is predicated on the fact that only the footing is available to resist the overturning moment. As a result, a substantial mass of concrete is needed to provide a proper factor of safety.

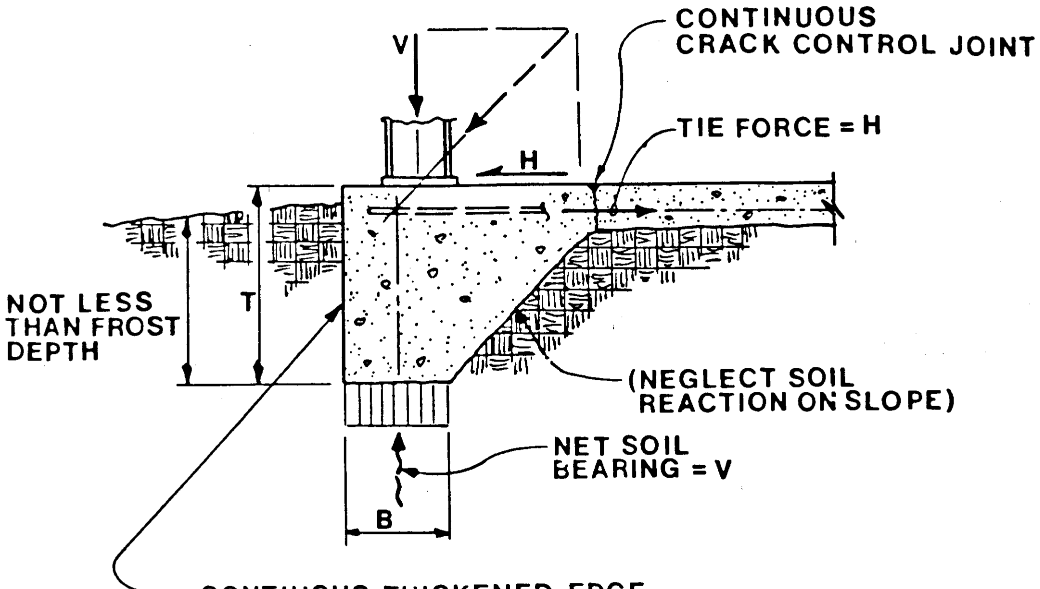
In the case of the "thickened slab" however, a slightly different condition exists. If in Figure 12-1 the column moment is clockwise, for the "footing" tq tip about the "clockwise tipping point", a portion of the slab would also have to be either broken in flexure or "sheared off" the rest of the slab. The footing weight provides the stabilizing force against a clockwise moment.

For counter clockwise moment, before the "footing" can tip it must literally tear out of the slab. The shearing strength of the concrete slab, (even as thin as 4") provides a considerable force which resists "tearing out" and thus stabilizes the footing provided that reinforcement actually crosses the line of a potential crack. However, in the case of the thickened slab there is every possibility that under actual field conditions, the slab mesh will be "on the ground" and be ineffective in tying the "footing" to the balance of the slab. For this reason the authors do not recommend counting on the slab shearing resistance for stability. As a result the thickened slab should be used only when moments are small.

A major disadvantage of this system occurs when geographical location requires a deep, thick footing to get below frost. In such cases it will generally be cheaper to pour an individual footing. If a "thickened slab" footing can be used the size, reinforcement and construction jointing should be selected by someone experienced with concrete design.

Referring again to Figure 12-1, the reader can see that it is easily possible for the column to be eccentric on a thickened slab footing. In the case of the Landmark system, the endwall columns have considerable moment due to wind bending with a small column load. In the Widespan system there may be little or no column moment but a large eccentric column load can still cause large moments to be "thrown" into the footing. Again, it must be emphasized that the "thickened slab footing" is not recommended for large moment conditions - whatever the source of the moment.

Finally, there is one other practical aspect of the thickened slab footing which should be noted. This applies to those regions of the country where expansive soils are commonly encountered. It should be obvious that expansive soils acting on a shallow footing could cause tremendous damage to the floor and/or roof systems. This shallow thickened slab is not recommended where expansive soils exist even when other conditions noted previously are satisfied.

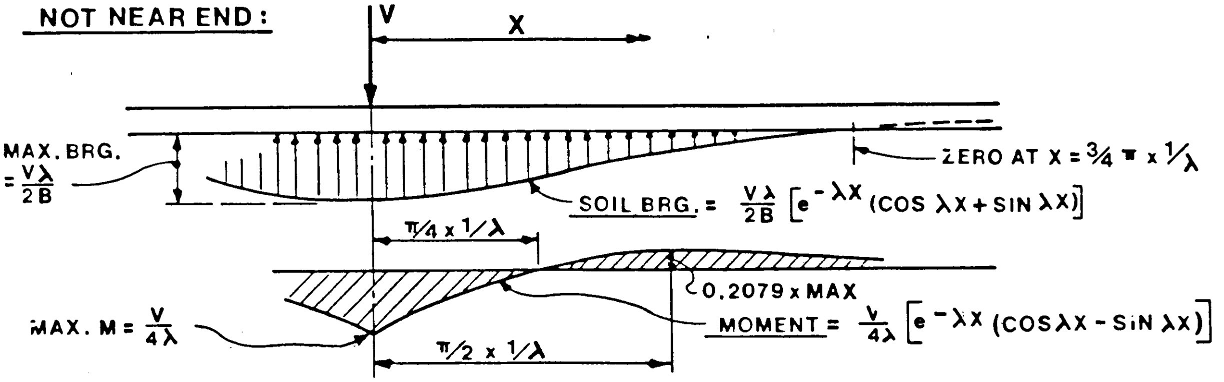


CONTIUOUS THICKENED EDGE – –
ANALYZE AS BEAM ON ELASTIC FOUNDATION *:

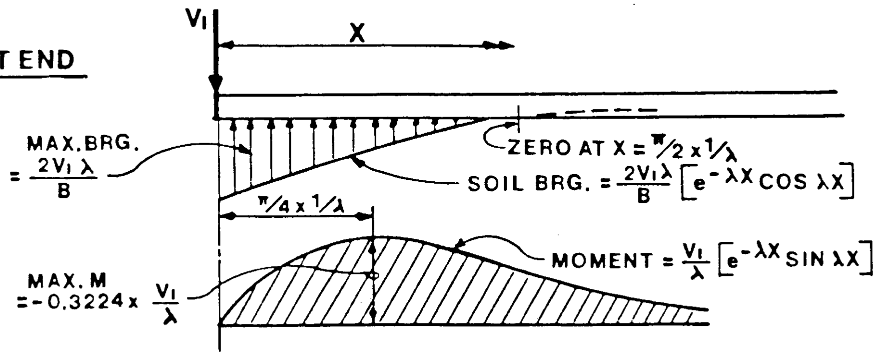
CHARACTERISTIC PARAMETER, $\lambda = \sqrt{\frac{K \times B}{4 E_c I}}$

IN WHICH:
K = MODULUS OF SUBGRADE REACTION
B = WIDTH OF BEARING
E_c = MODULUS OF ELASTICITY OF CONC.
I = MOMENT OF INERTIA

NOT NEAR END:



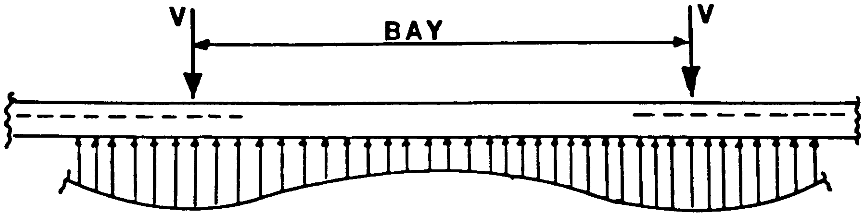
LOAD AT END



SIMPLIFIED ANALYSIS:

Let "characteristic length", $L = 1/\lambda = \sqrt[4]{\frac{4E_cI}{KxB}}$

1. Bay Not Adjacent to Corner



when BAY < 2L, treat bearing pressure as approximately uniform.

Then $+M$ @ column $\simeq \frac{V \times BAY}{11}$

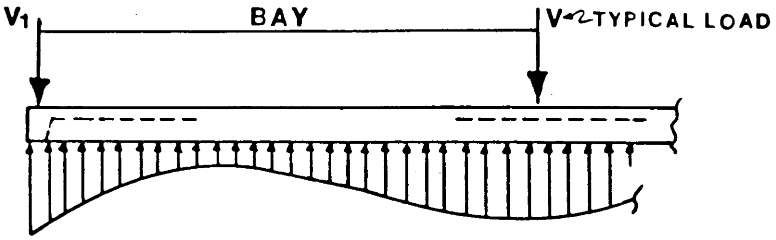
$-M$ @ Mid-Bay $\simeq$ - 50% x M @ column

when BAY > 2L: Max. brg. $\simeq \frac{V}{Bx2L}$

$+M$ @ Column $\simeq \frac{V}{Bx2L}$

$-M$ @ Mid-Bay $\simeq$ - 40% x M @ column

2. Bay Adjacent to Corner



Assume: V_1 = 1/2 of typical load, V
Edge Beam continues around (90°) corner

Then soil bearing @ corner is approximately the same as @ first typical column

When BAY <2L:

$+M$@ 1st typical col. $\simeq \frac{VxBAY}{10}$

$-M$ @ approx. 0.4xBAY from corner $\simeq$ -75%xM @ 1st typical col.

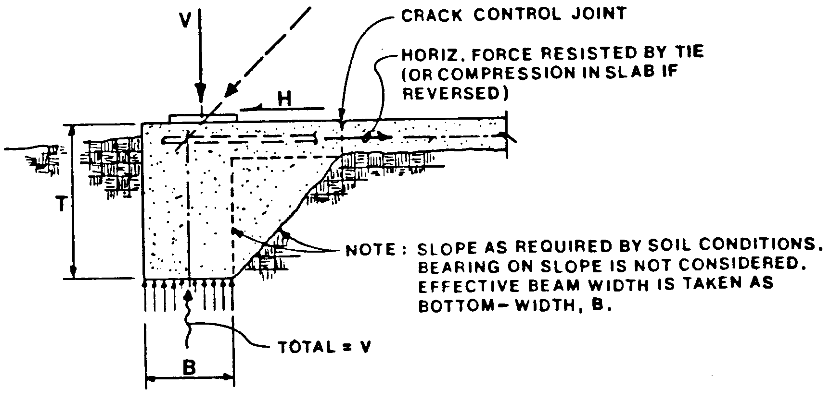
When BAY >2L:

$+M$ @ 1st typical col. $\simeq \frac{VxL}{4}$ (same as @ other typical cols.)

$-M$ near Mid-Bay $\simeq$ -50% x M @ typical col.

SUGGESTED DESIGN PROCEDURE FOR THICKENED SLAB EXTERIOR FOOTINGS

(A) COLUMNS WITH NO BASE-MOMENT



Assumed Material and Section Properties:

Subgrade Modulus, $K = 75 \text{ pci} \times (12)^3$
Modulus of Elasticity of Concr., $E_c = 3{,}500{,}000 \text{ psi} \times (12)^2$
Moment of Inertia, $I \simeq B(T)^3/12$

$$\text{Then "L" (ft.)} = \sqrt[4]{\frac{4E_c x I}{K x B}} = \sqrt[4]{\frac{4x3{,}500{,}000(12)}{12x75(12)}} \quad x \sqrt[4]{\frac{B(T)}{B}}$$

$$= 6.00\ (T)^{3/4} \quad \text{[with T in feet]}$$

Assume Concrete fc' = 3000 psi
Reinforcement f_y = 60,000 psi

T	L	Bay = 2L*
1.5'	8.13'	16'
2.0'	10.09'	20'
2.5'	11.93'	24'

(*) Approx. max.BAY for treating bearing as uniform

Design Assumptions used in example and table on following pages:

Load Factor = 1.7 for full load
Effective width (for shear and compression) = B

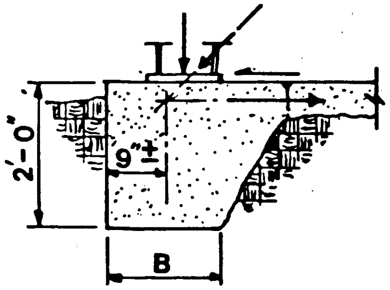
<u>EXAMPLE</u> -- THICKENED EDGE OF SLAB TO SUPPORT SIDEWALL COL.

<u>GIVEN:</u> BAY = 30' wide

Vertical Load, $V = 42^k$ Dead + Live

$= -7.2^k$ Dead + Wind Uplift

SECTION:



Material properties as on previous page

Max. allowable soil bearing = 1500 psf

<u>SOLUTION:</u>

Choose $B \simeq 2x9" = 18" = 1.5'$

Uplift: If slope = 12:12, wt. $\simeq 0.15x2(1.5+\frac{2}{2})=0.75^k/ft$

Safety factor $\simeq 0.75x30/7.2 = 3.12$ -- OK

Characteristic Length, $L = \sqrt[4]{\frac{4Ec\ I}{KB}}$ $6.0(T)^{3/4} = 10.09'$

Since BAY size >2xL, use elastic theory rather than assuming uniform bearing.

Design at columns:

$$M \simeq \frac{VL}{4} = \frac{42x10.09}{4} = 105.95 \text{ ft.-k}$$

$$\text{Max. Bearing} \simeq \frac{V}{Bx2L} = \frac{42^k x1000}{1.5x2x10.09} = 1388 \text{ psf}$$

$$\text{Max. Shear} \simeq \frac{V}{2} - \text{Brg. } (T-0.33')$$

$$= \frac{42^k}{2} - 1.388x2(2-0.33) = 16.36^k$$

Reinforcement:

Assume effective depth, d = 2.0x12 - 4 = 20"

with Load Factor = 1.7,

Reqd. $M_u = 1.7 \times 105.95 = 180.1$ ft-k

$$A_s \simeq \frac{180.1x12}{0.9\ f_y x0.9xd} = \frac{180.1x12}{.9x60x.9x20} = 2.22 \text{ in.2}$$

Use 4 - #7 Bottom @ Col., $\begin{cases}\text{2 continuous}\\ \text{2 partial length}\end{cases}$

Shear:

Ultimate capacity reqd. = $1.7 \times 16.36 = 27.81^{k}$

Capacity = $\phi \times 2 \sqrt{fc' x b x d}$

$$= 0.85 \times 2 \frac{\sqrt{3000}}{1000} \times 1.5 \times 12 \times 20 = 33.52^{k}$$

Shear reinforcement is not required.

Design at Mid-Bay:

Since maximum negative M = -50% x M @ col. for end bay, use approx. 50% as much top reinforcement as bottom reinforcement at columns

Say 2 - #7 Top, continuous
[Also, for crack control, consider adding a bar in the top of the sloped portion.]

Check Minimum Reinforcement:

ACI flexural minimum $= \frac{200}{f_y} \times bd = 1/3\% \times bd$

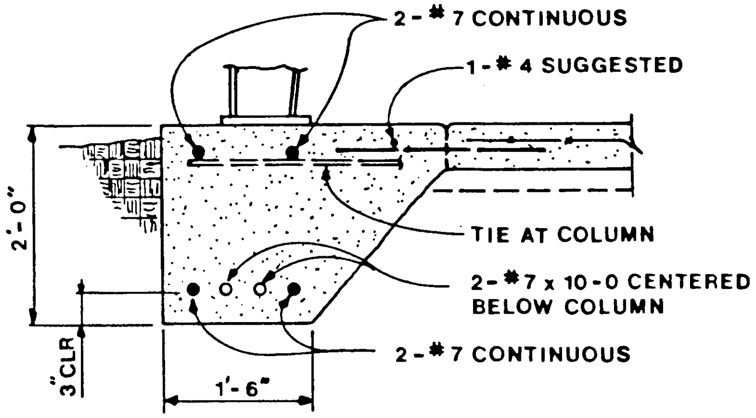
$$= \frac{1.5 \times 12 \times 20}{300} = 1.20 \text{ in.}^2 (= 2 - \#7)$$

Cut-off Points for Partial-length Bottom Bars:

For isolated load, distance to section where Moment is 50% x Max. Moment = 0.2923 L
= 0.2923 x 10.09 = 2.95'

Assuming col. width = 8", and extending bars a distance = d beyond theoretical cut-off,

Use cut-off $= \frac{8"}{2} + 2.95' + 20" = 4.95' = 5.0'$ each side of column centerline.



THICKENED-SLAB EXTERIOR FOOTING TABLE 12-1

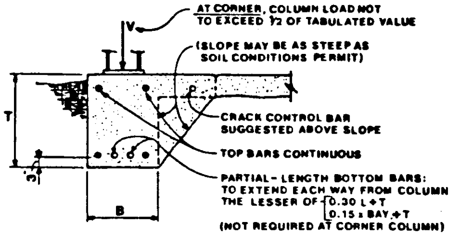
(A)COLUMNS WITH NO BASE-MOMENT

Material, Section Properties & Design Assumptions -- see p. 116

Moment and Soil Bearing Calculation Procedure:

$$\text{with "L"} = \sqrt{\frac{4\ E_c I}{K x B}} = 6.0(T)^{3/4}, \quad M = \begin{cases} \frac{VL}{4} \text{ @ column} \\ = -40\% \times \frac{VL}{4} \text{ @ Mid-Bay} \end{cases}$$

$$\text{Max. soil Brg.} = \frac{V}{2\ BL}$$

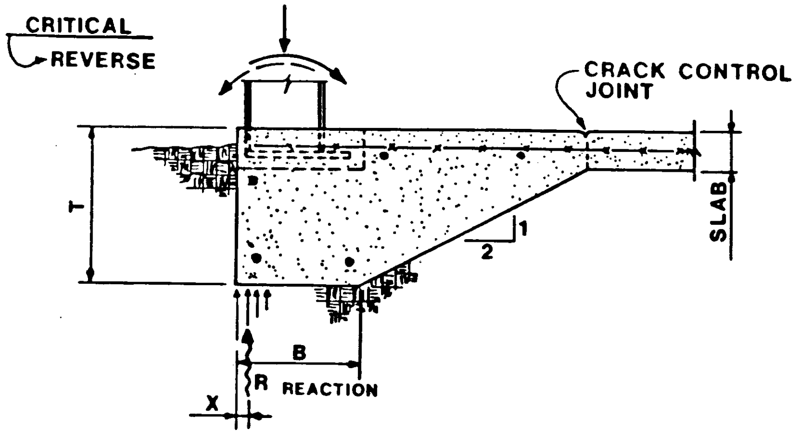


Dimensions, Ft		REINFORCEMENT			MAX. Column Load(k)	MAX.SOIL Brg.(psf) @ Max. Ld.
Depth T	Width B	Top	Bottom			
			Cont.	Partial		
1.5'	1.0'	2-#5	2-#5	None	11.4	699
		2-#5	2-#5	1-#5	16.7	1025
		2-#5	2-#5	2-#5	21.5	1322
	1.5'	2-#6	2-#6	2-#6	30.9	1266
	2.0'	2-#7	2-#7	2-#7	41.8	1286
2.0'	1.0'	2-#6	2-#6	None	18.2	904
		2-#6	2-#6	1-#6	26.8	1327
		2-#6	2-#6	2-#6	31.5	1561
	1.5'	2-#7	2-#7	1-#7	36.6	1210
		2-#7	2-#7	2-#7	46.7	1543
	2.0'	2-#8	2-#8	2-#8	61.3	1519
2.5'	1.0'	2-#6	2-#6	None	15.1	633
		2-#6	2-#6	1-#6	29.7	1244
		2-#6	2-#6	2-#6	37.7	1581
	1.5'	2-#7	2-#7	2-#7	51.5	1439
		3-#7	3-#7	2-#7	62.7	1751
	2.0	2-#8	2-#8	2-#8	67.6	1418
		3-#8	3-#8	2-#8	83.6	1751

THICKENED-SLAB EXTERIOR FOOTING -- COLUMNS WITH NO BASE MOMENT (Contd.)

Dimensions, ft		REINFORCEMENT			Max. Column Load (k)	Max. Soil Brg. (psf) @ Max. Ld.
Depth T	Width B	Top	Bottom			
			Cont.	Partial		
3.0'	1.0'	2-#6	2-#6	None	16.2	593
		2-#6	2-#6	1-#6	32.0	1170
		2-#6	2-#6	2-#6	40.6	1483
		2-#7	2-#7	1-#7	42.9	1569
		2-#7	2-#7	2-#7	52.3	1911
	1.5'	2-#7	2-#7	2-#7	55.4	1349
		3-#7	3-#7	2-#7	71.1	1732
	2.0'	2-#8	2-#8	2-#8	72.8	1330
		3-#8	3-#8	2-#8	93.5	1708

(B) FIXED-BASE ENDWALL POSTS



Assume: $V \simeq 0$ -- Reaction = weight of concrete
Help from slab beyond joint is negligible
For Reverse Moment, $x \simeq 3"$
Load Factor reqd. = 1.5

Then allowable $M = \frac{1}{1.5}$ x Moment of Concrete-Weight about R

EXAMPLE

Given:
T = 2.0'
B = 1.5'
Slope = 2:1
Slab = 6"

Solution for Allowable M: Slope length = 2(2-0.5)=3'

Area		Arm		Product
2.0x1.5=3.0 ,	x	$\left(\frac{1.5}{2} - 0.25\right)$	=	1.50
1.5x3/2=2.25,	x	(1.5+3/3-0.25)	=	5.062
0.5x3 =1.50,	x	(1.5+3/2-0.25)	=	4.125
6.75 sq.ft.				10.687 ft.^{3}

$$\text{Allowable Moment} = \frac{0.15^k/ft^2 x 10.687}{1.5} \times 12$$
$$= 12.825 \text{ in}^{-k} \text{ per foot}$$

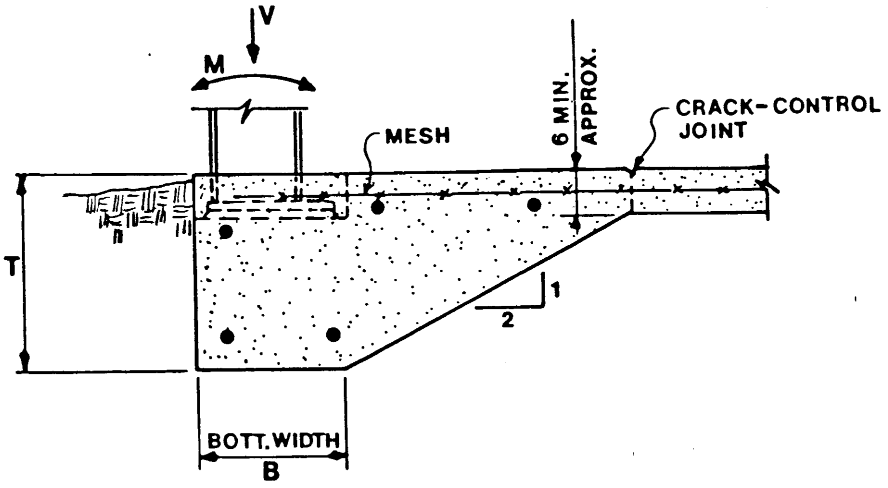
If post spacing $= \begin{cases} 20', & M = 256 \text{ in}^{-k} \\ 25', & M = 320 \text{ in}^{-k} \end{cases}$

Reinforcement for shrinkage and temperature:

0.18% = 0.0018 x 6.75 sq.ft.x$(12)^2$ = 1.75 sq.in.
4 - #6 OK (=1.76); but use 5 bars for better spacing
say 2-#6 Bottom, 3-#5 Top

THICKENED-SLAB EXTERIOR FOOTING TABLE 12-2

(B) FIXED-BASE ENDWALL POSTS



Vertical Load: +V is small
-V (uplift) is negligible

Concrete unit-weight approx. 150 psf

Suggested reinforcement based on 0.18% of concr. area, min.

See previous page for other assumptions

Dimensions, ft			Maximum Moment (in.-kips)		Suggested Temp. & Shrinkage Reinf.	
Depth	Width					
T	Bot.	Total	20'o.c.	25'o.c.	Bottom	Top
1.5'	2.0'	4.0'	178	222	2-#5	3-#5
	2.5'	4.5'	238	297	2-#5	3-#5
2.0'	1.5'	4.5'	256	320	2-#6	3-#5
	2.0'	5.0'	337	421	2-#6	3-#6
	2.5'	5.5'	430	538	2-#6	2-#6+2-#5
2.5'	1.5'	5.5'	449	561	2-#7	2-#6+2-#5
	2.0'	6.0'	566	707	2-#7	4-#6
	2.5'	6.5'	698	872	2-#7	5-#6

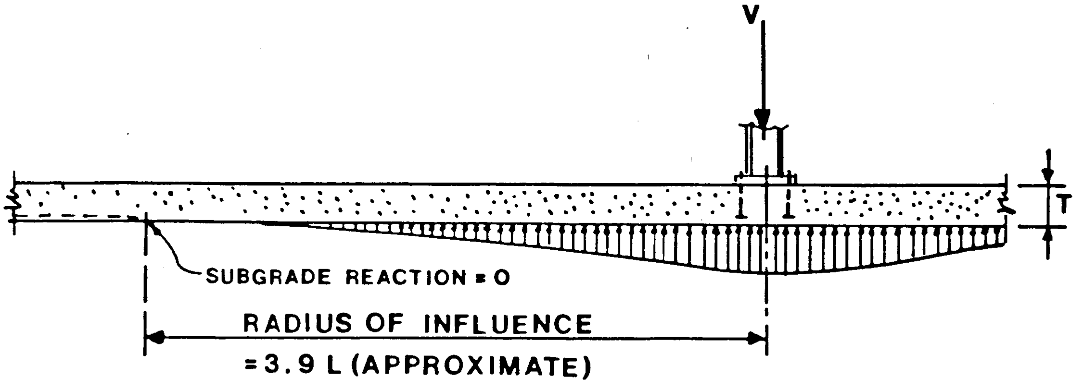
(2) SLABS AS FOOTINGS FOR INTERIOR COLUMNS

(a) Constant-Thickness Slabs

When a floor slab is of sufficient thickness (8 inches or more), light to medium column loads may be imposed on the slab without thickening.

The slab may be analyzed as an elastic plate or mat supported on an elastic subgrade. Considerations which may be critical in design include:

1. Punching shear
2. Bending under maximum load
3. Uplift
4. Crack-control jointing and/or reinforcement
5. Condition and uniformity of subgrade



For typical column and base-plate sizes, the column reaction may be treated as a point load.*

Max. Moment (Radial direction, @ Col. centerline) = V/4

"Radius of relative stiffness", $L = \sqrt[4]{\frac{E_C T^3}{12(1-\mu^2)K}}$

Where: E_C = Modulus of elasticity of slab
μ = Poisson's ratio for slab (usually taken as 0.15)
K = Modulus of subgrade reaction (typically about 50 to 100 psi per in.)

Max. Subgrade reaction $= \frac{V}{4L^2}$

(*) "Beams on Elastic Foundation" by Hetenyi, University of Michigan Press, Ann Arbor, Mich. (1946)

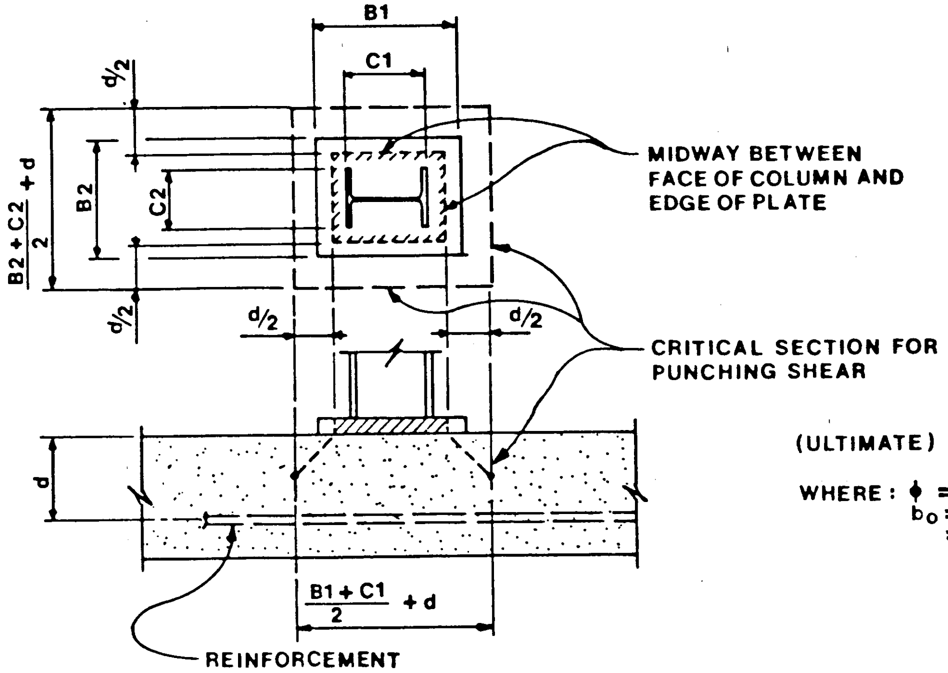
For typical slabs in the 8" to 12" range:

L is approximately 4 to 5 times thickness, T
Radius of influence is about 16 to 20 time T

with L roughly 3 to 5 feet, it can be seen that subgrade reaction for practical column loads will be very moderate (say 500 to 1000 psf maximum) so that ultimate soil bearing capacity as such is not a consideration. Rather, a uniform, dependable subgrade providing an adequate elastic modulus is the critical soil requirement.

1. Punching Shear

This is likely to be the critical limitation on column load capacity. In accordance with ACI 318-83:



(ULTIMATE) $V_u = \phi \times \sqrt{4\, f'_c}\; b_o\, d$

WHERE : $\phi = 0.85$
b_o = PERIMETER OF CRITICAL SECTION
$= B1 + C1 + B2 + C2 + 4 \times d$

2. Bending Moment with Maximum Load

Radial and tangential moments decrease with increasing distance radially outward from the load point. Assuming an uncracked slab, flexural capacity without reinforcement should be adequate at approximately 1.2 to 1.5 times "L" (about 5 to 7 times the slab thickness) from the load. Within that radius, bottom reinforcement should be provided.

3. Uplift

If uplift is moderate, so that the slab does not lift off the subgrade over a significant area, the stress may be calculated by foregoing elastic analysis but for negative load. For common ratios of net uplift to maximum positive load, stress in an uncracked unreinforced section will usually be within the allowable range. However, reinforcement (probably mesh) should be provided near the top of the slab for crack control and to insure integrity.

4. Crack-Control Jointing

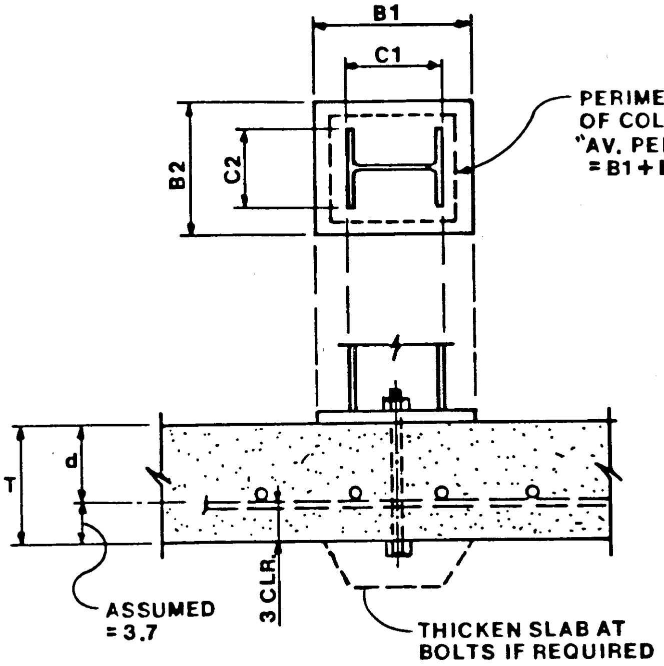
Ordinarily, crack-control joints are commonly located at columns (and at appropriate places between for long spans). But with columns directly on the slab, continuity of elastic behavior and strength is assumed in the vicinity of the columns, so that joints should be kept away from these areas (roughly 10 to 12 times the slab thickness).

5. Subgrade

A well-compacted and uniform subgrade is important for satisfactory behavior of all slabs on grade. This is especially true where substantial loads are to be placed on the slab. In addition, the subgrade and underlying subsoil must not be settlement-prone, as would be the case with loose material, soft clays, or organic soil.

CONSTANT-THICKNESS SLABS SUPPORTING COLUMNS

TABLE 12-3 -- UPLIFT & PUNCHING SHEAR CAPACITY



ASSUMPTIONS:

f'_c = 3000 psi

LOAD FACTOR = 1.7 FOR PUNCHING SHEAR
1.7 x ¾ FOR UPLIFT

FOR PUNCHING SHEAR:
RATIO (B1+C1)/(B2+B2) ≤ AND ≥ ½
d = T - 3.7

FOR UPLIFT:
LIMITED BY FLEXURAL CONCRETE TENSION IN SLAB ON ELASTIC SUBGRADE

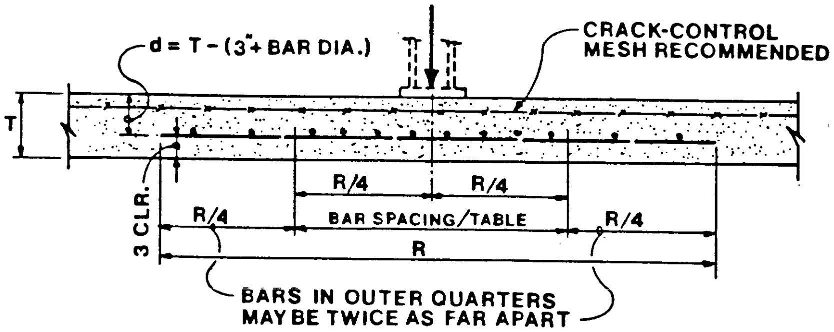
Thick-ness, T	Max. UPLIFT (Kips)	PUNCHING SHEAR	
		Av. Perimeter =B1+B2+C1+C2	LOAD (Kips)
8"	6.0	30" 36" 42"	22.2 25.1 27.9
9"	7.5	30" 36" 42"	29.7 33.2 36.7
10"	9.3	30" 36" 42"	38.1 42.2 46.4
12"	13.4	30" 36" 42"	57.5 62.9 68.4

TABLE 12-4 — CAPACITY IN BENDING

Moment calculated assuming a point load on a continuous elastic slab supported on an elastic subgrade.

Material Properties Subgrade modulus, K = 75 psi/in.
Concrete: E = 3,500,000 psi
fc' = 3000 psi
Allow (Ult.) Flexural tension = 0.65x5 $\sqrt{fc'}$
Reinforcement: Yield strength = 60,000 psi

Load Factor for ultimate strength = 1.7

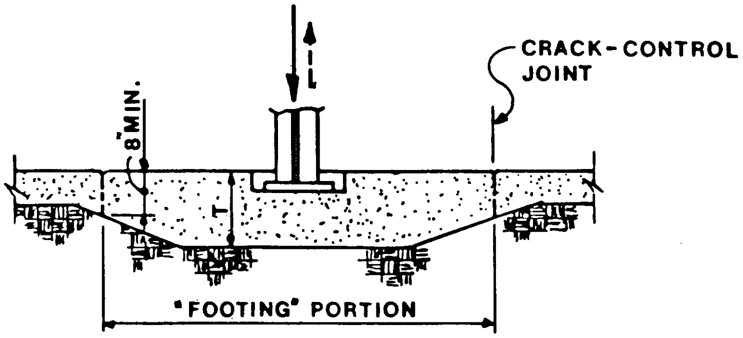


Thickness, T	BOTTOM REINF. BARS			Column Load Kips
	SIZE	Spacing @ Col.	Length, R (Ft.)	
8"	#4	@ 7"	6.0	15.1
	#4	@ 6"	6.5	17.4
	#5	@ 8"	7.0	19.3
	#5	@ 7"	7.5	21.7
	#5	@ 6"	8.5	24.7
	#5	@ 5"	9.0	28.7
9"	#4	@ 6"	7.0	21.6
	#5	@ 8"	7.5	24.2
	#5	@ 7"	8.5	27.3
	#5	@ 6"	9.0	31.3
	#5	@ 5"	10.0	36.6
10"	#5	@ 8"	8.5	29.1
	#5	@ 7"	9.0	32.9
	#5	@ 6"	10.0	37.8
	#5	@ 5"	10.5	44.4
	#6	@ 6.5"	11.0	46.9
	#6	@ 6"	11.5	50.2
12"	#5	@ 8"	9.0	39.0
	#5	@ 7"	10.0	44.2
	#5	@ 6"	11.0	51.0
	#5	@ 5"	12.0	60.2
	#6	@ 6"	13.0	68.8
	#6	@ 5.5"	13.5	74.3

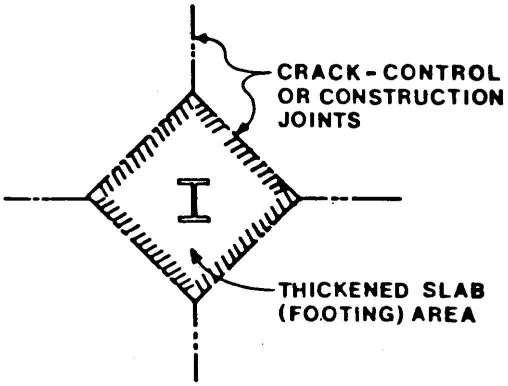
(b) Thickened Slab Supporting Interior Column

When a floor slab is thickened at a column to serve as a footing, it is recommended that the thickened area be designed to support the column load without help from the surrounding slab, except as extra uplift resistance for safety under wind overload conditions.

Any crack-control joints should run around the thickened area rather than through it, as shown in the sketch below.



SECTION



SUGGESTED PLAN

Suggested Design Procedure:

1. For punching shear:
   Select adequate thickness for full DL+LL (Neglect benefit of soil reaction within critical shear perimeter. Check <u>net</u> thickness if base is recessed.)

2. With max. uplift:
   Calculate "footing" area required to provide weight = 1.0xUplift. (Increase thickness if required to keep area reasonable.) Check for uplift safety factor, including portion of surrounding slab.

3. With Full DL+LL:
   Check net soil bearing.
   Design bottom reinforcement in "footing" area.

(See Tables on p. 131 ff.)

EXAMPLE -- THICKENED SLAB TO SUPPORT INTERIOR COL.

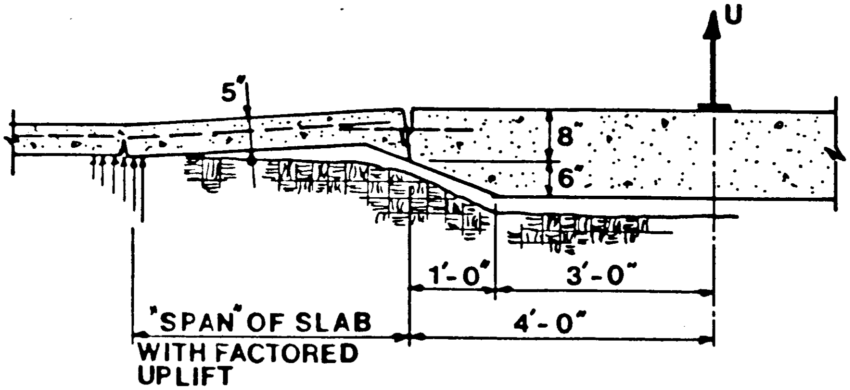
Given: Load from column: Dead + Live = 63^k
Wind + Wind Upl. = -10
Column = 7" x 7"
Base Plate = 9" x 9"
Maximum soil bearing = 2000 psf, to keep settlement small
f_c' = 3000 psi
Slab = 5" thick, except @ columns
Reinforcement grade 60 (60 ksi yield)

Solution:
Try thickness = 14"

Check Shear:
Effective depth, d ≈ 14"-3" cover - 3/4" = 10.25"
Reqd. (factored) $V_u = 1.7 \times 63 = 107.1^k$
Critical shear perimeter, $b_o = 2(7+9)+4\times10.25 = 73"$
Actual $V_u = \phi \times 4\sqrt{f_c'}\ \underline{b_o \times d}$
$= 0.85 \times 4\sqrt{3000}/1000 \times 73 \times 10.25$
$= 139.3^k$ -- OK

Area reqd. for weight to equal uplift:

Wt. @ 14" thick = 14/12 x 150 = 175 psf
Assuming avg. wt. = 160 psf,
Area reqd = 10/0.160 = 62.5 sq.ft.
Try 8.0' x 8.0' thickened area, thus:



Volume of thickened area $= \frac{14}{12}x8x8- \frac{0.5x1.0}{2}x4x2(4-\frac{1.0}{3})$
$= 67.33$ cu.ft.
Weight = 67.33 x 0.150 = 10.1^k — OK (≈ 10)

With Factored Uplift:

Assume min. resistance = 1.5 x net uplift
= 1.5 x 10 = 15k

Area of 5" slab reqd. to "hang" from edge of footing

$$= \frac{15k - 10.1k}{5/12x0.150} = 78.4 \text{ sq.ft.}$$

"footing" area = 8'x8' =64.0
Total Area = 142.4

Width of total area = $\sqrt{142.4}$ = 11.93'
− 8.0 ftg.
"Span" of slab required 3.93' ≈ 4.0'

Slab bending:

Simple $M = \frac{62.5}{8} (4)^2 = 125$ ft.#/ft.

stress, $f_t = \frac{125x6}{(5)^2} = 30$ psi -- OK

Negative bending in thickened area:

$$-M \approx \frac{10.1}{2} x \frac{4'}{2} + \frac{(15-10.1)}{4} x 4' = 15.0 \text{ ft-k}$$

Check bending in unreinforced concrete, assuming effective section ≈ 6' wide by 14" thick:

$$f_t = \frac{15.0x12x6}{6'x12(14)^2} = 0.077 \text{ ksi (=77 psi) -- OK}$$

(Allowable ultimate tension = $5\phi\sqrt{fc'}$=5x0.65 $\sqrt{3000}$ = 178 psi)

With Dead + Live Load:

Soil bearing pressure = $\frac{63k}{8x8} = 0.984 \approx 1.00$ ksf

Distance from column centerline to critical section

$$= \frac{7"+9"}{4} = 4" = 0.33'$$

With Load Factor = 1.7, reqd. $Mu=1.7x1.00x8 \frac{(4-0.33)^2}{2} = 91.6$ ft-k

Approx. reinf. area. reqd., $A_s = \frac{Mu}{\phi Fy(jd)} = \frac{91.6x12}{0.9x60(0.95x10)} = 2.14$ in.^{2}

Min. reinforcement for "flexural member" per ACI 318.77, Sec. 10.5
$= 200/fy\ bd = \frac{200}{60,000}x96x10 = 3.20$ in.^{2}

In lieu of this, provide 4/3 x 2.14 = 2.85 in.^{2}

Min. for shrinkage = 0.18% gross area=.0018(14x96-12x6)=2.29 in.^{2}

Try 9 - #5 ea. way

Average "d" with 3" cover = 14-3 - 0.62 = 10.38"

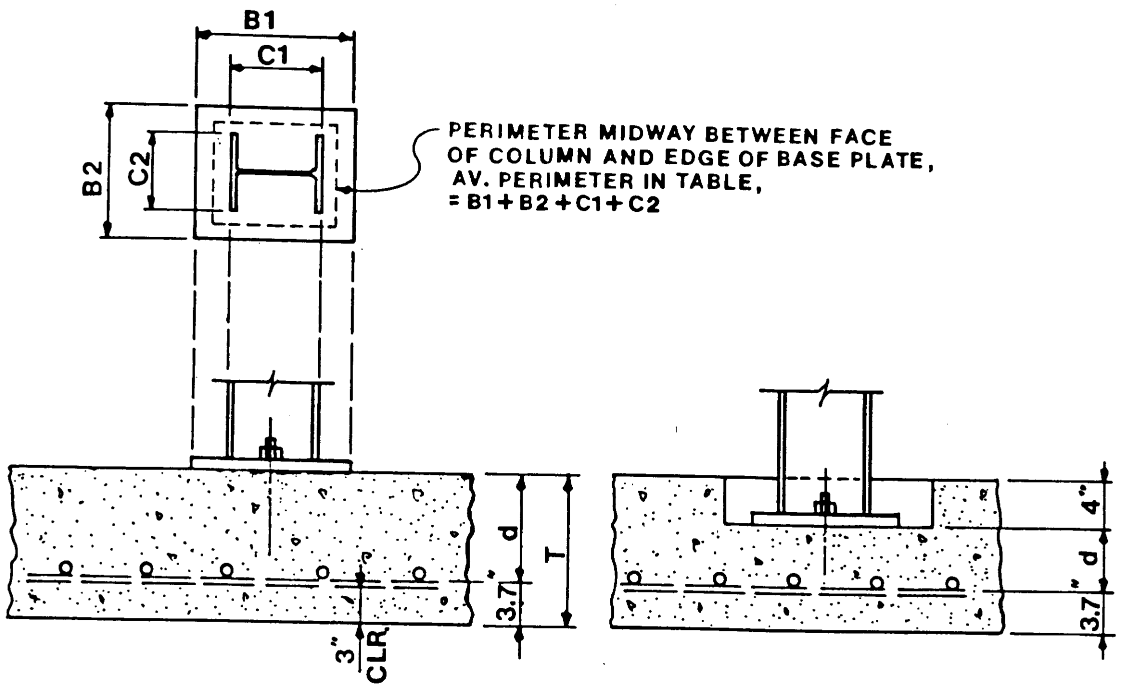
A_s x f_y = 9x0.31x60 = 167.4^k

$Mu = \phi(A_s\ f_y)(d-\frac{As\ x\ fy}{2x0.85fc'\ b}) = 0.9x167.4(10.38-\frac{167.4}{2x.85x3x96})$=1512.3 in-k

M_u/M_ureqd. = $\frac{1512.3}{91.6x12}$ = 1.376, > 4/3 -- OK

THICKENED - SLAB INTERIOR FOOTINGS

TABLE 12-5 -- PUNCHING SHEAR CAPACITY



FLUSH COLUMN BASE

COL. BASE RECESSED 4"

ASSUMPTIONS: fc' = 3000 psi
Load Factor = 1.7
Ratio (B1+C1)/(B2+C2) ≤ 2 and ≥ 1/2

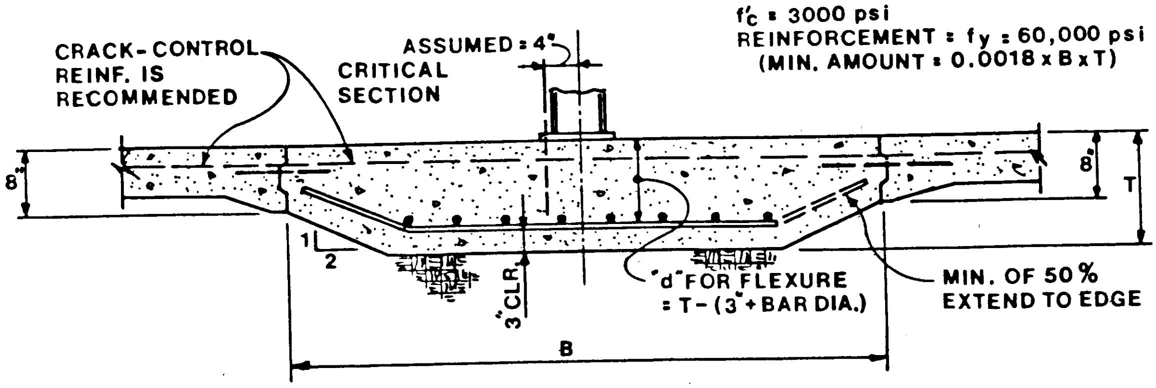
Thick-ness, T	Av. Perimeter, B1+B2+C1+C2 →	MAXIMUM PUNCHING SHEAR (KIPS)					
		Flush Col. Base			Base Recessed 4"		
		30"	36"	42"	30"	36"	42"
12"		57.5	62.9	68.4	22.2	25.1	27.9
13"		68.5	74.6	80.7	29.7	33.2	36.7
14"		80.3	87.1	93.9	38.1	42.2	46.4
15"		93.1	100.5	107.9	47.3	52.1	56.9
16"		106.7	114.8	122.9	57.5	62.9	68.4
18"		136.6	146.0	155.4	80.3	87.1	93.9
20"		170.0	180.7	191.4	106.7	114.8	122.9

THICKENED - SLAB INTERIOR FOOTINGS

TABLE 12-6 -- CAPACITY FOR UPLIFT AND MAX. LOAD IN FLEXURE

MAX. UPLIFT is taken as the weight of the footing @ 150 pcf. Confirm that adequate safety factor is provided by adjacent slab.

FOR MAX. FLEXURAL LOAD: Load Factor = 1.7 (except when reinf. < B·d/300, allow.load has been multiplied by 0.75 per ACI 318.77 Sect. 10.5.2)



Overall Ftg. Dimensions B x B x T	Max. Uplift (Kips)	Bottom Bars Ea. Way	FLEXURAL CAPACITY**	
			Max.Load (Kips)	Soil Brg.@ Max.Ld.,psf
4.0'x 4.0'x12"	2.2	5 - #4	46.3	2895
		6 - #4	48.0*	3000
4.5'x 4.5'x12"	2.8	6 - #4	47.3	2335
		7 - #4	54.7	2702
		8 - #4	60.8*	3000
5.0'x 5.0'x12"	3.4	7 - #4	48.0	1918
		8 - #4	54.4	2177
5.0'x 5.0'x14"	3.7	8 - #4	68.0	2719
		7 - #5	75.0*	3000
5.5'x 5.5'x12"	4.2	8 - #4	48.5	1602
		9 - #4	54.2	1792
		6 - #5	73.4	2426
5.5'x 5.5'x14"	4.6	9 - #4	67.7	2236
		10 - #4	74.8	2473
		7 - #5	79.8	2639
5.5'x 5.5'x15"	4.7	9 - #4	74.4	2459
		10 - #4	82.3	2720
6.0'x 6.0'x12"	5.0	8 - #4	43.7	1213
		9 - #4	48.9	1357
		10 - #4	72.0	2000
6.0'x 6.0'x14"	5.5	6 - #5	62.1	1725
		7 - #5	71.9	1999
		8 - #5	108.0*	3000
6.0'x 6.0'x16"	5.8	7 - #5	86.5	2402
		8 - #5	98.3	2730
		9 - #5	108.0*	3000

* Brg. arbitrarily limited to 3000 psf.
** PUNCHING SHEAR must be checked

Overall Ftg. Dimensions B x B x T	Max. Uplift (Kips)	Bottom Bars Ea. Way	FLEXURAL CAPACITY**	
			Max.Load (Kips)	Soil Brg.@ Max.Ld.,psf
6.5'x 6.5'x13"	6.2	6 - #5	50.8	1203
		7 - #5	58.9	1394
		8 - #5	89.1	2109
6.5'x 6.5'x14"	6.5	7 - #5	65.5	1549
		8 - #5	74.4	1760
		9 - #5	110.9	2624
6.5'x 6.5'x16"	7.0	8 - #5	89.4	2116
		9 - #5	100.1	2368
7.0'x 7.0'x14"	7.6	7 - #5	60.0	1225
		8 - #5	68.2	1393
		9 - #5	76.3	1558
		10 - #5	112.5	2295
7.0'x 7.0'x16"	8.2	8 - #5	82.0	1673
		9 - #5	91.8	1874
		10 - #5	101.5	2072
		11 - #5	111.2	2269
7.5'x 7.5'x14"	8.8	8 - #5	63.0	1121
		9 - #5	70.6	1254
		10 - #5	104.0	1849
7.5'x 7.5'x16"	9.5	9 - #5	84.8	1507
		10 - #5	93.8	1668
		11 - #5	102.8	1827
7.5'x 7.5'x18"	10.0	10 - #5	109.6	1949
		11 - #5	120.1	2136
		9 - #6	137.4	2443
8.0'x 8.0'x14"	10.1	8 - #5	58.6	915
		10 - #5	72.5	1133
		11 - #5	105.9	1654
8.0'x 8.0'x16"	10.9	7 - #6	85.8	1340
		8 - #6	97.5	1523
		9 - #6	145.4	2271
8.0'x 8.0'x18"	11.5	10 - #5	101.8	1591
		8 - #6	114.1	1783
		9 - #6	127.7	1996
		10 - #6	141.2	2207
8.5'x 8.5'x15"	12.0	9 - #5	67.4	933
		11 - #5	81.7	1131
		9 - #6	124.2	1720
8.5'x 8.5'x16"	12.4	10 - #5	81.4	1127
		8 - #6	91.0	1260
		9 - #6	101.9	1410
		10 - #6	150.2	2078
8.5'x 8.5'x18"	13.2	8 - #6	106.5	1474
		10 - #6	132.0	1827
		11 - #6	144.5	2000
9.0'x 9.0'x16"	14.0	10 - #5	76.3	943
		8 - #6	85.4	1055
		9 - #6	95.6	1181
		10 - #6	105.7	1305

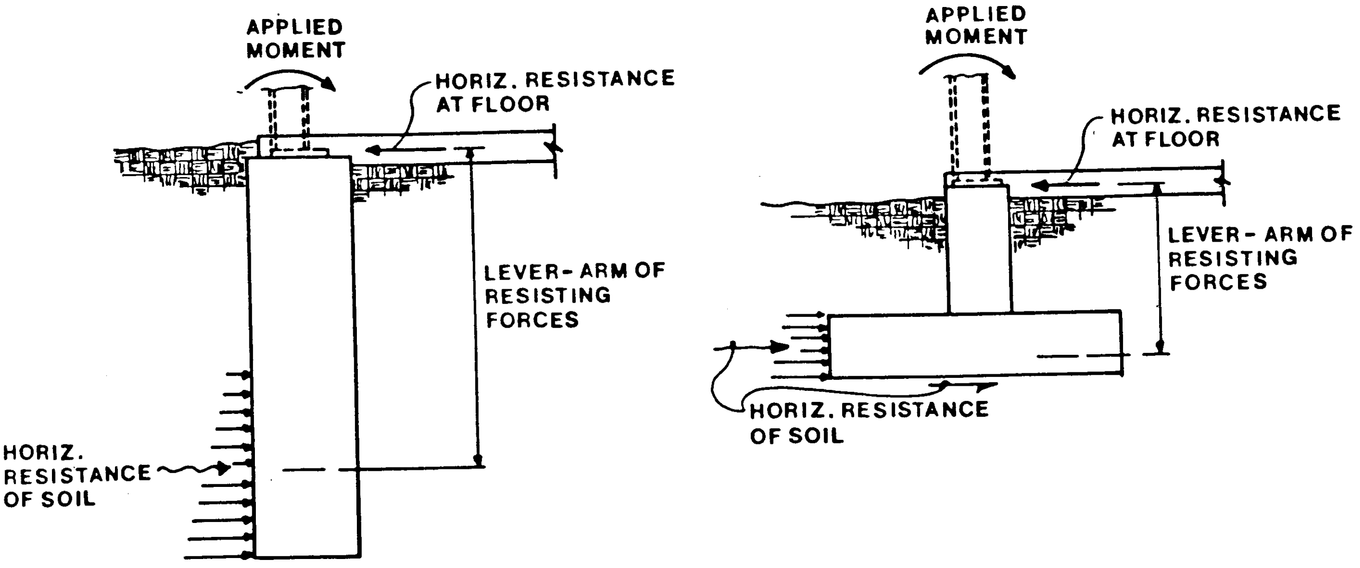
** PUNCHING SHEAR must be checked

Overall Ftg. Dimensions B x B x T	Max. Uplift (Kips)	Bottom Bars Ea. Way	FLEXURAL CAPACITY**	
			Max.Load (Kips)	Soil Brg.@ Max.Ld.,psf
9.0'x 9.0'x18"	14.9	9 - #6	111.9	1382
		10 - #6	123.8	1529
		11 - #6	135.7	1675
9.0'x 9.0'x20"	15.7	9 - #6	128.2	1583
		10 - #6	142.0	1753
		11 - #6	155.6	1921
9.5'x 9.5'x16"	15.8	8 - #6	80.4	891
		9 - #6	90.1	998
		10 - #6	99.6	1104
		11 - #6	145.5	1612
9.5'x 9.5'x18"	16.8	9 - #6	105.4	1168
		10 - #6	116.7	1293
		12 - #6	138.9	1539
9.5'x 9.5'x20"	17.7	10 - #6	133.7	1481
		11 - #6	146.5	1624
		12 - #6	159.3	1765
10.0'x10.0'x18"	18.8	9 - #6	99.6	996
		10 - #6	110.2	1102
		12 - #6	131.3	1313
		13 - #6	189.0	1890
10.0'x10.0'x20"	19.8	10 - #6	126.3	1263
		11 - #6	138.5	1385
		12 - #6	150.6	1506
		14 - #6	174.5	1745

** PUNCHING SHEAR must be checked

CHAPTER XIII - FOUNDATIONS FOR FIXED-BASE ENDWALL POSTS

To resist large column-base moments it is possible to develop restraint by means of horizontal resistance rather than by means of eccentric vertical reaction. This may be achieved by tying the top of the pier to the floor slab and embedding the bottom of the foundation into the ground to develop horizontal soil resistance as shown in Figure 13-1 below. This is a completely different concept from that outlined in Chapter VII and used in the design tables of Appendix B. Where large moments exist along with small or negligible vertical loads, as is the case for endwall posts for the Butler Landmark system, applying the method of this chapter may result in more economical designs where soil conditions provide adequate lateral resistance.



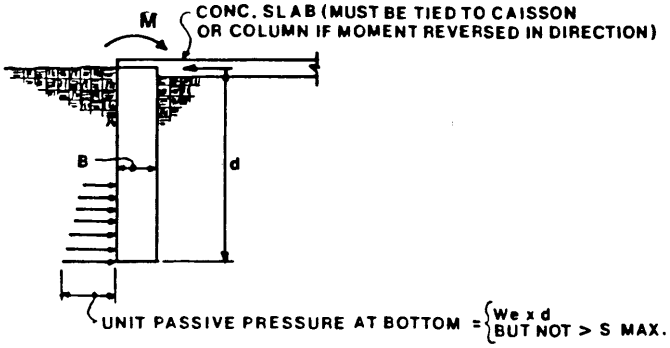
(A) CAISSON (DRILLED PIER) (B) SPREAD FOOTING

FIGURE 13-1

FOUNDATIONS RESISTING MOMENT BY MEANS OF HORIZONTAL RESTRAINT

(A) WITH CAISSON (DRILLED PIER)

The following method, adapted from the design procedure for pole foundations restrained at the groundline contained in the "Timber Construction Manual" of the American Institute of Timber Construction, may be used to find the required depth of a caisson for moment resistance.



where: W_e = Passive "Equivalent Fluid" weight for soil ⎫ See
S_{max} = upper limit of unit soil pressure ⎭ Table 13-1

With given moment M, and assumed diameter B, the required depth d is the larger of the values calculated from the following two equations:

$$d = \sqrt[3]{\frac{4.25\ M}{W_e x B}} \qquad (13.1)$$

$$d = \sqrt{\frac{4.25\ M}{S_{max} x B}} \qquad (13.2)$$

TABLE 13-1 -- ALLOWABLE PASSIVE SOIL RESISTANCE

CLASS OF SOIL	"Equiv.Fluid"wt., W_e (pcf)	Max.Pressure S_{max} (psf)
GOOD Compact,well-graded sand & gravel Hard Clay Well-graded fine & coarse sand (all drained, so water will not stand)	400	8,000
AVERAGE Compact fine sand Medium Clay Compact sandy loam Loose sand and gravel (all drained so water will not stand)	200	2,500
POOR Soft Clay Clay loam Poorly compacted sand Clay with large amts. of silt (Water stands during wet season)	100	1,500

(B) WITH SPREAD FOOTING

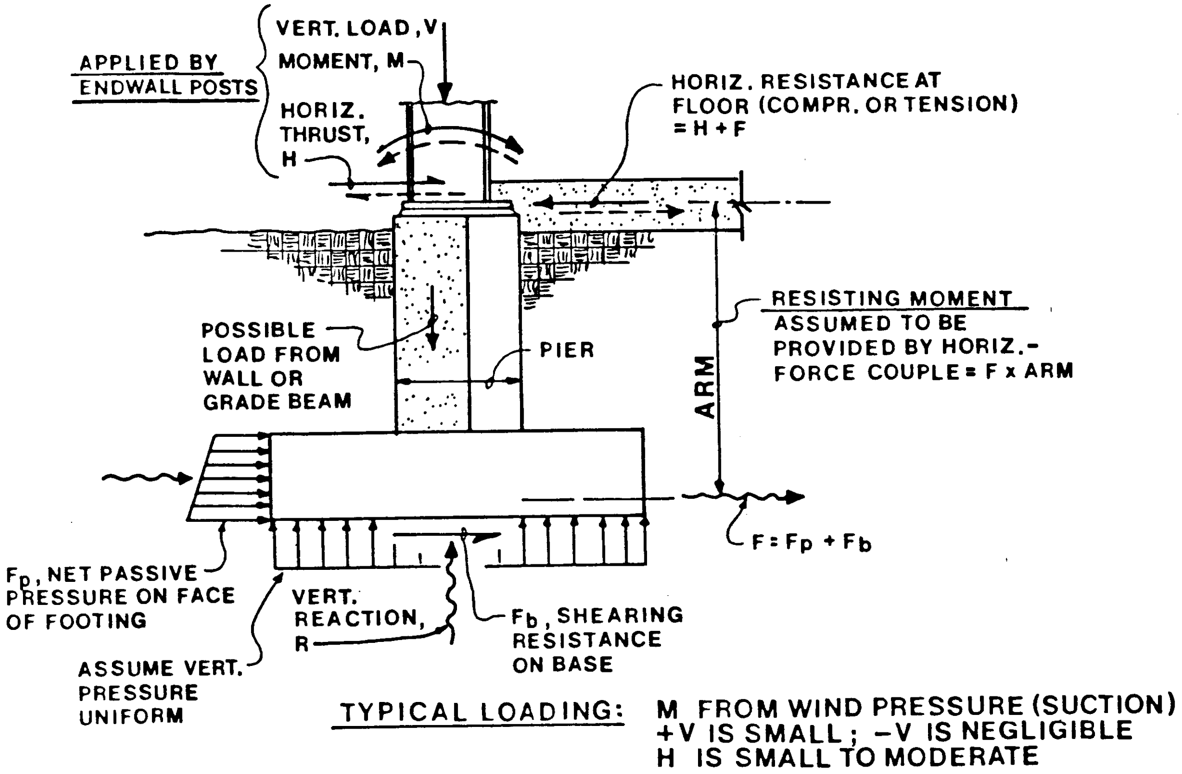
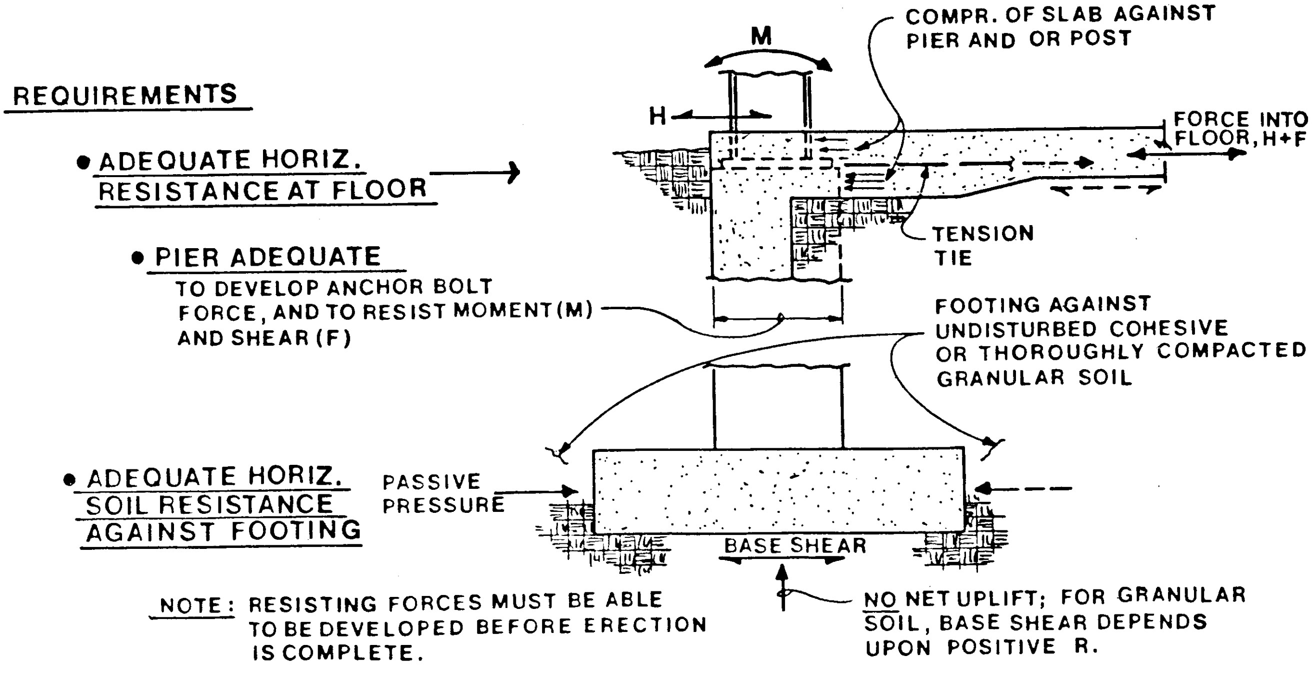
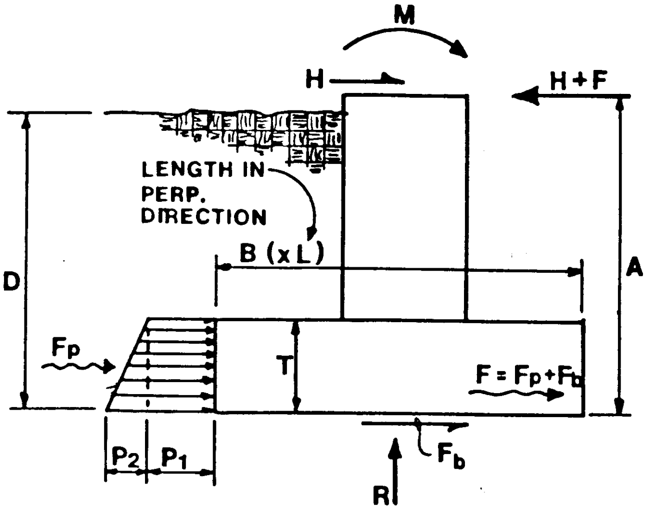


FIGURE 13-2

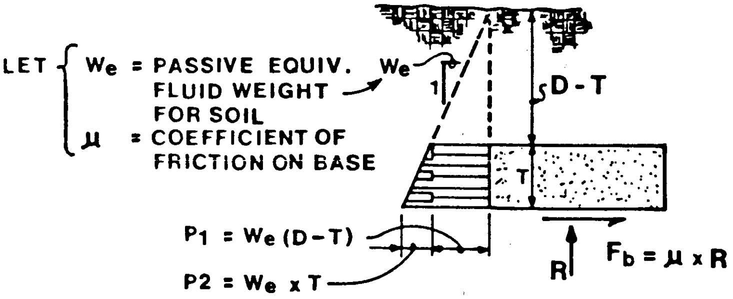
EQUILIBRIUM OF APPLIED AND RESISTING FORCES



CALCULATION OF MOMENT CAPACITY



GRANULAR SOIL:



For an isolated footing use

$$\left.\begin{aligned} F_{p1} &= P_1 \times T \times L \\ F_{p2} &= P_2 \times T \times L/2 \end{aligned}\right\} F_p = F_{p1} + F_{p2}$$

$$M = F_b \times A + F_{p1}\,(A - T/2) + F_{p2}\,(A - T/3)$$

COHESIVE (clay-like) SOIL

Let: C_a = unit adhesion of soil to base

C_p = allowable passive unit pressure

$P_1 = C_p$

$P_2 = 0$

$F_p = C_p \cdot T \cdot L$

$F_b = C_a \cdot B \cdot L$

$M = F_b\,A + F_p(A-T/2)$

SELECTION OF SOIL PROPERTIES FOR DESIGN

Calculation of the load capacity of soils (e.g. vertical bearing capacity) is most commonly based on an ultimate (failure) strength divided by a safety factor. Thus, determination of working-load resistance values for design involves the choice of a safety factor, as well as ultimate strength properties. For gravity loads (no wind), factors of safety for soils are commonly around 3. With a reduction factor of 3/4 for wind, a factor of safety of about 2.25 would seem appropriate for resisting wind moments. On the other hand, where reliance is placed on passive pressure and base friction acting together, a higher-than-normal safety factor is often suggested.

(1) Granular Soil

Passive resistance against edge of footing:

Using Rankine theory,

$$\left.\begin{array}{l}\text{"Active" pressure} = K_a\gamma h = \tan^2(45^\circ - \phi/2)\gamma h \\ \text{"Passive" pressure} = K_p\gamma h = \frac{1}{K_a}\gamma h\end{array}\right\}\text{for } \underline{\text{no slope of}} \text{ surface}$$

where: ϕ = angle of internal friction
γ = effective unit-weight of soil
(= submerged wt. if below water)
h = depth below surface

Maximum net (ultimate) passive resistance = $(K_p - K_a)\gamma h$

However, the above approach neglects three-dimensional or "end" effects which add to the capacity where members are not continuous. (This is recognized in the design of short "dead-man" anchorages and in allowable values used in pole-foundation design.) Actual capacities for intermittent footings of this type will probably be of the order of 1.5 to 2.0 times the values calculated by the two-dimensional Rankine approach.

If it is assumed that a safety factor of 2.5 is adequate with wind, and that actual resistance is 1.5 times the Rankine value, then working-load would be the Rankine value divided by 1.67.

If the foregoing assumptions are made, then working-load passive "equivalent fluid" weight, $W_e = (1/K_a - K_a)\gamma/1.67$, with representative values as follows: K_p

	Relative Density	Angle, ϕ	Unit wt., γ (moist)	K_a	Passive Equiv. Fluid wt., W_e
(a)	Loose	25	100 pcf	0.406	123 -- say 100
(b)	Medium (Firm)	32	110	0.307	194 -- say 200
(c)	Dense	38	120	0.238	285 -- say 300

COEFFICIENT OF FRICTION ON BASE:
With concrete cast against undisturbed earth, the coefficient of ultimate frictional resistance is approximately the tangent of angle ϕ. Dividing by a safety factor of 2.5, the values for the three densities listed above are respectively 0.19, 0.25, and 0.31 -- or approximately 1/5, 1/4 and 1/3.

(2) COHESIVE SOIL

Passive resistance against edge of footing:
Based on comparison of bearing capacity factors, horizontal resistance is approximately 30% of vertical bearing capacity. Conservatively, working-load passive resistance may be taken as 1/4 of the unconfined compressive strength, q_u.

Adhesion of soil to base of footing:
Ultimate values are assumed to be similar to those recommended for friction-piles, which are approximately equal to the cohesion (.5 q_u) for soft clays and about 1/2 of the cohesion for stiffer clays. Using a safety factor of 2.5, working adhesion for medium and stiff clays may be taken as 1/10 of the unconfined compressive strength.

Some Design Considerations
Check Uplift: With DL + wind uplift, Total DL $\geq$ Uplift x Safety Factor

Max. Vert. Soil Bearing: With maximum V + extra load from wall or grade beam, check soil bearing pressure.

Floor-Slab Resistance:
Is tensile capacity adequate?
Can force in slab be transferred to ground via friction?

Pier Size and Reinforcement:
Check length for development of bolts and dowels.
Reinforcement for moment; adequate anchorage in footing.
Check horizontal shear capacity.

Footing Reinforcement:
Adequate for max. soil bearing, or minimum percent steel.

Stability during Erection:
Must be adequate for all stages of construction.

EXAMPLES

Example No. 1

Given:

Load from Endwall Post:	M(in-k)	V(K)	H(K)
Dead + Live	0	16.5	0
Dead + Wind	995	-1.3	6.4
Dead + Uplift	0	-3.0	0

Medium (firm) granular soil -- for wind moment, use:
Coefficient of friction on base = 0.25
Passive-pressure equivalent fluid wt.= 200 lb/cu.ft

Depths below top/floor: grade = -1.0'
bottom of footing = -5.5'

Solution:

(a) Using Chart on p. 145

Enter upper chart with moment = 995 in-k; at depth = 5.5'
read size reqd. ≃ 8'x8'x20" (capacity ≃ 1050 in^{-k})

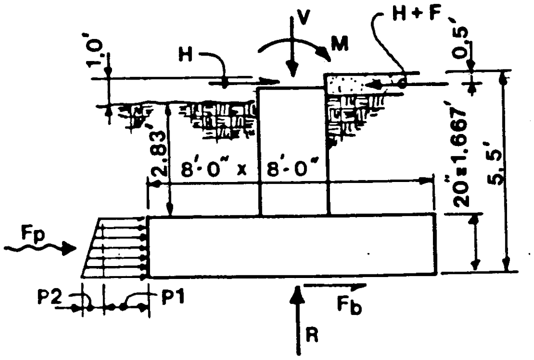
Use Footing 8'x8'x20"

From lower chart, @ 5.5' depth for this footing size,
read added horiz. thrust @ full moment capacity = 19.0^k

Therefore added horiz. thrust, $F = \frac{995}{1050} \times 19.0 = 18.0^k$

Total horiz. thrust = $6.4 + 18.0 = 24.4^k$

(b) Check by Calculation:



Assuming soil unit-wt. = 100 pcf, wt. of soil above ftg.
≃ 0.10x(4'x8'x2.833+4'x8'x3.833) = 21.33^k

Reaction, R = V+soil+ftg. = -1.3+21.33+1.667x0.150x8x8 = 36.03^k

$F_b = 0.25 \times 36.03 = 9.001^k$

$P_1 = 2.833 \times 200 = 566.6$ psf; $P_2 = 1.667 \times 200 = 333.4$ psf

$F_{p1} = 566.6 \times 8 \times 1.667/1000 = 7.556^k$; $F_{p2} = 333.4/2000 \times 8 \times 1.667 = 2.223^k$

Max. Allowable F = $9.001+7.556+2.223 = 18.78^k$

Centroid of F above base = (7.556/2+2.223/3)x1.667/18.78 = 0.401'

Moment Capacity = 18.78(5.5-0.5-0.401)12 = 1036 in^k

F = 995/1036 x 18.78 = 18.04^k

Total Thrust = $6.4 + 18.04 = 24.44^k$ @ Floor

EXAMPLE NO. 2

Given: Load from Endwall Post:

Load from Endwall Post	M(in-k)	$V^{(k)}$	$H^{(k)}$
Dead + Live	0	8.5	0
Dead + Wind	420	2.5	4.0
Dead + Uplift	0	-3.4	0

Stiff Cohesive (clay) soil -- for wind moment use:
Adhesion to base = 300 psf
Passive pressure = 750 psf
Depth of footing = 4.5' below top of floor

Solution:

(a) Approximate solution using charts on pp. 148 & 149

Interpolate between results for medium-stiff and very stiff soils for moment = 420 in-kips:

From chart for medium-stiff soil, size ≈ 5.6' square x 12"
From chart for very stiff soil, size ≈ 3.7' square x 12"
Average width = 4.65'

Try 4.5' x 4.5' x 12"

Approx. additional thrust $= \frac{6.3+12.6}{2} = 9.45^k$

(b) Check by Calculation:

Allowable shear on base, F_b = 300 psf x 4.5' x 4.5' = 6.075^k

Allowable passive pressure on face, F_p = 750 psf x4.5x1 = 3.375^k

Max. allowable F = 6.075 + 3.375 = 9.45^k

Centroid of F above base $= \frac{3.375}{9.45} \times 1/2 = 0.1786'$

Moment Capacity = 9.45 (4.5-0.5-0.1786)12 = 433 in^{-k}

$F = \frac{420}{433} \times 9.45 = 9.17^k$

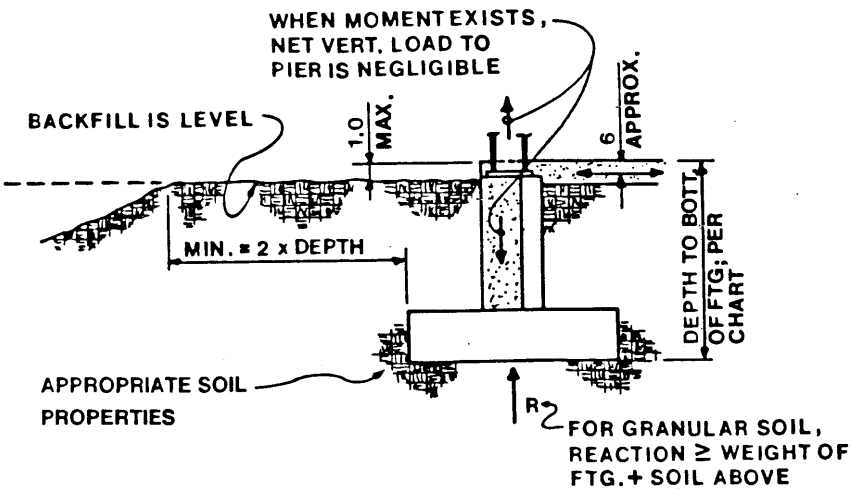
Total Thrust = 4.0 + 9.17 = 13.17^k @ floor

Net soil brg. pressure $= \frac{8.5}{4.5x4.5} = 0.42$ ksf

Wt. of soil + footing = 4.5'x4.5'(0.10x1/2(2.5+3.5)+0.15x1)=9.11^k

Uplift Factor of Safety $= \frac{9.11}{3.4} = 2.68$

REQUIRED CONDITIONS FOR USE OF CHARTS on following pages



SOIL PROPERTIES USED IN CHARTS on following pages

GRANULAR:

Relative Density →	(a) Loose	(b) Medium (firm)	(c) Dense
Coeff. of friction at base	0.20	0.25	0.333
Passive Equivalent fluid weight	100 pcf	200 pcf	300 pcf

COHESIVE:

Consistency ——→	(a) Medium	(b) Medium Stiff	(c) Very Stiff
Adhesion to base	100 psf	200 psf	400 psf
Passive Pressure	250 psf	500 psf	1000 psf

NOTE: The above are working-load values for wind loading, for soil above the water table.

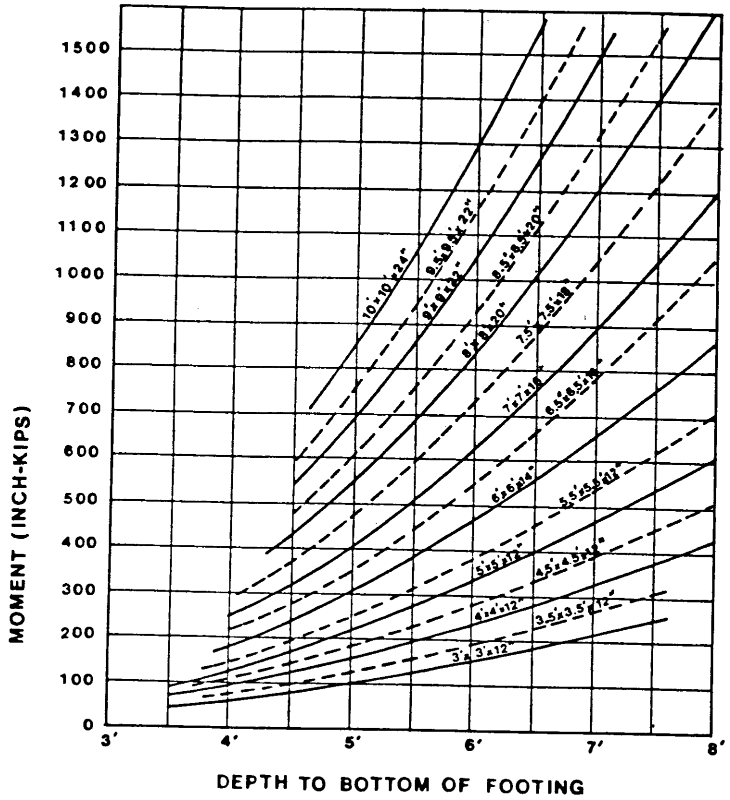
Values are considered to be representative of the type of soil indicated. However, values used in design should be chosen to provide an adequate factor of safety for the particular type and condition of the actual soil involved.

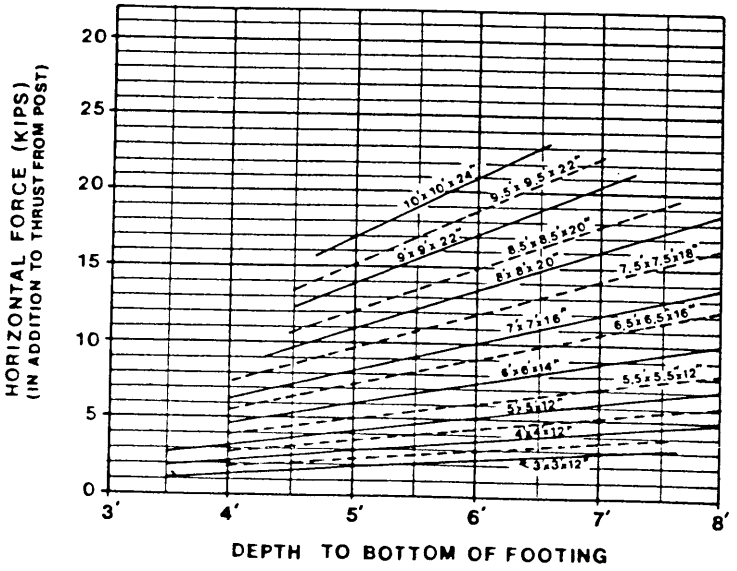
MOMENT-RESISTING FOOTINGS FOR FIXED-BASE ENDWALL POSTS

(For required conditions, see p.143)

GRANULAR SOIL - (a) LOOSE
Table 13-2

Coefficient of Friction on Base = 0.20 } Working
Passive-Pressure Equiv.Fluid = 100 pcf } LOAD

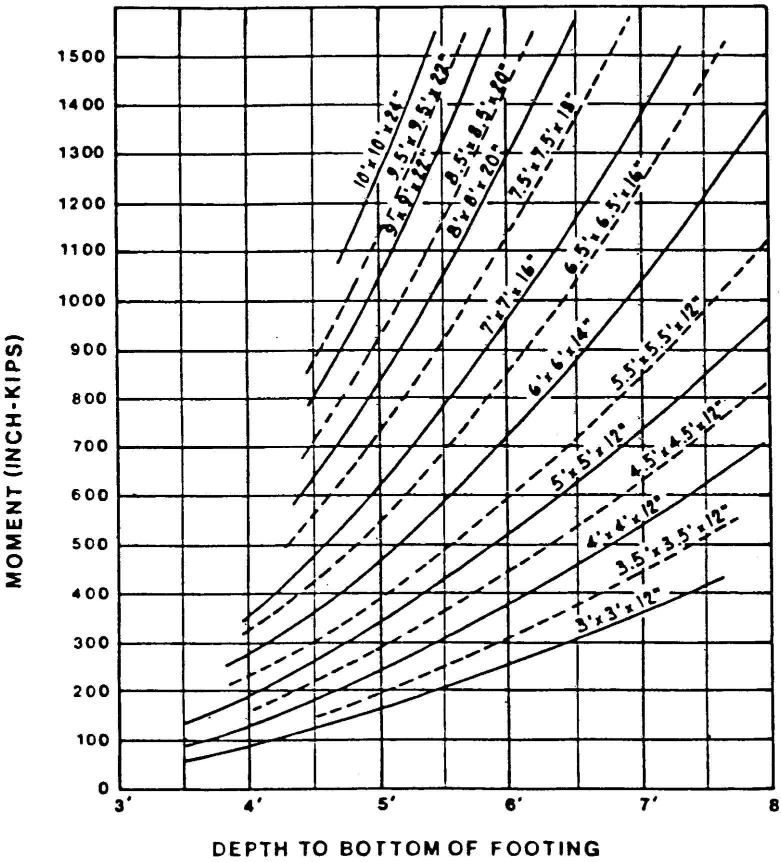


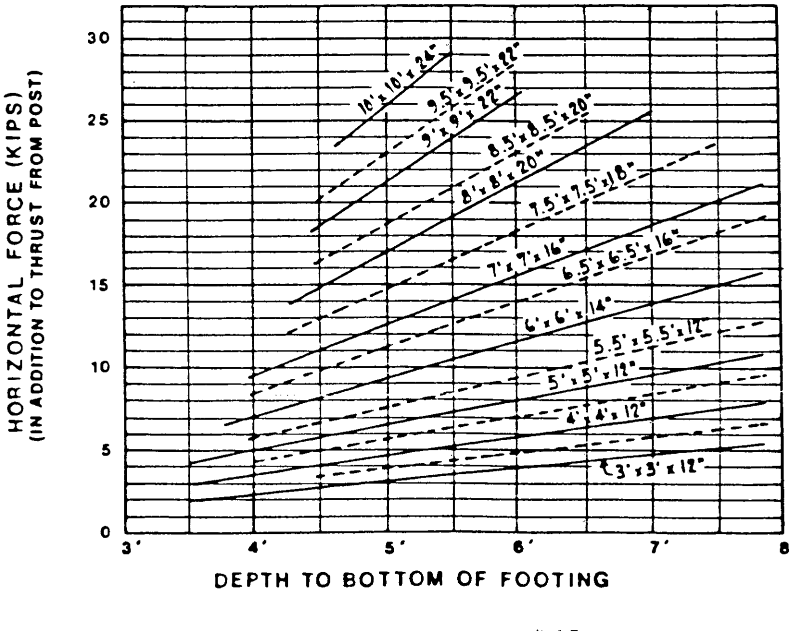


MOMENT-RESISTING FOOTINGS FOR FIXED-BASE ENDWALL POSTS

(For required conditions, see p.143)

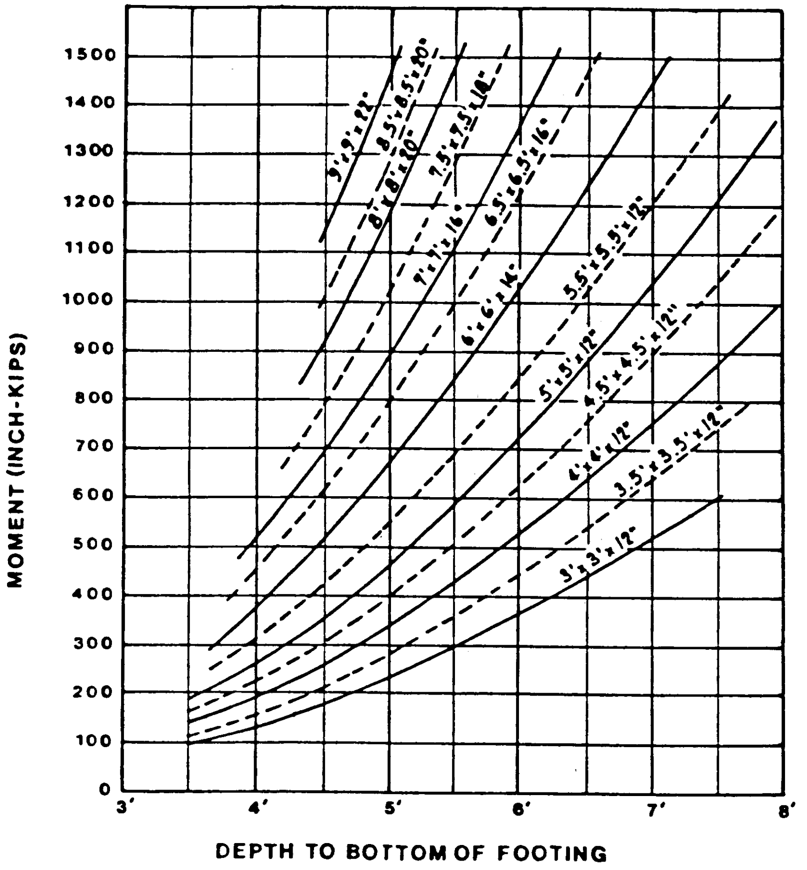
GRANULAR SOIL - (b) Medium (Firm)
Table 13-3 Coefficient of Friction on Base = 0.25 } Working
Passive-Pressure Equiv.Fluid = 200 pcf } LOAD

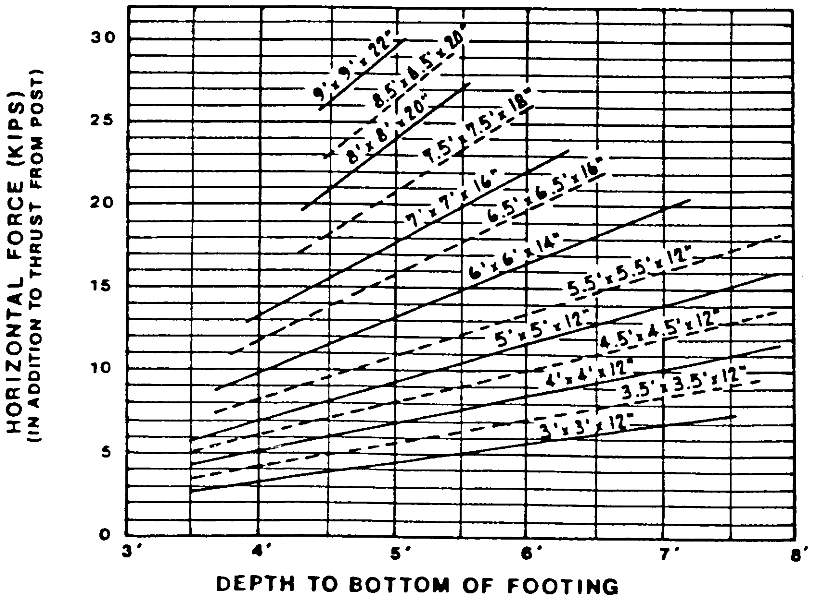




MOMENT-RESISTING FOOTINGS FOR FIXED-BASE ENDWALL POSTS

GRANULAR SOIL -- (c) DENSE
TABLE 13-4
Coefficient of Friction on Base = 0.333 } Working
Passive-Pressure Equiv.Fluid = 300 pcf } LOAD





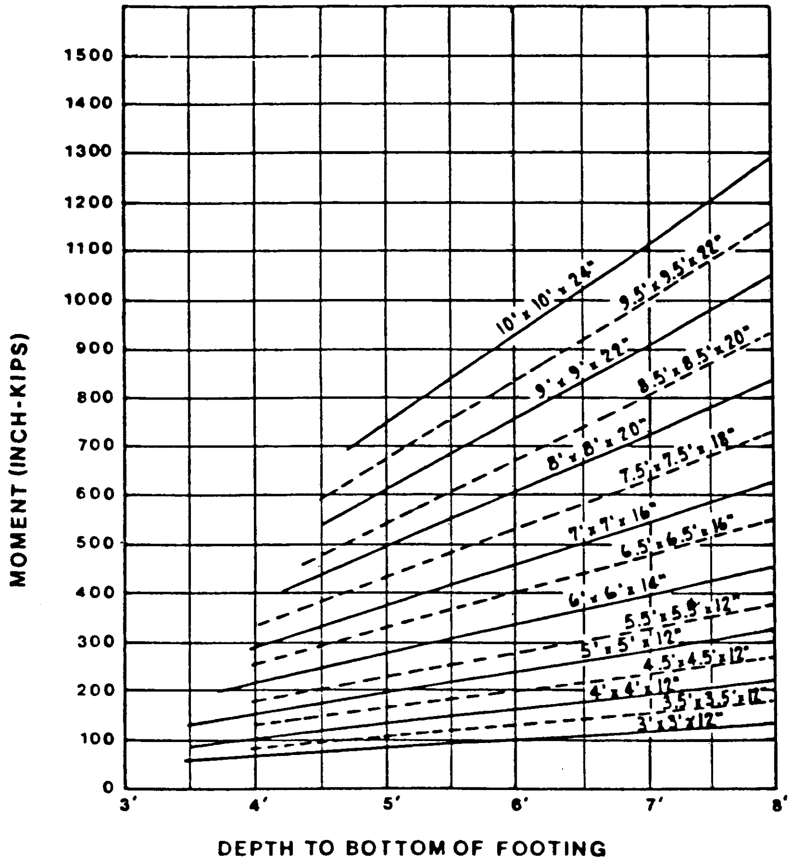
MOMENT-RESISTING FOOTINGS FOR FIXED-BASE ENDWALL POSTS

(For Required Conditions, see p.143)

COHESIVE (Clay-like) SOIL -- (A) MEDIUM

TABLE 13-5

Adhesion to Base = 100 psf } Working
Passive Pressure = 250 psf } LOAD



FOOTING SIZE	HORIZ. FORCE (KIPS)*
3' x 3' x 12"	1.65
3.5' x 3.5' x 12"	2.10
4' x 4' x 12"	2.60
4.5' x 4.5' x 12"	3.15
5' x 5' x 12"	3.75
5.5' x 5.5' x 12"	4.40
6' x 6' x 14"	5.35
6.5' x 6.5' x 16"	6.39
7' x 7' x 16"	7.23
7.5' x 7.5' x 18"	8.43
8' x 8' x 20"	9.73
8.5' x 8.5' x 20"	10.76
9' x 9' x 22"	12.22
9.5' x 9.5' x 22"	13.37
10' x 10' x 24"	15.00

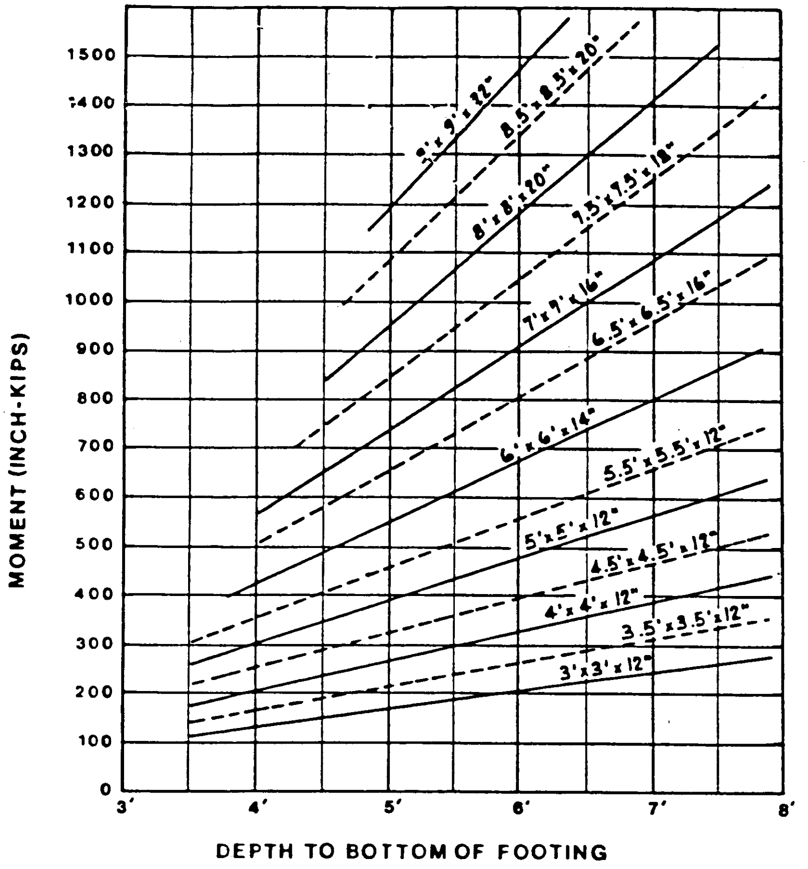
* FORCE IN ADDITION TO THRUST FROM POST

MOMENT-RESISTING FOOTINGS FOR FIXED-BASE ENDWALL POSTS

(For Required Conditions, see p.143)

COHESIVE (clay-like) SOIL - (b) MEDIUM-STIFF
TABLE 13-6

Adhesion to Base = 200 psf }
Passive Pressure = 500 psf } Working LOAD



FOOTING SIZE	HORIZ. FORCE (KIPS)*
3' x 3' x 12"	3.30
3.5' x 3.5' x 12"	4.20
4' x 4' x 12"	5.20
4.5' x 4.5' x 12"	6.30
5' x 5' x 12"	7.50
5.5' x 5.5' x 12"	8.80
6' x 6' x 14"	10.70
6.5' x 6.5' x 16"	12.78
7' x 7' x 16"	14.46
7.5' x 7.5' x 18"	16.87
8' x 8' x 20"	19.46
8.5' x 8.5' x 20"	21.53
9' x 9' x 22"	24.45

* FORCE IN ADDITION TO THRUST FROM POST

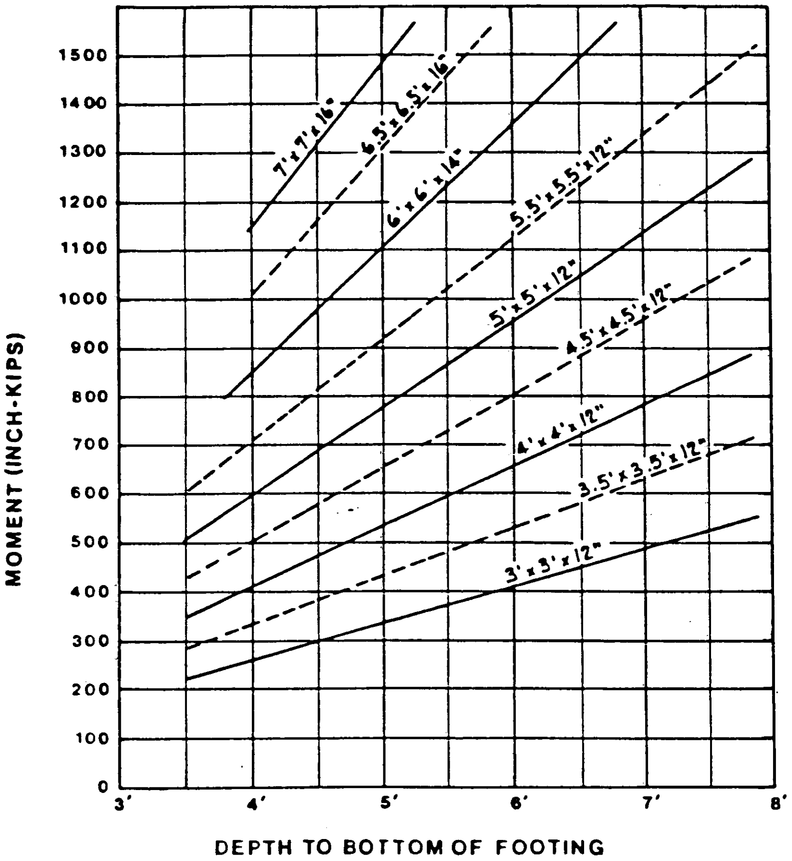
MOMENT-RESISTING FOOTINGS FOR FIXED-BASE ENDWALL POSTS

(For Required Conditions, See p.143)

COHESIVE (clay-like) SOIL — (c) VERY STIFF

TABLE 13-7

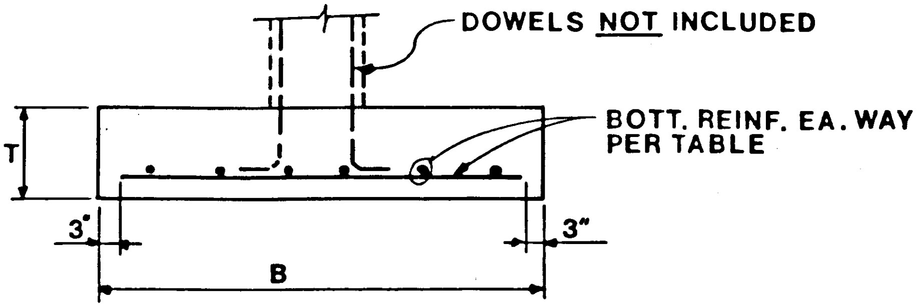
Adhesion to Base = 400 psf } Working
Passive Pressure = 1000 psf } LOAD



FOOTING SIZE	HORIZ. FORCE (KIPS)*
3' x 3' x 12"	6.60
3.5' x 3.5' x 12"	8.40
4' x 4' x 12"	10.40
4.5' x 4.5' x 12"	12.60
5' x 5' x 12"	15.00
5.5' x 5.5' x 12"	17.60
6' x 6' x 14"	21.40
6.5' x 6.5' x 16"	25.56
7' x 7' x 16"	28.93

* FORCE IN ADDITION TO THRUST FROM POST

TABLE 13-8
MATERIAL QUANTITIES FOR FOOTINGS WITH APPROX. 0.18% STEEL



FOOTING SIZE B x B x T	BOT. REINF. EA. WAY			MATERIAL QUANTITIES	
	0.18%	Bars	As	Bars(Lb.)	Concr.(Yd)
3.0'x 3.0'x 12"	0.78	4-#4	0.80	14	0.33
3.5'x 3.5'x 12"	0.91	5-#4	1.00	20	0.45
4.0'x 4.0'x 12"	1.04	6-#4	1.20	29	0.59
4.5'x 4.5'x 12"	1.17	6-#4	1.20	33	0.75
5.0'x 5.0'x 12"	1.30	7-#4	1.40	43	0.93
5.5'x 5.5'x 12"	1.43	5-#5	1.55	53	1.12
6.0'x 6.0'x 14"	1.81	6-#5	1.86	70	1.56
6.5'x 6.5'x 16"	2.25	8-#5	2.48	101	2.09
7.0'x 7.0'x 16"	2.42	8-#5	2.48	110	2.42
7.5'x 7.5'x 18"	2.92	7-#6	3.08	147	3.13
8.0'x 8.0'x 20"	3.46	8-#6	3.52	180	3.95
8.5'x 8.5'x 20"	3.67	9-#6	3.96	215	4.46
9.0'x 9.0'x 22"	4.28	10-#6	4.40	254	5.50
9.5'x 9.5'x 22"	4.51	8-#7	4.80	294	6.13
10.0'x10.0'x 24"	5.18	9-#7	5.40	349	7.41

CHAPTER XIV - FOUNDATION CONSTRUCTION

This chapter includes two basic areas which will be covered. The first relates to overall construction of foundations as dictated by engineering requirements. This will include proper preparation of soil, placing of reinforcing, forming, etc,. The second area relates to installation of anchor bolts. This has been a particularly important field problem and requires special attention.

General Construction Requirements

The first and most significant point that should be made relates to comments made several times in this manual about the variability of soils. Footing depths are established all too often from a limited number of soil borings. It is entirely possible that the proposed elevation for a given footing are inappropriate due to a localized pocket of weak, soft, compressible or organic materials. The authors firmly believe that the decision regarding the adequacy (or inadequacy) of the soil bearing at a particular footing location should be that of the design engineer. The excavator, forms carpenter or concrete contractor should not be permitted to decide on the proper base elevation for a footing and especially should not be permitted to raise (or lower) footings from the elevation shown on the drawings, without written approval.

On the other hand, the designer should encourage and request contractors to alert him to any questionable soil conditions. A concerned, observant contractor is a welcome addition to the total construction "team".

If the foundations are to be placed on clay soils, use can effectively be made of the pocket penetrometer. This instrument is especially valuable in locating the poor soft soils which are improper for use in the structure. Low readings may suggest deepening the footings to get below the "soft spot".

Portland cement concrete will set up under water. This means that footings can be placed even if the excavation is full of water. However, the water-cement ratio would go up considerably under such conditions and the mix design would have to be adjusted to account for the extra water. It is preferred procedure to pump any water from the excavation prior to placing concrete.

The bottom of footing excavations should be flat and level, free from debris and large rocks and organic materials. Reinforcing bars should be spaced uniformly per the plans on bricks or other stable support. Bars which fall from their supports during placing operations are likely to be structurally ineffective.

The authors have had numerous experiences with the question of whether it is necessary to form footings or whether the concrete may be "poured in the hole" without form work. It is our opinion that form work is not necessary and adds an unneeded expense to the job. There may, in fact, be a structural benefit to not using forms. This comes from the fact that when forms are used, the space between the form and the side of the hole must be filled. This space may be narrow and it will be difficult to compact the soil placed in this area. Without forms the concrete fills all the spaces and no compaction is needed. Clearly for footings in loose sands or sandy silts, formwork will be required. Many local building codes require that footings be formed.

A danger which may result from not using forms relates to having the footing end up to be too thin. One can only caution the need for inspection of all footing construction. Once the footings are back filled there is little that can be done, short of expensive underpinning, in the event of a "mistake".

An important aspect of footing construction relates to concrete placement. Often the footing will be considerably below the ground surface and the tendency will be to "drop" the concrete into the hole rather than place it. Concrete should not be dropped into forms. Dropping causes segregation and resulting poor quality. Concrete dropped through a deep pier is especially poor. The paste will stick to the bars and forms while the coarse aggregate drops to the bottom. This condition is common and results in exceptionally poor concrete quality.

Use of vibration is helpful to avoid segregation. Vibrators are commonly used to improve the overall uniformity of concrete in all types of construction. It is especially useful in cases where concrete placement is difficult. (Most people in the construction business use the expression "pouring concrete". Strictly speaking, concrete should be placed; concrete should not be wet enough to be "poured".) Both experience and research have shown that vibration cannot be overdone in concrete. Vibration is an effective means of insuring that the concrete will be adequately bonded to reinforcing bars and anchor bolts.

Reinforcing bars should be placed to the accuracy required by the ACI Code. This generally means a ± 1/4" placement tolerance.

Anchor Bolts

Anchor bolts play a multiple role in the footing-column interaction.

(1) Anchor bolts serve to connect column to footing (or pier) in the right location. Properly located and positioned anchor bolts will almost assure proper fit up of structural members above. Since anchor bolts are so critical to proper alignment of the column they are always located with a template. The common steel used for anchor bolts is ASTM A307. The anchor bolts usually are placed with about 5 inches of thread projecting from the concrete. This permits the use of leveling nuts. These nuts are run down the bolt threads and are thus underneath the base plate. In this way the column base plate can be accurately leveled to assure the plumbness of the column. The space between the bottom of the base plate and top of the footing is then grouted with a non-shrink grout.

(2) Anchor bolts hold columns during erection of structure. In many buildings it is common and accepted practice to use the anchor bolts to support columns until beams and X-bracing can be installed. The authors are aware of a recent situation in which 12" long anchor bolts were to be installed in a spread footing. The footing was to be 16 inches thick but was constructed only 10 inches thick. The anchor bolts were pushed or "stuck" into the wet concrete and in leaving the proper projection of the bolt out of the top of the concrete, the workman pushed the hook through the footing and down into the soil. The anchor bolt hook was obviously totally ineffective (being anchored in the soil). An iron worker was severely injured when the column and beam he was working on (30 feet in the air) tipped over. The anchor bolts simply pulled out of the concrete until the hook caught on the bottom of the footing. This tragic story has a number of significant messages for all of us.

(3) Anchor bolts transfer vertical uplift forces from column to footing.

(4) Anchor bolts transfer horizontal shearing forces from column to footing.

The most complex situation involving anchor bolts is the condition wherein large shears in combination with high tensions or compressions exist. The strength of the bolt itself is well known but when the bolt is anchored in a concrete pier or footing it is the concrete that controls the bolt capacity. (See Chapter X for a discussion of anchor bolt design.)

There are a number of factors that are significant in terms of the use of anchor bolts.

(a) Proper confinement of the concrete between and around these bolts is essential. The most effective means yet developed is the use of horizontal bent rebars or ties around the bolts to form a "bolt cage".

(b) A proper space must be maintained between anchor bolts and ties so that concrete can be properly placed. The area in and around the anchor bolts is likely to be highly congested and concrete placement will be difficult at best. The authors are aware of a failure of one structure requiring major, expensive repairs because the pier into which the anchor bolt cage was placed was so congested that concrete could not be properly placed around the bolts and ties. As soon as the column horizontal shear force (due to the roof dead load) was developed the piers exhibited major spalling and cracking and the ensuing examination revealed major voids in the concrete.

(c) Properly positioned, tightened anchor bolts are the only means by which a column moment may be transferred to a footing or pier. If this assumption is made in the design and the footing is designed for this moment, then the proper moment transfer is both reasonable and warranted.

Anchor bolts generally develop their anchorage capability from two sources. First there is a basic adhesion of the concrete to the anchor bolt. This "adhesive bond" accounts for a portion of the anchorage strength. The other aspect of anchorage is called "mechanical bond". This comes from the mechanical anchorage of the head of the bolt if a standard bolt is used or from the bent leg of the bolt which is hooked into the concrete.

Strength of Anchor Bolts

It should be emphasized that anchor bolts play an important part in the column-foundation interaction. Poorly placed concrete and/or misalignment will undoubtedly reduce the capacity of anchor bolts and care should be exercised to insure that the full design value can be developed.

CHAPTER XV - EXPLANATION OF TABLES AND DESIGN EXAMPLES

The Footing Tables in this manual were developed to aid the engineer and contractor with foundation design. The Tables provide much information that cannot be found in existing manuals. For example, the CRSI Design Handbook does not include effects of bending moments and is limited to the axial load case only. Many Butler buildings are subjected to loadings which result in small axial loads with large bending moments. The authors are aware of no manual providing designs of this type.

The Footing Tables were designed specifically to fit the needs of Butler Manufacturing Co. As a result there are certain material, dimensional and other restrictions which are built into the computer programs which generated the Footing Tables. These are described as follows:

(A) Constants in Tables:

(1) Reinforcing Steel:

(a) ASTM 615-Grade 60 (F_y = 60,000 psi). See Section (H) for application of Grade 40 bars.

(b) Reinforcing Bar Cover.

Bottom Face - (Parallel x-axis) either 3.0" or 7.5"

Bottom Face - (Parallel y-axis) 4.0" or 8.5"

(c) Minimum Steel Area = 0.18% of gross concrete area.

(d) Maximum Bar Size is based on development length or a maximum spacing of 18".

(2) Concrete:

(a) Density is 150 pounds/cubic foot.

(b) Concrete strength 2000 and 3000 psi.

(c) Ultimate strength design is used for concrete.

(d) One-way shear limit is $2\sqrt{fc'}$.

Punching shear limit is $4\sqrt{fc'}$.

(3) Soil:

(a) Soil strength of 1, 2, 3, 4 and 5 kips per square foot.

(b) Allowable soil pressures for moments are 25% higher than allowable soil pressure for axial loads only.

(4) Dimensions:

(a) Minimum footing size is 2.5' x 2.5' x 10".

(b) Footing lengths and widths are listed in 0.5' increments and footing thicknesses in 1 inch increments.

(c) Minimum pier size is 10" x 10" and is assumed to be concentrically located.

(B) Design Philosophy

Another important aspect of the Footing Table development relates to design philosophy. Steel structures are generally designed using elastic design methods and working loads. Concrete structures, including footings, are designed by both working stress and ultimate strength methods. Although the ACI Code recognizes principally ultimate strength methods, with working stress procedures only as an alternate treated in Appendix B, many engineers in practice continue to use the working stress method. Finally, most soil engineering is done using a working load - allowable stress approach. This manual was developed using ultimate strength design methods for concrete and a working stress approach for soil engineering in keeping with what the authors feel is common practice.

(C) Load Factors

In using the ultimate strength design method, the ACI Code permits the use of two different load factors (factors of safety). A load factor of 1.4 is used for dead loads and 1.7 for live loads. The philosophy behind two values is that dead loads are more easily computed and predictable than live loads and can thus have a lower factor of safety.

In design work, and especially in preliminary design, the engineer may not know exactly what precentages of loads may exist. Also the ratio of DL to LL will vary from structure to structure. As a result and in the interest of both conservatism and speed, these load tables assume all load to be live load and a 1.7 load factor is used in all designs. For a structure that has 50% DL and 50% LL these tables are 9.6% on the conservative side.

(D) Stress Increases for Wind and Earthquake Loads

Another important point concerning use of the tables relates to loading conditions which include effects of wind or earthquake. Most building codes permit increases in allowable stresses of 33% when wind or earthquake loadings are being considered. The problem of designing for wind or earthquake can simply be handled by entering the tables with load and moment values equal to 3/4 of the normal amount. This will automatically compensate for the permitted increases in stresses.

(E) Sign Conventions

The sign conventions and terms used in the tables are shown for convenience in Figure 15-1.

(F) Concrete Cover on Rebars

Another aspect of the use of these tables which requires comment relates to the fact that two values of concrete cover for the rebars are used (3.0" or 7.5" at the bottom layer of bars). For the case of the footing with little or no moment plus a downward axial load, the rebars would be most efficiently placed (from a structural point of view) near the bottom of the footing. The ACI Code requires 3" of clear cover so that 3.5" to the center of the bars is called for in all such cases.

However, in many Butler building structures, large moments and small (or upward) axial loads exist. For such cases the best location for the rebars is not near the bottom. In a cantilever retaining wall for example, rebars are placed in the bottom of the toe section and in the top of the heel section of the footing. The use of top bars in a footing is a construction problem since these bars must be suspended in some manner. This is a particular problem when no formwork is used and there is nothing to use for the support of the top bars.

To avoid this situation the tables have been developed using only one layer of bars. When top bars would normally be required to accommodate top tensile stresses due to large bending moments, these "raised" bars will provide the necessary reinforcement. The 8" dimension used to the center of the steel means that a 7.5" bottom cover would be required. This can easily be provided using standard sections of concrete block which are readily available at most construction sites.

(G) Overburden

Chapter VII includes a discussion of the overturning potential of some footings (those subject to large moments with small or upward axial loads). It may be necessary in such cases to place these footings deeper in the ground than required for proper frost protection. The design tables give a value (in kips per square foot) of required "overburden". This is the required weight of earth or concrete above the footing, needed to provide a proper factor of safety against overturning. For determining the depth (in feet) that the footing must be "lowered" to prevent overturning, the user must simply divide the listed "overburden" pressure by 0.1 (which is an average weight of soil). If concrete is to be used divide by 0.15.

If no value appears in the "overburden" column in the table there is no potential for the footing to overturn.

(H) Use of Footing Tables

Appendix B includes the Footing Tables which provide the necessary information for the majority of footing problems encountered in the design of Landmark, and Widespan and Space Grid buildings. Five sets of tables are provided for axial loads of -20, -10, -5, 0, 5, 10, 20, 30, 40, 50, 60, 80, 100 kips in combination with moments of 0, 250, 500, 750, 1000, 1250, 1500, 2000 inch kips for each of five soil pressure values.

The tables are entered using the design axial load and moment (adjusted by .75 if wind or earthquake are involved). In addition to providing the user with the required overburden the tables also give the footing dimensions X, Y and T, the total area (sq. in.) of required steel reinforcement, the required cover, the maximum size bar that can be used (based on ACI anchorage and development criteria), the total steel weight (lbs.) and the total volume of concrete (cu. yds.). Five footing sizes are given for each moment. For the case of axial load only, only one size is provided.

Accurate answers can be obtained by interpolating between the Tables. If the user does not wish to interpolate, a conservative answer can be obtained by comparing the results in the two tables with axial loads that bound the actual design load and using a moment value greater or equal to the design moment.

Although the Tables were specifically developed using Grade 60 reinforcing bars, Grade 40 bars may be substituted as follows:

(1) When no * appears next to the listed steel areas then an equal area of Grade 40 steel may be substituted for the Grade 60 steel.

(2) When a * appears Grade 40 bars may be substituted for the Grade 60 bars provided the area of the Grade 40 bars is increased by 50%. This procedure will always lead to a conservative design. In some cases this procedure yields overly conservative results and the engineer may wish to perform calculations to determine Grade 40 steel requirements more accurately.

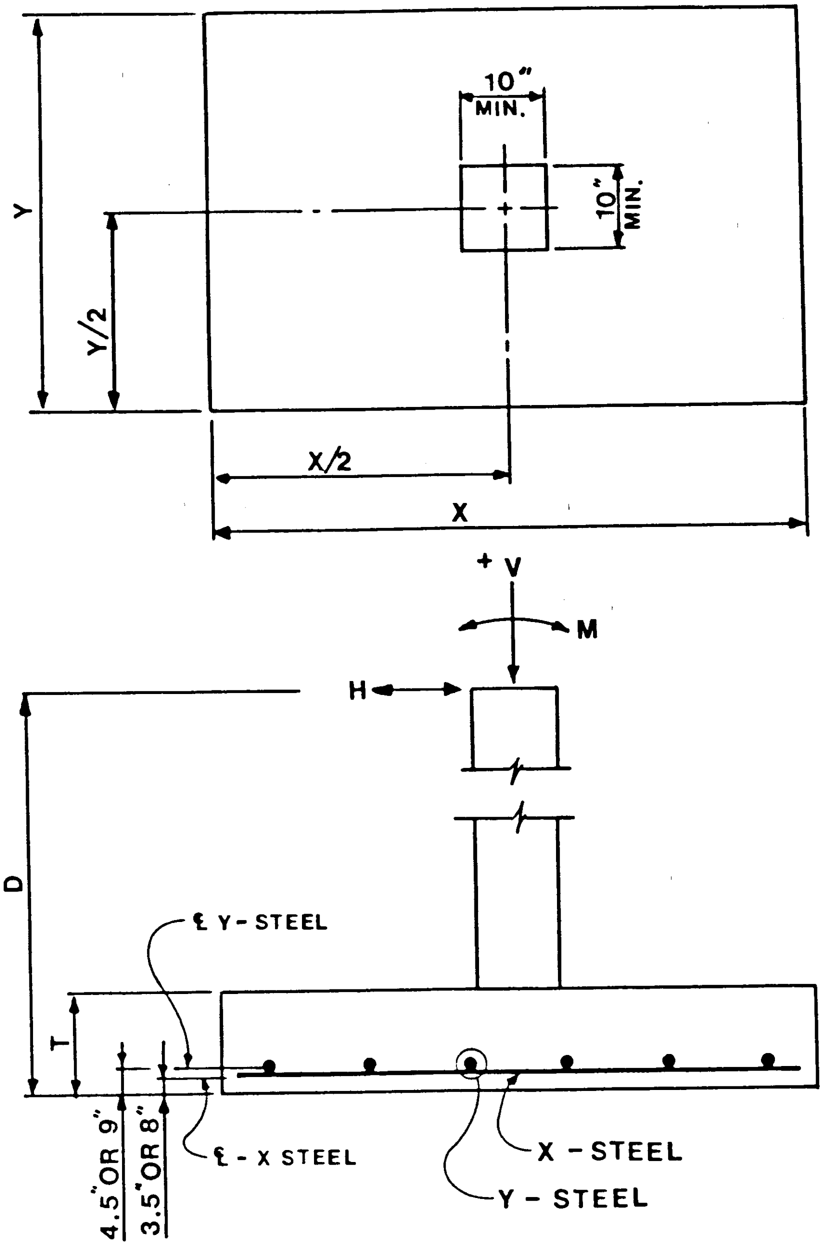


FIGURE 15-1
NOMENCLATURE FOR FOOTING TABLES

Design Examples

Three design examples are provided herein:

Example 1 has four parts. The loading for each part is similar to the type of loading that exists on the Landmark Endwall Post footings. Following the longhand solution is an example of how the footing design tables can be used to solve the same problem.

Example 2 has three parts. Each part illustrates a different system for which a horizontal thrust on a footing can be resisted. A solution based on use of the footing tables follows the longhand solution.

Example 3 gives the solution for the design of a footing for a 29 foot eave height Landmark Endwall Post using the footing tables.

EXAMPLES

EXAMPLE NO. 1

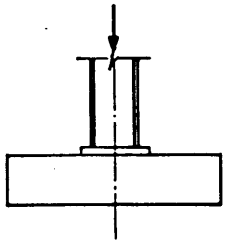
This example has four parts. The reactions for each part are typical of those that would be provided to the builder for a Landmark Endwall post.

Assume the following:

- $f'c = 3{,}000$ psi
- $fy = 60{,}000$ psi
- The footing center line and the column or pier center line coincide.
- Pier size is 24" x 14"
- 3,000 psf soil

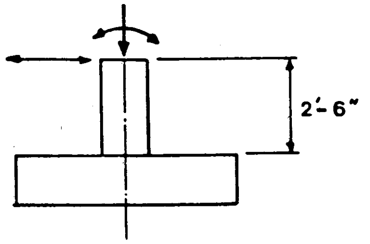
PART a

MOMENT = 0
AXIAL LOAD = 8.5^{K}



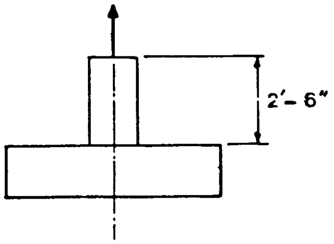
PART b

MOMENT = ± 237^{K} (WIND)
AXIAL LOAD = 2.4^{K} (WIND)
HORIZONTAL THRUST = ± 3.9^{K} (WIND)
PIER HEIGHT = 2'-6"



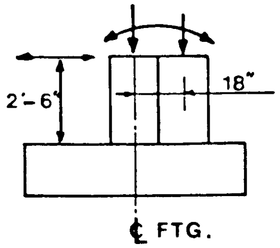
PART c

MOMENT = 0
AXIAL LOAD = 3.3 (UP)
PIER HEIGHT = 2'-6"



PART d

MOMENT = ± 237^{K} WIND
AXIAL LOAD = 2.4^{K} WIND
HORIZONTAL THRUST = ± 3.9^{K} WIND
GRADE BEAM REACTION =
P = 6^{K}
e = 18"



EXAMPLE NO. 1 - CALCULATED SOULTION

PART a - AXIAL ONLY

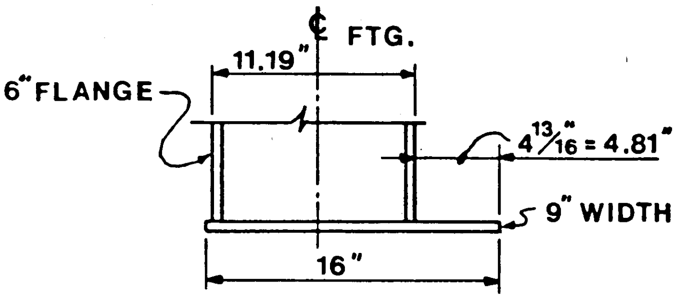
Select Footing Size: $A_f = \frac{P}{P_{allow}} = \frac{8500}{3000} = 2.83$ sq. ft.

TRY FTG. 2'-6"x 2'-6"x 10" (Minimum Size Recommended); $d = 6.5"$

Actual Soil Pressure: $= \frac{8500}{2.5 \times 2.5} = 1{,}360$ psf $= 1.36$ ksf

CHECK FOOTING THICKNESS:

Assume the base plate below:



Ultimate Shear Strength of Concrete (ACI 318-83)

$$\phi\ V_c = \phi \times 4\sqrt{3{,}000}\ b_o d = \phi \times 219\ b_o d$$

Punching Shear Failure Perimeter:

$$b_o = (16 - 2.40 + \frac{d}{2})\ 2 + (9 - 1.5 + \frac{d}{2})\ 2$$

$$= 27.2 + d + 15 + d = 42.2 + 2d$$

Ultimate Load to Footing:

$P_u = 1.7(8.5) - 14.45^k$

(Load factor of 1.7 applied to entire load)

Ultimate punching Shear:

$$V_u = 14.45 - 1.36 \quad \frac{(9 + 6.5)}{12} \times \frac{(16 - \frac{4.81}{2} + 6.5)}{12} = 11510\ \#$$

Check Punching Shear Strength:

$\phi\ V_c = \phi\ (219\ b_o d = 0.85\ (219)\ (42.2 + 2 \times 6.5)\ 6.5 = 66{,}790^{\#},$

$> 11{,}510^{\#}$ O.K.

Check Flexural Shear Strength:

$$\phi\ V_c = \phi \times 2\sqrt{f'c}\ \ b_w d = 0.85 \times 2\sqrt{3000}\ (2.5 \times 12)\ 6.5 = 18{,}160^{\#}$$

Ultimate Flexural Shearing Force:

$$V_u = \left(\frac{2.5}{2} - \frac{d}{12} - \frac{11.19}{2 \times 12}\right)(\ 2.5\ )(\ 1.36\ ) = 2.41^k < 18.16^k \quad \text{O.K.}$$

Since footing is small, bending steel requirements should not control depth. (Use 10").

SELECT REINFORCING:

$$M_u = \frac{1.36}{2}\left(\frac{2.5}{2} - \frac{11.09}{2 \times 12}\right)^2 1.7 \text{ Load Factor} = 0.72^{'k} = 8.61^{''k}$$

Cant. Bending Length to Col. Face

$$M_u = 0.9\, f_y A_s \left(d - \frac{a}{2}\right)$$

$$a = \frac{f_y A_s}{.85\, f_c' b} = \frac{60000\, A_s}{.85(3000)(12)} = 1.96\, A_s$$

Therefore $8.61 = 0.9\ (60)\ A_s\ (6.5 - .98A_s)$

$A_s = 0.03$ sq. in. per ft.

Minimum Steel Based on Temp. and Shrinkage:

$= .0018\ (12x10) = 0.22$ sq. in. per ft.

USE 3-#3 E.W. (EACH WAY)
USE 2'-6" x 2'-6" x 10"

PART b - Axial + Horizontal + Moment

Compute Maximum Moment at Footing Base:

$$M = 237^{''k} + \underbrace{3.9\ (3.5 \times 12)}_{} = 400.8^{''k}$$

Moment due to horizontal load (2.5' + 1')

Assumed ftg. thickness

Select Footing size: (Based on Eqs. 7.4 and 7.5)

Try footing 8'-0" x 4'-0" x 18" *

Total Footing Wt = $(8 \times 4 \times 1.5 \times .15) = 7.2^k$

Total axial load = $7.2 + 2.4 = 9.6^k$

Compute e:

$$e = \frac{M}{P} = \frac{400.8}{9.6} = 41.75" = 3.48'$$

$$\frac{L}{6} = \frac{8 \times 12}{6} = 16"$$

Therefore $$A_f = \frac{P}{3\, P_{allow}}\left(\frac{4L}{L - 2e}\right)$$

$$A_f = \frac{9.6}{3\ (3.7)}\left(\frac{4 \times 8}{8-2 \times 3.48}\right) = 26.6 \text{ sq. ft.}$$

$< 8 \times 4 = 32$ sq. ft. O.K.

* Previous Trial not Shown

Since footing thickness is 18", compute new eccentricity.

$$M = 237 + 3.9\ (4 \times 12) = 424.2''^{k}$$

$$e = \frac{424.2}{9.6} = 44.2'' = 3.68'$$

$$A_f = \frac{9.6}{3(3.7)} \quad \frac{4 \times 8}{8 - 2 \times 3.68} \quad = 43.24 > 32 \quad \text{N.G.}$$

TRY FTG. 8'-6" x 4'-0" x 18"

$$WT = 7.65^{k};\ P = 7.65 + 2.4 = 10.05^{k};\ e = \frac{424.2}{10.05} = 42.21'' \quad = 3.52'$$

$$A_f = \frac{10.05}{(3.7)(3)} \quad \frac{4 \times 8.5}{8.5-2 \times 3.52} \quad = 21.08 \text{ sq. ft.} < 34 \text{ sq. ft.} \quad \text{O.K.}$$

CHECK OVER TURNING:

$$M_o = 0.75\ (424.2) = 318.15''^{k}$$

$$M_r = (2.4 \times .75 + 7.65)\ \left(\frac{8.5}{2}\right)(12) = 482''^{k} \quad \text{O.K.}$$

$$F.S. = \frac{482}{318.15} = 1.51 > 1.5$$

THEREFORE, OVERBURDEN NOT REQUIRED FOR RESISTING OVERTURNING

CHECK FOOTING THICKNESS

$$\text{ACTUAL SOIL PRESSURE} = \frac{P}{3A_f}\ \frac{4L}{L-2e} = \frac{10.9}{3 \times 34}\ \frac{4 \times 8.5}{8.5-2 \times \underset{\text{MODIFIED}}{3.52}} = 2.49$$

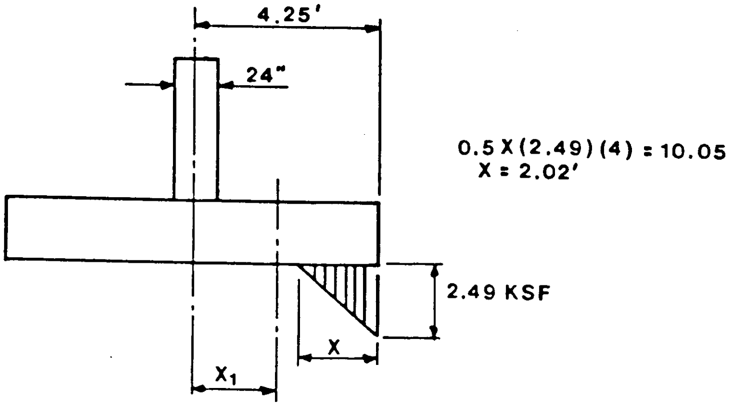
BY INSPECTION PUNCHING SHEAR WILL NOT CONTROL.

CHECK FLEXURAL SHEAR:

ULTIMATE SHEAR STRENGTH =

$$\phi\ V_c = 0.85(4)\sqrt{f'c}\ b_w d = 0.85(4)\sqrt{3000}\ (4 \times 12)\ 14.5 = 129{,}600\#$$

ULTIMATE FLEXURAL SHEARING FORCE:



X_1 = CRITICAL SECTION

= 12" + d = 26.5" = 2.21'

$$\text{ULTIMATE SHEAR FORCE} = 1.7(10.05)-1.7(1.5)(4)\underbrace{(2.04)}_{4.24-2.21}(1.5)$$

$$= 13.96^{k} < 129.6$$

DETERMINE REINFORCEMENT:

COMPUTE MOMENT:

$$M = 10050\ (4.25 - 1.0 - \frac{2.02}{3}) - \frac{150(4)(4.25 - 1.0)^2}{2}$$

$$= 22726'\#$$

$$M_u = 1.7(22726) = 38635'\# \quad = 464''^k$$

$$464 = 0.9(60)A_s\ (14.5 - 0.98\ A_s)$$

A_s = 0.62 sq. in. = 0.15 sq. in. per ft.

MINIMUM STEEL = .0018(12 x 18) = 0.39" sq. in. per ft.

TOTAL A_s = 4(.39) = 1.56 sq. in. (LONG DIRECTION)
= 8.5(.39) = 3.32 sq. in. (SHORT DIRECTION)

USE FOOTING 8'-6" x 4'-0" x 18"
4-#6 (LONG DIRECTION)
8-#6 (SHORT DIRECTION)

→ FOR PARTS c & d ONLY THE OVERALL FOOTING SIZE WILL BE DETERMINED. REINFORCEMENT AND CONCRETE STRESSES SHOULD BE DETERMINED AS IN ABOVE

PART c - UPLIFT ONLY

ASSUMING NO OVERBURDEN:

$$\text{FOOTING WEIGHT REQUIRED} = \underset{\text{SAFETY FACTOR}}{1.5} \times \overset{\text{UPLIFT}}{3.3} = 4.95^k$$

USE 5'-0" x 5'-0" x 1'-4"
WT = 4.99^k O.K.

CONSIDERING THE OVERBURDEN:

WT. OF OVERBURDEN ASSUMING 4'x 4' FOOTING
$2.5\ (4 \times 4)(.110)^* = 4.4^k$

TRY 3'-6" x 3'x 6" x 12"

WT. OF OVERBURDEN = $(3.5 \times 3.5)(2.5)(.110)^* = 3.37^k$

WT. OF FOOTING = $(3.5 \times 3.5)(1)(.15) \quad = \underline{1.85^k}$
5.22^k O.K.

* 110 PCF = TYPICAL SOIL WT.

PART d - AXIAL + HORIZONTAL + MOMENT WITH GRADE BEAM

MAXIMUM MOMENT: $M = 237''^{k} + 3.9^{k} \times 4' \times 12''/' + 6^{k} \times 18''$
$= 532.2''^{k}$

AXIAL LOAD = $2.4^{k} + 6^{k}$ + FTG. WT.

SELECT FOOTING SIZE:

TRY 7'-6" x 3'-6" x 18"

$WT = (7.5 \times 3.5 \times 1.5 \times .15) = 5.91^{k}$

$P = 2.4 + 6 + 5.91 = 14.31$

$$e = \frac{M}{P} = \frac{532.2}{14.31} = 37.2'' = 3.1'$$

$$\frac{L}{6} = \frac{7.5}{6} = 1.25' \text{ therefore } e > \frac{L}{6}$$

Therefore $$A_f = \frac{P}{3\ P_{allow}} \quad \frac{4L}{L-2e}$$

$$= \frac{14.31}{3(3.7)} \quad \frac{4 \times 7.5}{7.5-2 \times 3.1} = 29.75 \text{ sq. ft.}$$

AREA FURNISHED = (7.5 x 3.5) = 26.25 sq. ft., N.G.

TRY 7'-6" x 4'-0" x 1'-6"

$WT. = 6.75^{k}$

$e = 33.16'' = 2.76'$

$$A_f = \frac{15.15}{3(3.7)} \quad \frac{4 \times 7.5}{7.5-2 \times 2.76} = 20.68 \text{ sq. ft.}$$

AREA FURNISHED = 30 sq. ft. O.K.

<u>CHECK OVERTURNING:</u> (FIRST ASSUME NO OVERBURDEN)

$M_o = 0.75\ (237 + 3.9 \times 48) + 6 \times 18 = 426.15''^{k}$

$$M_r = (2.4 \times .75 + 6.75) \left(\frac{7.5}{2}\right)(12) + 6\left(\frac{7.5}{2} \times 12 - 18\right) = 546.75''^{k}$$

F.S. = 1.28 < 1.5 N.G.

CONSIDER BENEFIT OF OVERBURDEN

$$M_w = 2.5\ (.110) \left(\frac{7.5}{2}\right)(12)(7.5)(4.0) = 371.25''^{k}$$

$M_r = 546.75''^{k} + 371.25''^{k} = 918''^{k}$

$$\text{F.S.} = \frac{918}{426.15} = 2.15 > 1.5 \quad \text{O.K.}$$

EXAMPLE NO. 1 - DESIGN TABLE SOULTION

PART a: $M = 0$, $P = 8.5^k$, $H = 0$

FROM TABLE 3-3-6
USE 2'-6" x 2'-6" x 10" (MINIMUM SIZE RECOMMENDED)
$A_s = 0.54$ sq. in. each way USE 3-#4 E.W.

PART b: $M = 400.8^{"k}$, $P = 2.4^k$
USE DOUBLE INTERPOLATION. USE TABLES 3-3-4 AND 3-3-5:

					A_s		
P	M	X	Y	T	X	Y	
0	250	8.5	3.0	20.0	1.59	3.67	TABLE
0	400.8	9.4	3.6	21.2	2.14	4.32	3-3-4
0	500	10.0	4.0	22.0	2.51	4.75*	
5	250	7.0	2.5	16.0	0.86	2.41	TABLE
5	400.8	7.9	3.1	18.4	1.63	3.17	3-3-5
5	500	8.5	3.5	20.0	2.14	3.67	
0	400.8	9.4	3.6	21.2	2.14	4.32	
2.4	400.8	8.68	3.36	19.86	1.90	3.77	
5	400.8	7.9	3.1	18.4	1.63	3.17	

*DIRECT SOLUTION W/O INTERPOLATION

USE 8'-9" x 3'-6" x 20"
4-#7 (LONG DIR.)
9-#6 (SHORT DIR.)

BY INSPECTION 2'-6" OVERBURDEN
PROVIDES STABILITY, BARS @ 7.5"

PART c : $M = 0$, $P = 3.3^k$ (UP), $H=0$
(TABLES ASSUME NO OVERBURDEN FOR UPLIFT)

					A_s		
P	M	X	Y	T	X	Y	
-5	0	5.0	5.0	24	2.59	2.59*	3-3-4
-3.3	0	4.15	4.15	19.24	1.89	1.89	
0	0	2.5	2.5	10	.54	.54	3-3-5

*INDICATES DIRECT SOLUTION

USE 4'-6" x 4'-6" x 20"
5-#6 each way (7.5" COVER)

PART d: $M = 532.2^{"k}$, $P = 8.4^{k}$, $H = 0$

					A_S		
P	M	X	Y	T	X	Y	
5	500	8.0	4.0	21.0	1.81	3.67	3-3-5
8.4	500	7.32	4.0	18.96	1.63	3.15	
10	500	7.0	4.0	18.0	1.55	2.91	3-3-6
5	750	9.0	5.0	23.0	2.66	4.47*	3-3-5
8.4	750	8.64	4.66	20.96	2.36	3.93	
10	750	8.5	4.5	20.0	2.22	3.67	3-3-6
8.4	532	7.49	4.08	19.22	1.72	3.25	

*DIRECT SOLUTION W/O INTERPOLATION

USE 7'-6" x 4'-0" x 20"
3-#7 (LONG DIRECTION)
8-#6 (SHORT DIRECTION)

{2-6" OVERBURDEN PROVIDES
STABILITY, BARS @ 7.5"}

EXAMPLE NO. 2 - CALCULATED SOLUTION

SHOWN BELOW ARE REACTIONS WHICH ARE APPLIED TO A RIGID FRAME PIER FOOTING SYSTEM. DESIGN THE FOOTING THREE WAYS.

A) ASSUME A CONCENTRICALLY LOADED FOOTING.

B) ASSUME AN ECCENTRICALLY CONSTRUCTED FOOTING.

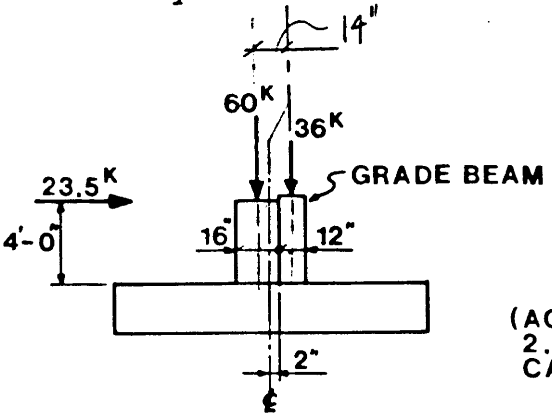
C) ASSUME HAIR PIN BARS ARE TO BE USED IN THE SLAB TO RESIST THE HORIZONTAL FORCE.

ALSO ASSUME:

- ALLOWABLE SOIL PRESSURES OF:
    3000 PSF (AXIAL)
    3700 PSF (MOMENT)

- CONCRETE
    $f'_c = 3000$ PSI

- RE-BARS
    $f_y = 60{,}000$ PSI



(ACTUAL CONC. LOCATION IS 2.75 LEFT OF GRADE BEAM - SEE CALCS. NEXT PAGE)

PART a

ASSUME A 24" FOOTING THICKNESS IN ORDER TO CALCULATE THE MOMENT DUE TO THE HORIZONTAL LOAD.

RESULTANT FORCE LOCATION MEASURED FROM CENTER LINE OF $\underline{36^k}$ FORCE

$$e' = \frac{(6 + 8)60}{60 + 36} = 8.75"$$

THEREFORE FOR CONCENTRIC LOADING (DUE TO VERTICAL LOADS) THE FOOTING SHOULD BE CONSTRUCTED 3/4" OFF THE CENTER LINE OF PIER AND G.B. CENTROID. SEE FIGURE

CALCULATE MOMENT ON FOOTING:

$$M = 23.5(48 + 24) = 1692''^{k} = 141'^{k}$$

TRY FOOTING 11'-0" x 4'-6"

$$\frac{L}{6} = \frac{11 \times 12}{6} = 22''$$

$$e = \frac{1692}{96} = 17.63'' = 1.47' \text{ Therefore } e < \frac{L}{6}$$

FTG. WT. NEGLECTED FOR THIS EXAMPLE

$$A_f = \frac{P}{P_{allow}} \left(1 + \frac{6\,e}{L}\right)$$

$$= \frac{96}{3.7}\left(1 + \frac{6 \times 1.47}{11}\right) = 46.75 \text{ sq. ft.}$$

A Furnished = (11 x 4.5) = 49.5 sq. in. Therefore, OK

USE 11'-0" x 4'-6" FOOTING F.S. for overturning OK by inspection

Since the grade beam would extend across the width of the footing, punching type shear would not occur.

Check Flexural Shear:

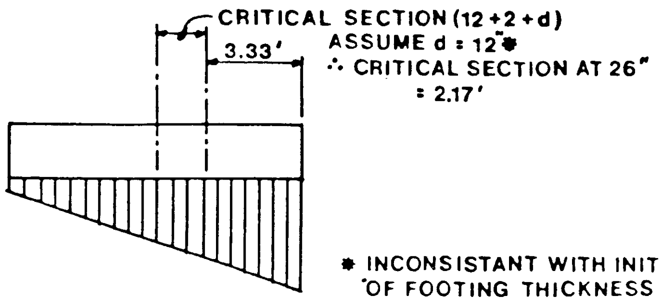
$$\text{Shear Strength} = \phi\, V_c = \phi\, (2)\, \sqrt{f'_c}\;\; b_w d$$

Determine soil pressure: Since the eccentricity is inside the kern of the footing:

$$\text{Pressure} = \frac{P}{A} \pm \frac{Mc}{I}$$

$$= \frac{96}{11 \times 4.5} \pm \frac{141 \times 5.5}{\frac{1}{12}(4.5)(11)^3} = 3.49 \text{ KSF (MAX.)}$$
$$= 0.39 \text{ KSF (MIN.)}$$

Pressure Diagram:



* INCONSISTANT WITH INITIAL CHOICE OF FOOTING THICKNESS, HOWEVER CONSERVATIVE.

Soil Pressure at critical section:

$$\text{SLOPE} = \frac{3.49 - .39}{11.0} = .028^{k/'}$$

$$\text{PRESSURE} = 0.39 + .28 \left(5.5 + \frac{2" + 12" + d}{12} \right) = 2.54 \text{ KSF}$$

Ultimate Flexural Shear

$$= 1.7 \left(\frac{2.54 + 3.49}{2} \right) (3.33)(4.5) = 76.76^{k}$$

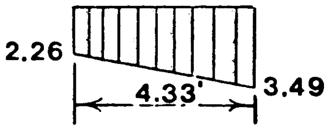
Depth required $= \dfrac{V_u}{\phi\,(2)\sqrt{3000}b_w} = \dfrac{76{,}760}{.85(110)(4.5 \times 12)} = \underline{15.20"}$

Select reinforcing (critical section is at column face) for economical reinforcement design:

Calculate moment @ face:

Soil pressure at face:
Face is 14" from center line
Slope $= \dfrac{3.49 - .39}{11'\text{-}0"} = 0.28$ k/"

Pressure $= 0.39 + .28(5.5 + \frac{14}{12}) = 2.26$ kips per sq. ft.



$$M = \frac{2.26(4.33)^2}{2} + \frac{1}{2}(4.33)^2(3.49 - 2.26)\frac{2}{3}$$

$$= 28.87'^{k}$$

$$M_u = 1.7(28.87) = 49.08'^{k}$$

For economical reinforcement design:

$$d = \frac{M_u}{bK_u} = \frac{49.08}{12 \times .667} = 6.13" \text{ (Shear controls)}$$

<u>Use thickness = 15.20 + 3.5 = 18.70, Say 19"</u>

$$d = 15.5"$$

Compute A_s: $a = \dfrac{f_y\,A_s}{.85f'_c b} = 1.96\,A_s$

$$M_u = 0.9\ f_y\ A_s\ (d - \frac{a}{2})$$

$$28.87 \times 12 = 0.9(60)\ A_s\left(15.5 - \frac{1.96\ A_s}{2}\right)$$

$$A_s = 0.43 \text{ sq. in. per ft.}$$

Minimum Steel = .0018(12)(19) = 0.41 sq. in. per ft.

<u>Use Footing: 11'-0" x 4'-0" x 19"</u>
<u>4-#6 in Long Direction</u>
<u>11-#6 in Short Direction</u>

Part b: Design the footing by eccentrically placing the footing.

Compute e: From G.B. - pier face

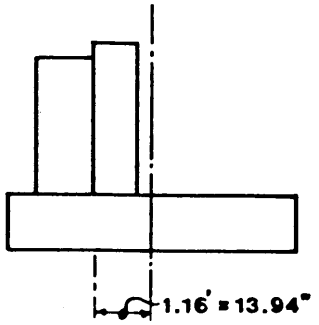
$$M = 23.5\ (48 + 12) - 96(.75) = 1338.00''^{k}$$

$\llcorner$ From Part a

$\llcorner$ 12" footing depth assumed

$$e = \frac{M}{P} \quad \frac{1338}{96} = 13.94'' = 1.16'$$

Locate footing as shown:



$A_{reqd} = \dfrac{96000}{3000*} = 32.0$ sq. ft. *Uniform Pressure

Use Footing 5'-9" x 5'-9"; A = 33.06 sq. ft.
(Footing must be of sufficient size to extend under pier)
Actual soil pressure $= \dfrac{96000}{33.06} = 2904$ PSF

Assuming d = 12"
Ultimate Flexural Shear:
Distance to Critical Section $= \dfrac{69}{2} + 1.94'' - 12'' = 24.44''$
$= 2.04'$

$$V_u = 1.7\ \frac{2.04}{2}\ 2904 \times 5.75 = 28954\#$$

$$d = \frac{V_u}{\phi(2)\sqrt{f'_c}b_w} = \frac{28954}{.85(110)(5.75 \times 12)} = 4.49''$$

Use 12" Depth

Compute A_s:

$$M_u = 1.7(2904)\frac{(2.04)^2}{2} = 10.27\ '^{k}$$

$$10.27 \times 12 = 0.9(60)(8.5 - \frac{1.96}{2} A_s)$$

A_s = 0.28 sq. in. per ft.

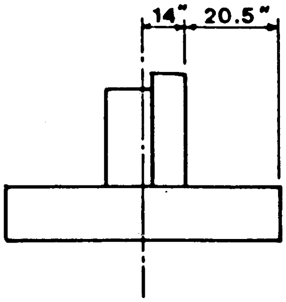
Use Footing: 5'9" x 5' 9" x 12"
Minimum $A_s = .0018(12 \times 12) = 0.26$ sq. in.
Stability O.K. - F.S. = $\frac{96(5.75/2+1.10)}{23.5(60/12)} = 3.30$

Use 6-#6 E.W.

Part c: Using Harpin Bars

Since the design of the footing is only for vertical loads, the required size (5'-9"x5'-9") would be the same as for Part b.

Use 5'-9"x5'-9"



Design of Hairpins:
Assume 6-6x6/6 WWF in slab
Required hairpin length

$$L_t = \frac{23500}{3168} = 7.42'$$

SEE TABLE CHAPTER 7

Hairpin Size:
$2A(24)\cos 30° = 23.5$
$A = 0.57$ sq. in.

Use 2-5# Hairpins: Footing thickness and reinforcing
can be found as before:
Solution Yields:
Thickness = 12"
A_s = 5-#5 E.W.

Note: For all of the above solutions, anchorage requirements were checked using Appendix "D".

EXAMPLE NO. 2 - DESIGN TABLE SOLUTION

PART a: $M = 141 \times 12 = 1692^{"k}$, $P = 96^k$

Interpolate using table 3-3-13 (Assume results for 100^k are O.K. for 96^k load)

					A_s	
P	M	X	Y	T	X	Y
100	1500	9.0	5.5	20	3.55	3.88
100	1692	9.19	5.69	20.38	3.69	4.04
100	2000	9.50	6.0	21	3.92	4.30*

*DIRECT SOLUTION W/O INTERPOLATION

Use Footing: 9'-3" x 5'-9" x 21"
7-#7 (Long Direction) No Overburden Required
7-#7 (Short Direction) Bars @ 3.0"

PART b and c: $M = 0$, $P = 96^k$
Using Table 3-3-13

Use Footing: 6'-0" x 6'-0" x 19"
5-#6 E.W.

EXAMPLE NO. 3 - DESIGN TABLE SOLUTION ONLY

Design a footing for a landmark endwall post (span 25', bay 40', 29' eave). Reaction for 12-15 UBC loading are shown below. Assume A 4KSF soil.

SPAN	BAY	ENDWALL POSTS (Both Ends Fixed Base]											
		DEAD + LIVE				DEAD + WIND				DEAD + UPLIFT			
		M	V	H	V-W/OH	M	V	H	V-W/OH	M	V	H	V-W/OH
20'	20'	0.	3.3	0.0	5.0	882.	0.9	6.8	1.4	0.	-1.3	0.	-2.0
	30'	0.	5.0	0.0	6.7	882.	1.4	6.8	1.9	0.	-2.0	0.	-2.6
	40'	0.	6.7	0.0	8.4	882.	1.9	6.8	2.4	0.	-2.6	0.	-3.3
	50'	0.	8.5	0.0	10.1	882.	2.4	6.8	2.9	0.	-3.3	0.	-4.0
25'	20'	0.	4.2	0.0	6.3	1102.	1.2	8.5	1.8	0.	-1.6	0.	-2.5
	30'	0.	6.3	0.0	8.4	1102.	1.8	8.5	2.4	0.	-2.5	0.	-3.3
	40'	0.	8.5	0.0	10.6	1102.	2.4	8.5	3.1	0.	-3.3	0.	-4.2
	50'	0.	10.6	0.0	12.7	1102.	3.1	8.5	3.7	0.	-4.2	0.	-5.0

SOLUTION:

DEAD + LIVE

$V = 8.5^k$ Use Table 3-4-6
Required footing 2.5' x 2.5' x 10"; A_s = 0.54 sq. in. each way

DEAD + WIND

$V = .75(2.4) \quad = 1.8^{k}$

$M = .75(1102) = 826.5^{''k}$ Use Table 3-4-4 or 3-4-5

$H = .75(8.5) \quad = 6.38^{k}$

Assume Footing is 6" Below Grade

Therefore, Total $M^{*} = 826.5 + 6.38\ \underset{\uparrow}{(24)} = 979.62^{''k}$

↑ Assumed footing thickness

Required Footing: 10'-0" x 8'-0" x 23"

$A_s = 3.97$ sq. in. (X) 3-4-4 Controls

4.96 sq. in. (Y)

0.12 k/sq. ft. Overburden Required

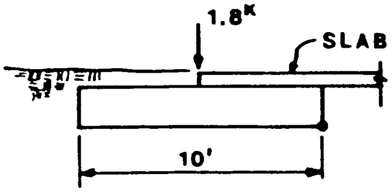
DEAD + UPLIFT

$V = 0.75(-3.3) = -2.48^{k}$ Use Table 3-4-3

Required Footing: 5'-0" x 5'-0" x 25"

$A_s = 2.70$ each way

Dead + Wind loading controls. Check the 10'-0" x 8'-0" x 24" footing for stability assuming a 6" slab acts as overburden over 1/2 the footing. Use exact loadings.



$$\text{O.T. } M = 979.62^{''k} = 81.64^{'k}$$

$$M = \left(10 \times 8 \times \frac{24}{12}\right).15\ (5)$$

$$+\ 1.8(5) \qquad\qquad \downarrow \text{ Soil Weight}$$

$$+\ \frac{6}{12}\ \frac{(5)^2}{2}(.15)\ +\ \frac{6}{12}(5)\,(7.5)\,(.10)$$

$$= 131.81^{'k} > 1.5 \times 81.64^{'k} = 122.45^{'k}$$

---

* Horizontal force assumed not to be taken by the slab.

Note: If the calculations had shown that the stability check was violated then the designer must either:

(1) Construct the footing with the required overburden or,

(2) increase the footing weight to achieve stability. In many cases, the designer can simply down grade the assumed soil strength.

For example, use Table 3-2-4. Stability criteria can also normally be satisfied by using the next higher tabulated moment values and then checking the stability.

Use Footing: 10'-0" x 8'-0" x 24"
7-#7 (Long Direction)
9-#7 (Short Direction)
7 1/2" cover on long bars

APPENDIX A
GLOSSARY OF TERMS

Atterberg limits -- limiting water contents for cohesive soil at the transition from one state to another: solid to plastic, plastic to liquid and semi-solid to solid. Standard tests are used to determine the "plastic limit", "liquid limit", and "shrinkage limit". These values are useful indices in classifying and determining properties of clays. (Named after A. Atterberg.)

Bearing capacity -- the load or pressure developed under a foundation. Usually refers to the ultimate capacity at failure of the soil, which is displaced and allows the foundation to drop suddenly downward. Allowable or safe, bearing pressure is equal to the ultimate capacity divided by a factor of safety.

Bearing capacity factors -- coefficients used in equations for the calculation of bearing capacity according to theory. These factors vary according to soil type and state.

Bell -- the enlarged bottom of a drilled caisson or pier.

Blow count -- number of blows required to drive the sample spoon or cone penetrometer one foot into the soil. Indicates standard penetration resistance. (Usually called "N" or boring logs.)

Boring log -- Written record compiled in the field as a soil boring is made, indicating depths or elevations, soil classification, standard penetration resistance, samples taken, etc. Final log may also indicate results of laboratory tests on samples. An accurate and complete boring log is essential to interpretation of the results of the exploration.

Caisson or drilled caisson -- a cylindrical deep concrete foundation, with or without bell, which is concreted in place after excavation: Usually excavated by special machines. Not to be confused with a caisson which is sunk into place, such as a pneumatic caisson used for a bridge pier.

Capillarity -- tendency for water to be raised within the soil pores above the free water surface. Rate of capillary rise is greatest in silts and very fine sands. Thus, these soils are the most susceptible to frost heave.

Classification system -- a standard system for describing soil type on the basis of certain properties, such as for engineering, agricultural, or geologic purposes. Engineering classification systems are based on grain size and texture. Examples are the Unified Classification System (UCS) and the Highway Research Board (HRB) system, based on the suitability as highway or runway construction materials. The American Society for Testing and Materials (ASTM) has a Standard Method D2487 for Classification of Soils for Engineering Purposes.

Clay -- fine-grained cohesive soil, plastic when moist. Composed predominately of needle - or flake-shaped clay minerals.

Coefficient of friction -- ratio of the frictional shearing force to the force perpendicular to the contract surface between two bodies.

Coefficient of subgrade reaction -- ratio of the pressure against the soil to the elastic movement or settlement at that point.

Cohesive -- possessing noticeable cohesion. Term used to describe a main class of fine-grained soils (including clays and some silts) as opposed to granular or cohesionless soils.

Cohesion -- sticking-together due to molecular attraction. A property of most fine-grained soils, especially clays, expressed in units of shear resistance such as psf (pounds per square foot).

Compaction -- process of increasing the density (or decreasing the voids) of a soil. Compaction equipment is used to increase the strength and density and/or to reduce the settlement of soils.

Compactness -- degree of compaction or relative density. Compactness of a man-made fill is commonly expressed as a percentage of compaction relative to a standard Proctor-type density test. Compactness of fills or natural deposits may be indicated by a standard penetration test.

Compression index -- a factor obtained from a laboratory consolidation test of a clay, indicating its long-time compressibility under load. The compression index is the ratio of the change in void ratio to the logarithm (base 10) of the ratio of initial load to final load.

Cone penetrometer -- probing device used to measure penetration resistance of soil. Generally driven into the ground in a manner similar to the standard penetration test using the split spoon.

Consistency -- degree of firmness of cohesive (fine-grained) soils. Expressed as "soft", "medium", "stiff", "hard", etc.

Consolidation -- the process of compaction of clay due to the expulsion of water from the voids over a long period of time, usually due to load.

Density -- compactness. Usually expressed in terms of unit weight.

Drilled pier -- same as caisson.

Eccentricity -- distance of a force or resultant pressure from the center of the member or area resisting the force.

Footing -- an enlargement at the base of a column, pier, or wall to spread the load over the supporting soil.

Frost heave -- raising or heaving of soil near the surface due to expansion caused by freezing of soil moisture and formation of ice lenses.

Grain size -- a property used to distinguish between major classes of soils (i.e. granular and cohesive). Grain-size distribution is also a significant property of coarse-grained (granular) soils.

Granular -- relatively coarse-grained; non-cohesive. A major class of soils as opposed to cohesive soils.

Hardpan -- a stratum of hard cohesive soil which is difficult to excavate or penetrate.

Intergranular pressure -- pressure acting between grains of soil. Also called "effective" pressure in contrast to porewater pressure. Only the intergranular pressure produces frictional resistance.

Internal friction -- friction between grains of soil. In purely granular material, the angle of internal friction equals the angle of repose.

Liquid limit -- water content of clay at the borderline between the plastic and liquid states, determined by standard laboratory test. (See ASTM Method D423).

Loam -- a mixture of clay, sand, and organic matter. Primarily an agricultural term, not commonly used in engineering.

Loess -- a wind-deposited silt, usually somewhat cemented by calcium carbonate or clay, porous and often showing root-hole structure. Able to stand on very steep slopes when undisturbed. Vulnerable to weathering or other disturbances. Foundations on loess require special consideration.

Mat foundation -- an extensive combined footing, generally covering the entire area beneath a structure and supporting all walls and columns.

Moisture content -- (water content) -- Amount of water in a given amount of soil, either on a weight basis or a volume basis. Most often expressed as a percentage of the dry weight of the soil.

Natural moisture -- moisture content of a soil in its natural state.

Normally consolidated (normally loaded) -- refers to a clay which has not been subjected to a vertical pressure greater than that existing at present.

Over-consolidated -- same as pre-consolidated.

Passive pressure -- lateral earth pressure resisting the tendency for a body to be pushed against the soil. Usually means the maximum value of horizontal pressure at failure. (This is contrasted with "active" pressure, which is the minimum horizontal pressure as the body is moved away from the soil.)

Peat -- predominately organic deposit. Dark brown to black, with vegetable matter in various states of decay.

Permeability -- a measure of the rate at which water flows through soil. The coefficient of permeability is equal to the velocity of flow divided by the hydraulic gradient. Coarse-grained soils have high permeability.

Pile -- a foundation element gaining support with depth or at a considerable depth, usually installed by driving. Used where soils near the surface are poor. Usually installed in groups.

Plastic -- capable of being molded.

Plastic limit -- water content of clay at the borderline between the plastic and the solid or semi-solid state, as determined by laboratory test. (See ASTM Method D 424).

Plasticity index -- difference (in percent moisture) between the liquid limit and the plastic limit.

Pocket penetrometer -- a hand-held device with a calibrated spring-loaded plunger used to obtain an approximate value of the strength of clay, based on resistance to penetration of the plunger.

Porosity -- ratio of the volume of voids to the total volume. Usually expressed as a percentage and sometimes termed "percentage of voids".

Pre-consolidated (pre-loaded) -- refers to a clay which was at one time subjected to greater vertical pressure than currently exist (such as due to glaciation).

Proctor density test -- a type of standard laboratory procedure for determining density of soil compacted in a standard way at various moisture contents. Used as a basis for comparison of field compaction. (See ASTM Methods D698 and D1557).

Raft foundation -- Same as mat foundation.

Relative density -- ratio (expressed as a percentage) of the difference between the void ratios in the loosest state and the natural state to the difference between the void ratios in the loosest and densest states.

$$D_d = \frac{e_{max} - e}{e_{max} - e_{min}}$$

Usually applied only to granular soil.

Rock core -- sample of rock extracted by drilling with a core barrel.

Sand -- granular soil with grains smaller than gravel and larger than silt. (Grain size between 2 and .05 milimeters.)

Sand drain -- a system of holes filled with sand to accelerate consolidation of cohesive soil.

Saturation -- Degree to which soil voids are filled with water. Degree of saturation is the ratio of volume of water to volume of voids, expressed as a percentage.

Sensitivity -- ratio of the unconfined compressive strengths of an undisturbed sample to a remolded sample of clay, indicating loss of strength due to disturbance.

Silt -- fine-grained soil usually possessing little plasticity or cohesion. Distinction between silt and clay cannot be made based on grain size alone, but for some purposes silt is defined as having particles between .05 and .005 milimeters in diameter.

Shear -- a force tending to cause relative displacement along a plane parallel to the force.

Shear failure -- point at which continuous shearing displacement takes place at a constant stress.

Shearing strength -- stress at shearing failure, usually expressed as a unit stress, such as psf (pounds per square foot).

Shelby tube -- thin-walled tube used in sampling of cohesive soil.

Shrinkage limit -- water content of clay at which shrinkage ceases.

Slab-on-grade -- a slab depending on continuous support from the subgrade, as contrasted with a "structural" slab spanning between isolated supports.

Soil profile -- the sequential arrangement of soil strata, with their distinguishing features and characteristics; a diagram showing such strata.

Specific gravity -- ratio of the density of a material to the density of water.

Split spoon (split-barrel sample spoon) -- a standard sampler which is driven into the soil at the bottom of a bore hole to obtain a sample (disturbed) and to measure penetration resistance. (See ASTM Method D1586).

Spread footing -- same as footing.

Standard penetration test -- a standard procedure (see ASTM Method D1586) for driving the split spoon (split-barrel) sampler into the soil to measure penetration resistance. The blow count (N) to advance the sampler one foot gives an indication of soil density or consistency.

Strain -- distortion of a material. Usually expressed as unit strain, such as inches of distortion per inch of length, or as a percentage.

Subgrade modulus - same as coefficient of subgrade reaction.

Surcharge -- load applied in addition to the normal or prevalent load. For a retaining wall, a surcharge may consist of a load applied to the surface of the ground near the top of the wall. For a footing, surcharge may be considered as the weight on the surrounding soil at the level of the bottom of the footing due to the soil above.

Triaxial compression test -- a laboratory test performed on an undisturbed sample of cohesive soil, in which some compression (confining pressure) is applied to the specimen in the lateral directions while the compressive force in the main (axial) direction is increased to failure. Used to determine the cohesion and angle of internal friction of the material.

Tube sample -- a relatively undisturbed sample of cohesive soil, suitable for laboratory testing, obtained by pushing a thin-walled (Shelby) tube into the soil.

Unconfined compression test -- a laboratory test similar to the triaxial compression test, but with no lateral (confining) pressure applied to the specimen. Compression is applied in one direction only, similar to the testing of a concrete cylinder. Commonly used to determine the cohesion of clays.

Unconfined compressive strength -- the unit stress in a specimen at failure when subjected to the unconfined compression test (expressed in pounds or tons per square foot). Equal to twice the cohesion of the material.

Vane shear test -- a field test used to determine the in-place shear strength of soft clays. A vane tester is pushed into the ground and torque is applied sufficient to rotate the vanes. From this the cohesion can be calculated.

Void ratio -- ratio of the volume of voids to the volume of solid matter.

APPENDIX B

FOOTING DESIGN TABLES

Tables in this section are numbered sequentially from 2-1-1 through 3-5-14

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	DIMENSIONS Y (FT)	DIMENSIONS T (IN)	STEEL AREA X (SQ.IN.)	STEEL AREA Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	MAX. BAR SIZE Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	QUANTITIES CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	6	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	7	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	8	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	7	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	8	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	7	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	8	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	7	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	8	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	7	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	33	6.77	10.33	7.5	10	9	0.06	639	14.03
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 2-1-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	DIMENSIONS Y (FT)	DIMENSIONS T (IN)	STEEL AREA X (SQ.IN.)	STEEL AREA Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	MAX. BAR SIZE Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	QUANTITIES CONC. (CU.Y
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.1
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.0
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	7	0.00	198	4.4
250	11.5	4.5	26	2.52	6.45	7.5	9	6	0.00	182	4.1
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.8
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.9
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.7
500	12.0	5.5	27	3.20	6.99	7.5	9	7	0.02	244	5.5
500	13.0	4.5	29	2.81	8.14	7.5	10	6	0.02	230	5.2
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.0
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.9
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.9
750	12.5	6.0	28	3.62	7.56	7.5	9	7	0.05	289	6.4
750	13.5	5.0	30	3.24	8.74	7.5	10	6	0.04	277	6.2
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.1
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.3
1000	12.0	7.5	28	4.53	7.25	7.5	9	8	0.06	350	7.7
1000	12.5	6.5	30	4.21	8.10	7.5	10	8	0.07	337	7.5
1000	14.0	5.0	32	*3.45	9.67	7.5	11	6	0.08	306	6.9
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.3
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.1
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.6
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.1
1250	14.5	5.5	32	*3.80	10.02	7.5	9	7	0.08	351	7.8
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.6
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.0
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.8
1500	13.5	7.0	32	4.83	9.33	7.5	9	8	0.09	420	9.3
1500	15.0	5.5	33	*5.00	10.69	7.5	11	7	0.11	428	8.4
2000	12.0	12.0	27	*8.70	*6.99	7.5	9	8	0.11	614	12.0
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.1
2000	13.5	9.0	31	6.02	9.03	7.5	9	9	0.10	528	11.6
2000	14.5	7.5	32	*5.18	10.02	7.5	9	8	0.11	485	10.7
2000	15.5	6.0	35	*5.47	11.71	7.5	11	7	0.13	498	10.0

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	6	6	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	6	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	6	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	25	3.78	5.67	7.5	8	8	0.07	254	5.67
750	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	6	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	28	*3.62	7.25	7.5	9	7	0.10	277	6.22
1000	13.0	5.0	29	*3.13	8.14	7.5	10	6	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*4.03	7.56	7.5	10	8	0.12	318	7.02
1250	14.0	5.0	31	*3.34	9.37	7.5	11	6	0.10	297	6.69
1500	11.0	11.0	24	*6.59	*5.70	7.5	9	8	0.11	439	8.96
1500	11.5	9.5	27	5.54	6.70	7.5	9	8	0.10	412	9.10
1500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.10	390	8.64
1500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.10	364	8.12
1500	14.0	5.5	31	*4.70	9.37	7.5	10	7	0.14	375	7.36
2000	12.0	12.0	27	6.99	6.99	7.5	8	8	0.08	547	12.00
2000	12.0	10.5	29	6.57	7.51	7.5	9	9	0.11	513	11.27
2000	13.0	9.0	29	*5.63	8.14	7.5	9	8	0.11	475	10.47
2000	14.0	7.5	31	5.02	9.37	7.5	9	8	0.11	453	10.04
2000	15.0	6.0	33	*4.27	10.69	7.5	10	7	0.13	411	9.16

TABLE 2-1-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	*1.74	2.91	7.5	8	6	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	9.0	3.0	20	1.29	3.88	7.5	9	4	0.09	70	1.66
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.5	7.0	19	2.87	3.48	7.5	7	7	0.09	155	3.48
500	9.0	6.0	20	2.59	3.88	7.5	8	7	0.09	147	3.33
500	9.5	5.0	21	2.26	4.30	7.5	9	6	0.10	135	3.07
500	10.0	4.0	22	*2.57	4.75	7.5	9	6	0.14	139	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.5	7.5	21	*3.40	4.30	7.5	8	8	0.10	206	4.61
750	10.0	6.5	22	*3.08	4.75	7.5	8	7	0.10	196	4.41
750	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.12	181	4.09
750	11.5	4.5	26	2.52	6.45	7.5	9	6	0.09	182	4.15
1000	9.5	9.5	21	*4.47	*4.30	7.5	8	8	0.12	269	5.84
1000	10.0	8.0	24	4.14	5.18	7.5	8	8	0.11	266	5.92
1000	10.5	7.0	25	3.78	5.67	7.5	8	8	0.11	254	5.67
1000	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.13	225	5.07
1000	12.5	4.5	28	2.72	7.56	7.5	10	6	0.12	214	4.86
1250	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.12	321	7.09
1250	11.0	8.5	24	4.40	5.70	7.5	8	8	0.10	312	6.92
1250	11.5	7.5	26	4.21	6.45	7.5	9	8	0.09	311	6.92
1250	12.0	6.0	27	*3.49	6.99	7.5	9	7	0.14	267	6.00
1250	13.0	5.0	29	3.13	8.14	7.5	10	6	0.13	257	5.81
1500	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.13	370	8.16
1500	11.5	9.0	26	5.05	6.45	7.5	8	8	0.09	375	8.30
1500	12.0	7.5	27	4.37	6.99	7.5	9	8	0.12	337	7.50
1500	12.5	6.5	28	*3.93	7.56	7.5	9	8	0.14	314	7.02
1500	14.0	5.0	31	3.34	9.37	7.5	11	6	0.12	297	6.69
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	12.0	10.0	27	5.83	6.99	7.5	8	8	0.12	454	10.00
2000	13.0	8.5	29	5.32	8.14	7.5	9	8	0.10	448	9.89
2000	14.0	7.0	31	4.68	9.37	7.5	9	8	0.09	422	9.37
2000	15.0	5.5	33	3.92	10.69	7.5	9	7	0.12	375	8.40

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.0	6.0	14	1.81	1.81	7.5	6	6	0.07	67	1.55
250	6.0	5.0	14	1.51	1.81	7.5	7	6	0.12	56	1.29
250	6.5	4.5	15	1.45	2.10	7.5	7	6	0.07	58	1.35
250	7.0	3.5	16	1.20	2.41	7.5	8	5	0.08	51	1.20
250	7.5	3.0	17	1.10	2.75	7.5	8	4	0.05	49	1.18
500	7.5	7.5	17	2.75	2.75	7.5	7	7	0.09	131	2.95
500	8.0	6.5	18	2.52	3.11	7.5	8	7	0.07	128	2.88
500	8.5	5.5	19	2.25	3.48	7.5	7	7	0.07	120	2.74
500	9.0	4.5	20	1.94	3.88	7.5	8	6	0.08	109	2.50
500	10.0	3.5	22	1.66	4.75	7.5	10	5	0.05	102	2.37
750	8.5	8.5	19	3.48	3.48	7.5	7	7	0.10	189	4.23
750	9.0	7.0	20	3.02	3.88	7.5	7	7	0.11	173	3.88
750	9.5	6.0	21	2.72	4.30	7.5	8	7	0.11	163	3.69
750	10.0	5.0	22	2.37	4.75	7.5	9	6	0.12	149	3.39
750	11.0	4.0	24	2.07	5.70	7.5	8	6	0.10	142	3.25
1000	9.5	9.5	21	4.30	4.30	7.5	8	8	0.07	263	5.84
1000	9.5	8.0	21	*3.62	4.30	7.5	8	8	0.13	221	4.92
1000	10.0	7.0	22	*3.32	4.75	7.5	8	7	0.12	212	4.75
1000	11.0	5.5	24	2.85	5.70	7.5	8	7	0.11	198	4.48
1000	12.0	4.5	27	2.62	6.99	7.5	9	6	0.08	197	4.50
1250	10.0	10.0	22	4.75	4.75	7.5	7	7	0.09	307	6.79
1250	10.5	8.5	23	4.22	5.21	7.5	8	8	0.10	285	6.33
1250	11.0	7.5	24	3.88	5.70	7.5	8	8	0.09	274	6.11
1250	11.5	6.0	26	3.36	6.45	7.5	9	7	0.12	246	5.53
1250	12.5	5.0	28	3.02	7.56	7.5	10	6	0.10	239	5.40
1500	10.5	10.5	23	5.21	5.21	7.5	8	8	0.09	355	7.82
1500	11.0	9.0	24	4.66	5.70	7.5	8	8	0.10	331	7.33
1500	11.5	7.5	26	4.21	6.45	7.5	9	8	0.12	311	6.92
1500	12.5	6.5	28	3.93	7.56	7.5	9	8	0.08	314	7.02
1500	13.5	5.0	30	3.24	8.74	7.5	10	6	0.09	277	6.25
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
2000	11.5	10.0	26	5.61	6.45	7.5	8	8	0.13	418	9.22
2000	12.5	8.5	28	5.14	7.56	7.5	8	9	0.10	415	9.18
2000	13.5	7.0	30	4.53	8.74	7.5	9	8	0.09	394	8.75
2000	14.5	5.5	32	3.80	10.02	7.5	9	7	0.11	351	7.87

TABLE 2-1-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD
0	3.5	3.5	10	0.75	0.75	3.0	5	5	0.00	15	0.37
250	5.5	5.5	14	1.66	1.66	7.5	6	6	0.00	56	1.30
250	6.0	4.5	14	*1.36	1.81	7.5	7	6	0.00	50	1.16
250	6.5	4.0	15	*1.29	2.10	7.5	7	6	0.00	51	1.20
250	7.5	3.0	17	*1.10	2.75	7.5	8	4	0.00	49	1.18
250	8.5	2.5	19	1.02	3.48	3.0	8	4	0.00	51	1.24
500	7.0	7.0	16	2.41	2.41	7.5	6	6	0.08	107	2.41
500	7.5	6.0	17	2.20	2.75	7.5	7	7	0.05	104	2.36
500	8.0	5.0	18	1.94	3.11	7.5	8	6	0.04	97	2.22
500	9.0	4.0	20	1.72	3.88	7.5	8	6	0.00	96	2.22
500	9.5	3.5	21	1.58	4.30	7.5	9	5	0.00	92	2.15
750	8.0	8.0	18	3.11	3.11	7.5	7	7	0.10	158	3.55
750	8.5	7.0	19	2.87	3.48	7.5	7	7	0.08	155	3.48
750	9.0	6.0	20	2.59	3.88	7.5	8	7	0.07	147	3.33
750	10.0	5.0	22	2.37	4.75	7.5	9	6	0.02	149	3.39
750	10.5	4.0	23	1.98	5.21	7.5	8	6	0.04	129	2.98
1000	9.0	9.0	20	3.88	3.88	7.5	7	7	0.08	224	5.00
1000	9.5	7.5	21	3.40	4.30	7.5	8	8	0.08	206	4.61
1000	10.0	6.5	22	3.08	4.75	7.5	8	7	0.08	196	4.41
1000	10.5	5.5	23	2.73	5.21	7.5	8	7	0.08	181	4.09
1000	11.5	4.5	26	2.52	6.45	7.5	9	6	0.04	182	4.15
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.11	263	5.84
1250	10.5	8.0	23	3.97	5.21	7.5	8	8	0.06	268	5.96
1250	11.0	7.0	24	3.62	5.70	7.5	8	8	0.06	255	5.70
1250	12.0	5.5	27	3.20	6.99	7.5	9	7	0.03	244	5.50
1250	13.0	4.5	29	2.81	8.14	7.5	10	6	0.01	230	5.23
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.12	307	6.79
1500	11.0	8.5	24	4.40	5.70	7.5	8	8	0.07	312	6.92
1500	11.5	7.5	26	4.21	6.45	7.5	9	8	0.06	311	6.92
1500	12.5	6.0	28	3.62	7.56	7.5	9	7	0.05	289	6.48
1500	13.0	5.0	29	3.13	8.14	7.5	10	6	0.07	257	5.81
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.11	407	8.96
2000	11.5	9.5	26	5.33	6.45	7.5	9	8	0.11	397	8.76
2000	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
2000	13.5	6.5	30	4.21	8.74	7.5	10	8	0.07	364	8.12
2000	14.5	5.5	32	3.80	10.02	7.5	9	7	0.05	351	7.87

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	10	0.97	0.97	3.0	6	6	0.00	26	0.62
250	6.0	6.0	14	1.81	1.81	3.0	6	6	0.00	67	1.55
250	6.5	5.0	15	1.62	2.10	3.0	7	6	0.00	65	1.50
250	7.0	4.5	16	1.55	2.41	3.0	7	6	0.00	67	1.55
250	8.5	3.5	19	1.43	3.48	3.0	9	5	0.00	74	1.74
250	9.5	3.0	21	1.36	4.30	3.0	9	4	0.00	78	1.84
500	7.0	7.0	17	2.57	2.57	7.5	7	7	0.00	113	2.57
500	7.5	6.0	17	*2.20	2.75	7.5	7	7	0.00	104	2.36
500	8.5	5.0	19	2.05	3.48	3.0	8	6	0.00	109	2.49
500	9.5	4.0	21	1.81	4.30	3.0	8	6	0.00	106	2.46
500	10.5	3.5	23	1.73	5.21	3.0	10	5	0.00	112	2.60
750	8.0	8.0	18	3.11	3.11	7.5	7	7	0.00	158	3.55
750	8.5	7.0	19	2.87	3.48	7.5	7	7	0.00	155	3.48
750	9.0	6.0	20	2.59	3.88	7.5	8	7	0.00	147	3.33
750	10.0	5.0	22	2.37	4.75	7.5	9	6	0.00	149	3.39
750	11.0	4.0	24	2.07	5.70	7.5	8	6	0.00	142	3.25
1000	8.5	8.5	19	3.48	3.48	7.5	7	7	0.02	189	4.23
1000	9.5	7.0	21	3.17	4.30	7.5	7	8	0.00	192	4.31
1000	10.0	6.0	22	2.85	4.75	7.5	8	7	0.00	181	4.07
1000	11.0	5.0	24	2.59	5.70	7.5	9	6	0.00	179	4.07
1000	12.5	4.0	28	2.41	7.56	7.5	9	6	0.00	188	4.32
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.00	263	5.84
1250	10.0	8.0	22	3.80	4.75	7.5	8	7	0.00	244	5.43
1250	10.5	7.0	23	3.47	5.21	7.5	8	8	0.00	233	5.21
1250	11.5	5.5	26	3.08	6.45	7.5	8	7	0.00	225	5.07
1250	13.0	4.5	29	2.81	8.14	7.5	10	6	0.00	230	5.23
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.02	307	6.79
1500	10.5	8.5	23	4.22	5.21	7.5	8	8	0.02	285	6.33
1500	11.0	7.5	24	3.88	5.70	7.5	8	8	0.00	274	6.11
1500	12.0	6.0	27	3.49	6.99	7.5	9	7	0.00	267	6.00
1500	13.0	5.0	29	3.13	8.14	7.5	10	6	0.00	257	5.81
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.03	407	8.96
2000	11.5	9.5	26	5.33	6.45	7.5	9	8	0.02	397	8.76
2000	12.0	8.0	27	4.66	6.99	7.5	9	8	0.03	361	8.00
2000	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
2000	14.5	5.5	32	3.80	10.02	7.5	9	7	0.00	351	7.87

TABLE 2-1-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	13	1.54	1.54	3.0	6	6	0.00	52	1.21
250	6.5	6.5	15	2.10	2.10	3.0	7	7	0.00	85	1.95
250	7.0	5.5	16	1.90	2.41	3.0	7	6	0.00	83	1.90
250	8.5	4.5	19	1.84	3.48	3.0	8	6	0.00	97	2.24
250	9.0	4.0	20	1.72	3.88	3.0	8	6	0.00	96	2.22
250	11.5	3.0	26	1.68	6.45	3.0	10	4	0.00	118	2.76
500	7.5	7.5	17	2.75	2.75	3.0	7	7	0.00	131	2.95
500	8.0	6.5	18	2.52	3.11	3.0	8	7	0.00	128	2.88
500	9.0	5.5	20	2.37	3.88	3.0	7	7	0.00	134	3.05
500	10.0	4.5	22	2.13	4.75	3.0	9	6	0.00	133	3.05
500	12.0	3.5	27	2.04	6.99	3.0	11	5	0.00	151	3.50
750	8.0	8.0	19	3.28	3.28	7.5	7	7	0.00	167	3.75
750	8.5	7.0	19	2.87	3.48	3.0	7	7	0.00	155	3.48
750	9.5	6.0	21	2.72	4.30	3.0	8	7	0.00	163	3.69
750	11.0	5.0	24	2.59	5.70	3.0	9	6	0.00	179	4.07
750	12.5	4.0	28	2.41	7.56	3.0	9	6	0.00	188	4.32
1000	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
1000	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
1000	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
1000	11.0	5.5	24	2.85	5.70	3.0	8	7	0.00	198	4.48
1000	12.5	4.5	28	2.72	7.56	3.0	10	6	0.00	214	4.86
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.00	263	5.84
1250	10.0	8.0	22	3.80	4.75	7.5	8	7	0.00	244	5.43
1250	10.5	7.0	23	3.47	5.21	7.5	8	8	0.00	233	5.21
1250	12.0	5.5	27	3.20	6.99	3.0	9	7	0.00	244	5.50
1250	14.0	4.5	31	3.01	9.37	3.0	10	6	0.00	266	6.02
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.00	307	6.79
1500	10.5	8.5	23	4.22	5.21	7.5	8	8	0.00	285	6.33
1500	11.0	7.5	24	3.88	5.70	7.5	8	8	0.00	274	6.11
1500	12.5	6.0	28	3.62	7.56	7.5	9	7	0.00	289	6.48
1500	14.0	5.0	31	3.34	9.37	3.0	11	6	0.00	297	6.69
2000	10.5	10.5	23	5.21	5.21	7.5	8	8	0.01	355	7.82
2000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.00	375	8.30
2000	12.5	7.5	28	4.53	7.56	7.5	9	8	0.00	365	8.10
2000	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
2000	15.5	5.0	34	3.67	11.38	7.5	11	6	0.00	361	8.13

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	15	2.10	2.10	3.0	7	7	0.00	85	1.95
250	7.0	7.0	16	2.41	2.41	3.0	6	6	0.00	107	2.41
250	8.0	6.0	18	2.33	3.11	3.0	7	7	0.00	117	2.66
250	9.0	5.0	20	2.16	3.88	3.0	9	6	0.00	122	2.77
250	10.5	4.0	23	1.98	5.21	3.0	8	6	0.00	129	2.98
250	12.0	3.5	27	2.04	6.99	3.0	11	5	0.00	151	3.50
500	8.0	8.0	18	3.11	3.11	3.0	7	7	0.00	158	3.55
500	8.5	7.0	19	2.87	3.48	3.0	7	7	0.00	155	3.48
500	9.5	6.0	21	2.72	4.30	3.0	8	7	0.00	163	3.69
500	10.5	5.0	23	2.48	5.21	3.0	9	6	0.00	164	3.72
500	12.5	4.0	28	2.41	7.56	3.0	9	6	0.00	188	4.32
750	8.5	8.5	19	3.48	3.48	3.0	7	7	0.00	189	4.23
750	9.5	7.0	21	3.17	4.30	3.0	7	8	0.00	192	4.31
750	10.5	6.0	23	2.98	5.21	3.0	8	7	0.00	199	4.47
750	12.0	5.0	27	2.91	6.99	3.0	10	6	0.00	221	5.00
750	14.0	4.0	31	2.67	9.37	3.0	10	6	0.00	234	5.35
1000	9.0	9.0	20	3.88	3.88	3.0	7	7	0.00	224	5.00
1000	10.0	7.5	22	3.56	4.75	3.0	8	7	0.00	228	5.09
1000	11.0	6.5	24	3.36	5.70	3.0	9	8	0.00	236	5.29
1000	12.0	5.5	27	3.20	6.99	3.0	9	7	0.00	244	5.50
1000	14.0	4.5	31	3.01	9.37	3.0	10	6	0.00	266	6.02
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.00	263	5.84
1250	10.5	8.0	23	3.97	5.21	3.0	8	8	0.00	268	5.96
1250	11.5	7.0	26	3.93	6.45	3.0	8	8	0.00	289	6.45
1250	13.0	5.5	29	3.44	8.14	3.0	9	7	0.00	285	6.39
1250	15.0	4.5	33	3.20	10.69	3.0	10	6	0.00	303	6.87
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.00	307	6.79
1500	11.0	8.5	24	4.40	5.70	7.5	8	8	0.00	312	6.92
1500	11.5	7.5	26	4.21	6.45	3.0	9	8	0.00	311	6.92
1500	13.5	6.0	30	3.88	8.74	3.0	9	7	0.00	335	7.50
1500	15.0	5.0	33	3.56	10.69	3.0	11	6	0.00	339	7.63
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
2000	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
2000	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
2000	14.0	6.5	31	4.35	9.37	3.0	10	8	0.00	391	8.70
2000	15.5	5.5	34	4.03	11.38	3.0	10	7	0.00	399	8.94

TABLE 2-1-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC (CU.Y
0	7.5	7.5	17	2.75	2.75	3.0	7	7	0.00	131	2.9
250	7.5	7.5	17	2.75	2.75	3.0	7	7	0.00	131	2.9
250	8.5	6.5	19	2.66	3.48	3.0	8	7	0.00	143	3.2
250	9.5	5.5	21	2.49	4.30	3.0	8	7	0.00	149	3.3
250	11.0	4.5	24	2.33	5.70	3.0	9	6	0.00	160	3.6
250	14.0	3.5	31	2.34	9.37	3.0	11	5	0.00	203	4.6
500	8.5	8.5	19	3.48	3.48	3.0	7	7	0.00	189	4.2
500	9.0	7.0	20	3.02	3.88	3.0	7	7	0.00	173	3.8
500	10.0	6.0	22	2.85	4.75	3.0	8	7	0.00	181	4.0
500	11.5	5.0	26	2.80	6.45	3.0	10	6	0.00	203	4.6
500	14.0	4.0	31	2.67	9.37	3.0	10	6	0.00	234	5.3
750	9.0	9.0	20	3.88	3.88	3.0	7	7	0.00	224	5.0
750	10.0	7.5	22	3.56	4.75	3.0	8	7	0.00	228	5.0
750	11.0	6.5	24	3.36	5.70	3.0	9	8	0.00	236	5.2
750	12.0	5.5	27	3.20	6.99	3.0	9	7	0.00	244	5.5
750	14.0	4.5	31	3.01	9.37	3.0	10	6	0.00	266	6.0
1000	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.8
1000	10.0	8.0	22	3.80	4.75	3.0	8	7	0.00	244	5.4
1000	11.0	7.0	24	3.62	5.70	3.0	8	8	0.00	255	5.7
1000	13.0	5.5	29	3.44	8.14	3.0	9	7	0.00	285	6.3
1000	15.0	4.5	33	3.20	10.69	3.0	10	6	0.00	303	6.8
1250	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.7
1250	10.5	8.5	23	4.22	5.21	3.0	8	8	0.00	285	6.3
1250	11.5	7.5	26	4.21	6.45	3.0	9	8	0.00	311	6.9
1250	13.5	6.0	30	3.88	8.74	3.0	9	7	0.00	335	7.5
1250	15.0	5.0	33	3.56	10.69	3.0	11	6	0.00	339	7.6
1500	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.7
1500	11.5	8.5	26	4.77	6.45	3.0	8	8	0.00	354	7.8
1500	12.0	7.5	27	4.37	6.99	3.0	9	8	0.00	337	7.5
1500	14.0	6.0	31	4.01	9.37	3.0	10	7	0.00	360	8.0
1500	16.0	5.0	35	3.78	12.09	3.0	11	6	0.00	384	8.6
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.9
2000	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.5
2000	13.0	8.0	29	5.01	8.14	3.0	9	8	0.00	420	9.3
2000	15.0	6.5	33	4.63	10.69	3.0	10	8	0.00	446	9.9
2000	16.5	5.5	36	4.27	12.83	3.0	10	7	0.00	451	10.0

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	18	3.11	3.11	3.0	7	7	0.00	158	3.55
250	8.0	8.0	18	3.11	3.11	3.0	7	7	0.00	158	3.55
250	9.0	7.0	20	3.02	3.88	3.0	7	7	0.00	173	3.88
250	10.0	6.0	22	2.85	4.75	3.0	8	7	0.00	181	4.07
250	12.0	5.0	27	2.91	6.99	3.0	10	6	0.00	221	5.00
250	15.0	4.0	33	2.85	10.69	3.0	10	6	0.00	268	6.11
500	8.5	8.5	19	3.48	3.48	3.0	7	7	0.00	189	4.23
500	10.0	7.0	22	3.32	4.75	3.0	8	7	0.00	212	4.75
500	11.5	6.0	26	3.36	6.45	3.0	9	7	0.00	246	5.53
500	13.0	5.0	29	3.13	8.14	3.0	10	6	0.00	257	5.81
500	15.5	4.0	34	2.93	11.38	3.0	10	6	0.00	285	6.50
750	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
750	10.0	8.0	22	3.80	4.75	3.0	8	7	0.00	244	5.43
750	11.0	7.0	24	3.62	5.70	3.0	8	8	0.00	255	5.70
750	13.0	5.5	29	3.44	8.14	3.0	9	7	0.00	285	6.39
750	15.5	4.5	34	3.30	11.38	3.0	11	6	0.00	323	7.31
1000	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
1000	11.0	8.0	24	4.14	5.70	3.0	8	8	0.00	293	6.51
1000	12.0	7.0	27	4.08	6.99	3.0	8	8	0.00	314	7.00
1000	14.0	5.5	31	3.68	9.37	3.0	9	7	0.00	328	7.36
1000	16.5	4.5	36	3.49	12.83	3.0	11	6	0.00	365	8.25
1250	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
1250	11.0	8.5	24	4.40	5.70	3.0	8	8	0.00	312	6.92
1250	12.0	7.5	27	4.37	6.99	3.0	9	8	0.00	337	7.50
1250	14.0	6.0	31	4.01	9.37	3.0	10	7	0.00	360	8.03
1250	16.0	5.0	35	3.78	12.09	3.0	11	6	0.00	384	8.64
1500	10.5	10.5	23	5.21	5.21	3.0	8	8	0.00	355	7.82
1500	11.5	9.0	26	5.05	6.45	3.0	8	8	0.00	375	8.30
1500	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
1500	14.0	6.5	31	4.35	9.37	3.0	10	8	0.00	391	8.70
1500	17.0	5.0	38	4.10	13.95	3.0	11	6	0.00	444	9.96
2000	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
2000	12.5	9.5	28	5.74	7.56	3.0	9	9	0.00	466	10.26
2000	13.5	8.0	30	5.18	8.74	3.0	9	9	0.00	452	10.00
2000	15.5	6.5	34	4.77	11.38	3.0	10	8	0.00	476	10.57
2000	17.5	5.5	39	4.63	14.74	3.0	10	7	0.00	518	11.58

TABLE 2-1-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	9.0	9.0	21	4.08	4.08	3.0	7	7	0.00	236	5.25
250	9.0	9.0	21	4.08	4.08	3.0	7	7	0.00	236	5.25
250	10.0	7.5	22	3.56	4.75	3.0	8	7	0.00	228	5.09
250	12.0	6.5	27	3.79	6.99	3.0	9	8	0.00	291	6.50
250	14.0	5.5	31	3.68	9.37	3.0	9	7	0.00	328	7.36
250	17.0	4.5	38	3.69	13.95	3.0	11	6	0.00	397	8.97
500	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
500	10.5	8.0	23	3.97	5.21	3.0	8	8	0.00	268	5.96
500	12.0	7.0	27	4.08	6.99	3.0	8	8	0.00	314	7.00
500	14.5	5.5	32	3.80	10.02	3.0	9	7	0.00	351	7.87
500	17.0	4.5	38	3.69	13.95	3.0	11	6	0.00	397	8.97
750	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
750	11.0	8.5	24	4.40	5.70	3.0	8	8	0.00	312	6.92
750	12.0	7.5	27	4.37	6.99	3.0	9	8	0.00	337	7.50
750	14.5	6.0	32	4.14	10.02	3.0	10	7	0.00	385	8.59
750	16.5	5.0	36	3.88	12.83	3.0	11	6	0.00	408	9.16
1000	10.5	10.5	23	5.21	5.21	3.0	8	8	0.00	355	7.82
1000	11.5	9.0	26	5.05	6.45	3.0	8	8	0.00	375	8.30
1000	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
1000	14.5	6.5	32	4.49	10.02	3.0	10	8	0.00	418	9.30
1000	17.5	5.0	39	4.21	14.74	3.0	11	6	0.00	469	10.53
1250	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
1250	11.5	9.5	26	5.33	6.45	3.0	9	8	0.00	397	8.76
1250	13.0	8.0	29	5.01	8.14	3.0	9	8	0.00	420	9.30
1250	15.0	6.5	33	4.63	10.69	3.0	10	8	0.00	446	9.93
1250	17.0	5.5	38	4.51	13.95	3.0	10	7	0.00	490	10.96
1500	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
1500	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
1500	14.0	8.0	31	5.35	9.37	3.0	10	9	0.00	485	10.71
1500	16.0	6.5	35	4.91	12.09	3.0	10	8	0.00	506	11.23
1500	18.0	5.5	40	4.75	15.55	3.0	10	7	0.00	547	12.22
2000	12.0	12.0	27	6.99	6.99	3.0	8	8	0.00	547	12.00
2000	12.5	10.5	28	6.35	7.56	3.0	9	9	0.00	516	11.34
2000	14.0	9.0	31	6.02	9.37	3.0	9	9	0.00	547	12.05
2000	15.5	7.5	34	5.50	11.38	3.0	10	8	0.00	552	12.19
2000	18.5	6.0	41	5.31	16.38	3.0	11	7	0.00	632	14.04

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 2000 PSI

TABLE 2-1-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	10.0	10.0	23	4.96	4.96	3.0	7	7	0.00	321	7.09
250	10.0	10.0	23	4.96	4.96	3.0	7	7	0.00	321	7.09
250	11.0	8.5	24	4.40	5.70	3.0	8	8	0.00	312	6.92
250	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
250	16.0	6.0	35	4.53	12.09	3.0	10	7	0.00	465	10.37
250	20.0	5.0	44	4.75	19.00	3.0	11	6	0.00	606	13.58
500	10.0	10.0	23	4.96	4.96	3.0	7	7	0.00	321	7.09
500	11.5	8.5	26	4.77	6.45	3.0	8	8	0.00	354	7.84
500	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
500	16.0	6.0	35	4.53	12.09	3.0	10	7	0.00	465	10.37
500	20.0	5.0	44	4.75	19.00	3.0	11	6	0.00	606	13.58
750	10.5	10.5	24	5.44	5.44	3.0	8	8	0.00	370	8.16
750	12.0	9.0	27	5.24	6.99	3.0	8	8	0.00	407	9.00
750	14.0	7.5	31	5.02	9.37	3.0	9	8	0.00	453	10.04
750	15.5	6.5	34	4.77	11.38	3.0	10	8	0.00	476	10.57
750	20.0	5.0	44	4.75	19.00	3.0	11	6	0.00	606	13.58
1000	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
1000	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
1000	14.0	8.0	31	5.35	9.37	3.0	10	9	0.00	485	10.71
1000	16.5	6.5	36	5.05	12.83	3.0	11	8	0.00	537	11.91
1000	18.5	5.5	41	4.87	16.38	3.0	10	7	0.00	577	12.87
1250	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
1250	12.5	10.0	28	6.04	7.56	3.0	8	9	0.00	491	10.80
1250	14.0	8.5	31	5.69	9.37	3.0	9	9	0.00	516	11.38
1250	16.0	7.0	35	5.29	12.09	3.0	9	8	0.00	546	12.09
1250	19.5	5.5	43	5.10	18.11	3.0	11	7	0.00	638	14.23
1500	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
1500	13.0	10.0	29	6.26	8.14	3.0	8	8	0.00	529	11.63
1500	14.5	8.5	32	5.87	10.02	3.0	9	9	0.00	552	12.17
1500	17.0	7.0	38	5.74	13.95	3.0	10	8	0.00	631	13.95
1500	20.0	5.5	44	5.22	19.00	3.0	11	7	0.00	670	14.93
2000	12.5	12.5	28	7.56	7.56	3.0	9	9	0.00	617	13.50
2000	13.5	10.5	30	6.80	8.74	3.0	9	9	0.00	598	13.12
2000	15.0	9.0	33	6.41	10.69	3.0	9	9	0.00	625	13.75
2000	17.0	7.5	38	6.15	13.95	3.0	10	8	0.00	678	14.95
2000	20.0	6.0	44	5.70	19.00	3.0	11	7	0.00	734	16.29

TABLE 2-1-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	11.0	11.0	26	6.17	6.17	3.0	8	8	0.00	441	9.70
250	10.5	10.5	25	5.67	5.67	3.0	8	8	0.00	385	8.50
250	13.0	9.0	29	5.63	8.14	3.0	9	8	0.00	475	10.47
250	16.0	7.5	35	5.67	12.09	3.0	10	8	0.00	587	12.96
250	18.0	6.5	40	5.61	15.55	3.0	11	8	0.00	651	14.44
250	24.0	5.0	53	5.72	27.47	3.0	11	6	0.00	878	19.62
500	11.0	11.0	26	6.17	6.17	3.0	8	8	0.00	441	9.70
500	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
500	15.0	8.0	33	5.70	10.69	3.0	10	9	0.00	554	12.22
500	18.0	6.5	40	5.61	15.55	3.0	11	8	0.00	651	14.44
500	21.0	5.5	46	5.46	20.86	3.0	11	7	0.00	736	16.39
750	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
750	12.5	10.0	28	6.04	7.56	3.0	8	9	0.00	491	10.80
750	14.0	8.5	31	5.69	9.37	3.0	9	9	0.00	516	11.38
750	17.0	7.0	38	5.74	13.95	3.0	10	8	0.00	631	13.95
750	21.0	5.5	46	5.46	20.86	3.0	11	7	0.00	736	16.39
1000	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
1000	13.0	10.0	29	6.26	8.14	3.0	8	8	0.00	529	11.63
1000	15.0	8.5	33	6.05	10.69	3.0	9	9	0.00	590	12.98
1000	17.5	7.0	39	5.89	14.74	3.0	10	10	0.00	667	14.74
1000	21.0	5.5	46	5.46	20.86	3.0	11	7	0.00	736	16.39
1250	12.0	12.0	27	6.99	6.99	3.0	8	8	0.00	547	12.00
1250	13.0	10.5	29	6.57	8.14	3.0	9	8	0.00	556	12.21
1250	14.5	9.0	32	6.22	10.02	3.0	9	9	0.00	586	12.88
1250	17.0	7.5	38	6.15	13.95	3.0	10	8	0.00	678	14.95
1250	20.5	6.0	45	5.83	19.92	3.0	11	7	0.00	769	17.08
1500	12.5	12.5	28	7.56	7.56	3.0	9	9	0.00	617	13.50
1500	13.5	10.5	30	6.80	8.74	3.0	9	9	0.00	598	13.12
1500	15.5	9.0	34	6.60	11.38	3.0	9	9	0.00	666	14.63
1500	17.5	7.5	39	6.31	14.74	3.0	10	8	0.00	716	15.79
1500	21.0	6.0	46	5.96	20.86	3.0	11	7	0.00	806	17.88
2000	13.0	13.0	29	8.14	8.14	3.0	8	8	0.00	692	15.12
2000	14.0	11.0	31	7.36	9.37	3.0	9	9	0.00	673	14.73
2000	16.0	9.5	35	7.18	12.09	3.0	10	9	0.00	749	16.41
2000	18.0	8.0	40	6.91	15.55	3.0	11	9	0.00	808	17.77
2000	21.0	6.5	46	6.45	20.86	3.0	11	8	0.00	876	19.37

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	6	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	7	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	8	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	7	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	8	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	7	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	8	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	7	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	8	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	7	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	33	6.77	10.33	7.5	10	9	0.06	639	14.03
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 2-2-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	7	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	6	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	7	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	6	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	7	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	6	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	28	4.53	7.25	7.5	9	8	0.06	350	7.77
1000	12.5	6.5	30	4.21	8.10	7.5	10	8	0.07	337	7.52
1000	14.0	5.0	32	*3.45	9.67	7.5	11	6	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	7	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	32	4.83	9.33	7.5	9	8	0.09	420	9.33
1500	15.0	5.5	33	*5.00	10.69	7.5	11	7	0.11	428	8.40
2000	12.0	12.0	27	*8.70	*6.99	7.5	9	8	0.11	614	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	31	6.02	9.03	7.5	9	9	0.10	528	11.62
2000	14.5	7.5	32	*5.18	10.02	7.5	9	8	0.11	485	10.74
2000	15.5	6.0	35	*5.47	11.71	7.5	11	7	0.13	498	10.04

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	6	6	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	6	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	6	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	25	3.78	5.67	7.5	8	8	0.07	254	5.67
750	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	6	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	28	*3.62	7.25	7.5	9	7	0.10	277	6.22
1000	13.0	5.0	29	*3.13	8.14	7.5	10	6	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*4.03	7.56	7.5	10	8	0.12	318	7.02
1250	13.5	5.0	31	*5.18	9.03	7.5	11	6	0.14	367	6.45
1500	11.0	11.0	24	*6.59	*5.70	7.5	9	8	0.11	439	8.96
1500	11.5	9.5	27	5.54	6.70	7.5	9	8	0.10	412	9.10
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	31	*4.35	8.70	7.5	10	8	0.12	362	8.08
1500	14.0	5.5	31	*4.70	9.37	7.5	10	7	0.14	375	7.36
2000	11.5	11.5	27	*7.41	*6.70	7.5	9	8	0.13	528	11.02
2000	12.0	10.0	30	6.48	7.77	7.5	9	9	0.12	504	11.11
2000	13.0	8.5	31	5.69	8.70	7.5	9	9	0.12	479	10.57
2000	14.0	7.0	32	*4.83	9.67	7.5	9	8	0.13	436	9.67
2000	15.0	5.5	35	*4.61	11.34	7.5	10	7	0.16	420	8.91

TABLE 2-2-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC (CU.Y
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.1
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.0
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.0
250	7.5	4.5	18	*1.74	2.91	7.5	8	6	0.10	81	1.8
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.7
250	8.5	3.0	20	*1.63	3.67	7.5	9	4	0.13	75	1.5
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.5
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.4
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.3
500	9.0	5.0	22	*2.37	4.27	7.5	9	6	0.13	134	3.0
500	10.0	4.0	22	*2.57	4.75	7.5	9	6	0.14	139	2.7
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.0
750	9.0	7.5	23	3.72	4.47	7.5	8	8	0.12	214	4.7
750	9.5	6.5	24	3.36	4.92	7.5	9	8	0.12	203	4.5
750	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.14	187	4.2
750	11.0	4.5	25	*2.43	5.94	7.5	9	6	0.14	167	3.8
1000	9.5	9.5	21	*4.47	*4.30	7.5	8	8	0.12	269	5.8
1000	10.0	8.0	24	4.14	5.18	7.5	8	8	0.11	266	5.9
1000	10.5	7.0	25	3.78	5.67	7.5	8	8	0.11	254	5.6
1000	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.13	225	5.0
1000	12.0	4.5	28	*2.80	7.25	7.5	10	6	0.16	208	4.6
1250	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.12	321	7.0
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.8
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.6
1250	11.5	6.0	29	*3.75	7.20	7.5	9	7	0.16	275	6.1
1250	12.5	5.0	29	*3.40	7.83	7.5	11	6	0.17	258	5.5
1500	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.13	370	8.1
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.9
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.4
1500	12.0	6.5	30	*4.21	7.77	7.5	10	8	0.15	323	7.2
1500	13.0	5.0	32	*3.76	8.98	7.5	11	6	0.19	297	6.4
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.6
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.9
2000	12.0	8.5	31	5.69	8.03	7.5	9	9	0.15	441	9.7
2000	13.0	7.0	31	*4.68	8.70	7.5	9	8	0.17	391	8.7
2000	14.0	5.5	33	*5.62	9.97	7.5	11	7	0.20	427	7.8

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	14	*1.66	1.66	7.5	6	6	0.16	56	1.30
250	6.0	4.5	15	1.45	1.94	7.5	7	6	0.14	53	1.25
250	6.0	4.0	15	*1.29	1.94	7.5	7	6	0.18	47	1.11
250	6.5	3.0	16	*1.03	2.24	7.5	8	4	0.20	40	0.96
250	7.0	2.5	16	*0.86	2.41	7.5	8	4	0.19	35	0.86
500	7.0	7.0	17	*2.65	*2.57	7.5	7	7	0.17	115	2.57
500	7.5	6.0	18	*2.33	2.91	7.5	7	7	0.15	110	2.50
500	8.0	5.0	19	*2.05	3.28	7.5	8	6	0.15	102	2.34
500	8.5	4.0	19	*1.80	3.48	7.5	8	6	0.19	90	1.99
500	9.0	3.5	20	*1.51	3.88	7.5	9	5	0.17	83	1.94
750	8.0	8.0	19	*3.79	*3.28	7.5	8	7	0.17	180	3.75
750	8.5	7.0	21	3.17	3.85	7.5	7	7	0.14	171	3.85
750	9.0	6.0	21	*2.72	4.08	7.5	8	7	0.15	155	3.50
750	9.5	5.0	22	*2.37	4.51	7.5	9	6	0.17	141	3.22
750	10.0	4.0	23	*2.32	4.96	7.5	9	6	0.21	134	2.83
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.5	7.5	22	*3.56	4.51	7.5	8	8	0.14	216	4.83
1000	9.5	6.5	25	3.51	5.13	7.5	9	8	0.17	212	4.76
1000	10.5	5.5	24	*2.85	5.44	7.5	8	7	0.16	189	4.27
1000	11.0	4.5	25	*2.56	5.94	7.5	9	6	0.19	172	3.81
1250	9.5	9.5	22	*4.51	4.51	7.5	8	8	0.15	276	6.12
1250	10.0	8.0	24	*4.14	5.18	7.5	8	8	0.15	266	5.92
1250	10.5	7.0	25	*3.78	5.67	7.5	8	8	0.15	254	5.67
1250	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.16	225	5.07
1250	12.0	4.5	27	*3.20	6.99	7.5	10	6	0.21	220	4.50
1500	10.0	10.0	23	*4.96	*4.96	7.5	7	7	0.16	321	7.09
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.72	6.95	7.5	9	7	0.20	269	5.96
1500	12.5	5.0	28	*3.69	7.56	7.5	11	6	0.21	266	5.40
2000	11.0	11.0	24	*5.93	*5.70	7.5	8	8	0.15	415	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.16	387	8.59
2000	12.5	6.5	31	*4.35	8.37	7.5	10	8	0.20	348	7.77
2000	13.5	5.5	31	*4.01	9.03	7.5	10	7	0.21	331	7.10

TABLE 2-2-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.0	5.0	13	*1.40	1.40	7.5	6	6	0.10	42	1.00
250	5.0	4.0	14	*1.20	1.51	7.5	6	6	0.15	36	0.86
250	5.5	3.5	15	*1.13	1.78	7.5	7	5	0.08	37	0.89
250	5.5	3.0	15	*0.97	1.78	7.5	7	4	0.12	31	0.76
250	6.0	2.5	15	*0.88	1.94	7.5	7	4	0.07	29	0.69
500	6.5	6.5	15	*2.10	*2.10	7.5	7	7	0.18	85	1.95
500	6.5	5.5	17	*2.01	2.38	7.5	7	7	0.22	81	1.87
500	7.0	4.5	18	*1.74	2.72	7.5	8	6	0.21	75	1.75
500	7.5	4.0	17	*1.46	2.75	7.5	7	6	0.19	67	1.57
500	8.0	3.0	18	*1.28	3.11	7.5	9	4	0.22	59	1.33
750	7.5	7.5	18	*2.91	*2.91	7.5	7	7	0.18	138	3.12
750	8.0	6.5	19	*2.66	3.28	7.5	8	7	0.17	135	3.04
750	8.5	5.5	19	*2.25	3.48	7.5	7	7	0.17	120	2.74
750	9.0	4.5	20	*1.94	3.88	7.5	8	6	0.18	109	2.50
750	9.5	3.5	21	*1.69	4.30	7.5	9	5	0.22	95	2.15
1000	8.5	8.5	19	*3.48	*3.48	7.5	7	7	0.16	189	4.23
1000	9.0	7.0	21	*3.17	4.08	7.5	7	7	0.16	182	4.08
1000	9.0	6.0	23	*2.98	4.47	7.5	8	7	0.21	169	3.83
1000	10.0	5.0	22	*2.37	4.75	7.5	9	6	0.19	149	3.39
1000	10.5	4.0	23	*2.19	5.21	7.5	9	6	0.23	136	2.98
1250	9.0	9.0	21	*4.08	*4.08	7.5	7	7	0.18	236	5.25
1250	9.5	7.5	23	*3.72	4.71	7.5	8	8	0.18	226	5.05
1250	10.0	6.5	24	*3.36	5.18	7.5	9	8	0.18	214	4.81
1250	10.5	5.5	24	*2.85	5.44	7.5	8	7	0.21	189	4.27
1250	11.5	4.5	26	*2.52	6.45	7.5	9	6	0.18	182	4.15
1500	9.5	9.5	22	*4.93	*4.51	7.5	8	8	0.19	289	6.12
1500	10.0	8.0	25	*4.32	5.40	7.5	9	8	0.18	277	6.17
1500	10.5	7.0	25	*3.78	5.67	7.5	8	8	0.19	254	5.67
1500	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.20	225	5.07
1500	12.0	4.5	27	*3.13	6.99	7.5	10	6	0.24	217	4.50
2000	10.5	10.5	24	*5.44	*5.44	7.5	8	8	0.18	370	8.16
2000	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.18	359	7.94
2000	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.20	335	7.45
2000	12.0	6.5	29	*4.07	7.51	7.5	10	8	0.22	312	6.98
2000	13.5	5.0	30	*3.24	8.74	7.5	10	6	0.20	277	6.25

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	10	0.75	0.75	3.0	5	5	0.00	15	0.37
250	4.5	4.5	15	1.45	1.45	7.5	6	6	0.00	39	0.93
250	5.0	4.0	14	*1.20	1.51	7.5	6	6	0.00	36	0.86
250	5.5	3.5	12	*0.90	1.42	3.0	7	5	0.00	29	0.71
250	6.0	3.0	14	*0.90	1.81	3.0	7	4	0.00	32	0.77
250	6.5	2.5	15	*0.81	2.10	3.0	7	4	0.00	30	0.75
500	6.0	6.0	16	*2.07	2.07	7.5	7	7	0.01	77	1.77
500	6.0	5.0	16	*1.72	2.07	7.5	7	6	0.05	64	1.48
500	6.5	4.5	17	*1.65	2.38	7.5	7	6	0.00	66	1.53
500	7.0	3.5	18	*1.36	2.72	7.5	8	5	0.00	57	1.36
500	7.5	3.0	18	*1.37	2.91	7.5	8	4	0.00	57	1.25
750	7.0	7.0	16	*2.41	*2.41	7.5	6	6	0.12	107	2.41
750	7.0	6.0	17	*2.20	2.57	7.5	7	7	0.16	96	2.20
750	7.5	5.0	19	*2.05	3.07	7.5	8	6	0.11	96	2.19
750	8.0	4.0	20	*1.72	3.45	7.5	8	6	0.10	85	1.97
750	8.5	3.5	20	*1.61	3.67	7.5	9	5	0.06	81	1.83
1000	7.5	7.5	17	*2.98	*2.75	7.5	7	7	0.22	136	2.95
1000	8.0	6.5	19	*2.66	3.28	7.5	8	7	0.17	135	3.04
1000	8.5	5.5	20	*2.37	3.67	7.5	7	7	0.16	127	2.88
1000	9.0	4.5	21	*2.04	4.08	7.5	8	6	0.15	114	2.62
1000	10.0	3.5	22	*1.84	4.75	7.5	10	5	0.10	108	2.37
1250	8.5	8.5	19	*3.48	3.48	7.5	7	7	0.16	189	4.23
1250	8.5	7.0	21	*3.17	3.85	7.5	7	7	0.22	171	3.85
1250	9.0	6.0	22	*2.85	4.27	7.5	8	7	0.21	162	3.66
1250	10.0	5.0	22	*2.37	4.75	7.5	9	6	0.15	149	3.39
1250	10.5	4.0	23	*2.09	5.21	7.5	8	6	0.18	133	2.98
1500	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.18	224	5.00
1500	9.5	7.5	22	*3.56	4.51	7.5	8	8	0.18	216	4.83
1500	10.0	6.5	22	*3.08	4.75	7.5	8	7	0.18	196	4.41
1500	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.19	181	4.09
1500	11.0	4.5	24	*2.40	5.70	7.5	9	6	0.21	163	3.66
2000	10.0	10.0	22	*4.75	*4.75	7.5	7	7	0.19	307	6.79
2000	10.5	8.5	24	*4.40	5.44	7.5	8	8	0.18	298	6.61
2000	11.0	7.5	25	*4.05	5.94	7.5	8	8	0.17	286	6.36
2000	11.5	6.0	26	*3.36	6.45	7.5	9	7	0.22	246	5.53
2000	12.5	5.0	28	*3.02	7.56	7.5	10	6	0.18	239	5.40

TABLE 2-2-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	12	1.03	1.03	3.0	6	6	0.00	24	0.59
250	5.0	5.0	12	*1.29	1.29	3.0	6	6	0.00	39	0.92
250	5.5	4.0	12	*1.08	1.42	3.0	6	6	0.00	35	0.81
250	6.0	3.5	14	*1.05	1.81	3.0	7	5	0.00	38	0.90
250	7.0	3.0	16	*1.03	2.41	3.0	8	4	0.00	43	1.03
250	7.5	2.5	17	*0.92	2.75	3.0	8	4	0.00	40	0.98
500	6.0	6.0	18	2.33	2.33	7.5	7	7	0.00	87	2.00
500	6.0	5.0	16	*1.72	2.07	7.5	7	6	0.00	64	1.48
500	6.5	4.5	18	*1.74	2.52	7.5	8	6	0.00	70	1.62
500	7.5	3.5	17	*1.28	2.75	3.0	8	5	0.00	58	1.37
500	8.5	3.0	19	*1.23	3.48	3.0	9	4	0.00	63	1.49
750	6.5	6.5	18	*2.52	2.52	7.5	8	8	0.00	103	2.34
750	7.0	5.5	18	*2.13	2.72	7.5	7	7	0.00	93	2.13
750	7.5	4.5	20	*1.94	3.24	7.5	8	6	0.00	90	2.08
750	8.0	4.0	20	*1.75	3.45	7.5	8	6	0.00	86	1.97
750	9.5	3.0	22	*1.68	4.51	7.5	9	4	0.00	90	1.93
1000	7.0	7.0	17	*2.73	*2.57	7.5	7	7	0.14	117	2.57
1000	7.5	6.0	19	*2.46	3.07	7.5	7	7	0.08	116	2.63
1000	8.5	5.0	21	*2.26	3.85	7.5	9	6	0.00	120	2.75
1000	9.5	4.0	21	*2.16	4.30	7.5	9	6	0.00	117	2.46
1000	10.0	3.5	22	*2.06	4.75	7.5	10	5	0.00	115	2.37
1250	8.0	8.0	18	*3.11	*3.11	7.5	7	7	0.12	158	3.55
1250	8.0	7.0	19	*2.87	3.28	7.5	7	7	0.15	145	3.28
1250	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.11	146	3.30
1250	9.5	5.0	22	*2.37	4.51	7.5	9	6	0.01	141	3.22
1250	10.5	4.0	23	*2.29	5.21	7.5	9	6	0.00	140	2.98
1500	8.5	8.5	19	*3.48	*3.48	7.5	7	7	0.16	189	4.23
1500	9.0	7.0	21	*3.17	4.08	7.5	7	7	0.14	182	4.08
1500	9.5	6.0	23	*2.98	4.71	7.5	8	7	0.10	179	4.04
1500	10.0	5.0	23	*2.56	4.96	7.5	9	6	0.11	158	3.54
1500	11.0	4.0	24	*2.51	5.70	7.5	9	6	0.05	157	3.25
2000	9.5	9.5	21	*4.30	*4.30	7.5	8	8	0.18	263	5.84
2000	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.17	255	5.67
2000	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.15	243	5.44
2000	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.11	225	5.07
2000	12.0	4.5	27	*2.69	6.99	7.5	10	6	0.13	200	4.50

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA (SQ.IN.) X	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	13	1.26	1.26	3.0	6	6	0.00	34	0.81
250	5.5	5.5	14	1.66	1.66	3.0	6	6	0.00	56	1.30
250	6.0	4.5	14	*1.36	1.81	3.0	7	6	0.00	50	1.16
250	6.5	4.0	15	*1.29	2.10	3.0	7	6	0.00	51	1.20
250	8.0	3.0	18	*1.16	3.11	3.0	9	4	0.00	56	1.33
250	9.0	2.5	20	*1.13	3.88	3.0	9	4	0.00	59	1.38
500	6.0	6.0	14	*1.81	1.81	3.0	6	6	0.00	67	1.55
500	6.5	5.0	15	*1.62	2.10	3.0	7	6	0.00	65	1.50
500	7.0	4.5	16	*1.55	2.41	3.0	7	6	0.00	67	1.55
500	8.5	3.5	19	*1.43	3.48	3.0	9	5	0.00	74	1.74
500	9.5	3.0	21	*1.36	4.30	3.0	9	4	0.00	78	1.84
750	6.5	6.5	19	*2.66	2.66	7.5	8	8	0.00	108	2.47
750	7.0	5.5	18	*2.18	2.72	7.5	7	7	0.00	94	2.13
750	8.0	4.5	18	*1.74	3.11	3.0	8	6	0.00	86	2.00
750	8.5	4.0	19	*1.64	3.48	3.0	7	6	0.00	86	1.99
750	10.5	3.0	23	*1.50	5.21	3.0	10	4	0.00	95	2.23
1000	7.0	7.0	20	*3.02	3.02	7.5	7	7	0.00	133	3.02
1000	7.5	6.0	19	*2.47	3.07	7.5	7	7	0.00	116	2.63
1000	8.5	5.0	21	*2.26	3.85	7.5	9	6	0.00	120	2.75
1000	9.5	4.0	22	*2.25	4.51	7.5	9	6	0.00	122	2.58
1000	10.5	3.5	23	*1.73	5.21	3.0	10	5	0.00	112	2.60
1250	7.5	7.5	20	*3.24	3.24	7.5	7	7	0.02	154	3.47
1250	8.0	6.5	20	*2.80	3.45	7.5	8	8	0.00	142	3.20
1250	9.0	5.5	22	*2.61	4.27	7.5	8	7	0.00	148	3.36
1250	10.0	4.5	23	*2.44	4.96	7.5	9	6	0.00	146	3.19
1250	11.5	3.5	26	*2.21	6.45	7.5	10	5	0.00	148	3.22
1500	8.0	8.0	19	*3.43	*3.28	7.5	8	7	0.11	171	3.75
1500	8.5	7.0	21	*3.17	3.85	7.5	7	7	0.05	171	3.85
1500	9.0	6.0	23	*2.98	4.47	7.5	8	7	0.00	169	3.83
1500	10.0	5.0	24	*2.59	5.18	7.5	9	6	0.00	163	3.70
1500	11.5	4.0	26	*2.44	6.45	7.5	9	6	0.00	168	3.69
2000	9.0	9.0	20	*4.16	*3.88	7.5	8	7	0.17	233	5.00
2000	9.5	7.5	23	*3.72	4.71	7.5	8	8	0.13	226	5.05
2000	10.5	6.5	24	*3.36	5.44	7.5	9	8	0.04	225	5.05
2000	11.0	5.5	25	*3.14	5.94	7.5	8	7	0.02	213	4.66
2000	12.0	4.5	27	*2.90	6.99	7.5	10	6	0.00	208	4.50

TABLE 2-2-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA (SQ.IN.) X	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	15	1.62	1.62	3.0	6	6	0.00	49	1.15
250	5.5	5.5	15	1.78	1.78	3.0	6	6	0.00	60	1.40
250	6.5	4.5	15	*1.45	2.10	3.0	7	6	0.00	58	1.35
250	7.0	4.0	16	*1.38	2.41	3.0	7	6	0.00	59	1.38
250	9.0	3.0	20	*1.35	3.88	3.0	9	4	0.00	72	1.66
250	10.0	2.5	22	*1.35	4.75	3.0	10	4	0.00	76	1.69
500	6.5	6.5	16	*2.24	2.24	3.0	7	7	0.00	91	2.08
500	6.5	5.5	15	*1.78	2.10	3.0	6	7	0.00	72	1.65
500	7.5	4.5	17	*1.65	2.75	3.0	7	6	0.00	76	1.77
500	8.5	4.0	19	*1.64	3.48	3.0	7	6	0.00	86	1.99
500	10.0	3.0	22	*1.55	4.75	3.0	10	4	0.00	90	2.03
750	7.0	7.0	16	*2.41	2.41	3.0	6	6	0.00	107	2.41
750	7.0	6.0	16	*2.07	2.41	3.0	7	6	0.00	91	2.07
750	8.0	5.0	18	*1.94	3.11	3.0	8	6	0.00	97	2.22
750	9.5	4.0	21	*1.81	4.30	3.0	8	6	0.00	106	2.46
750	10.0	3.5	22	*1.75	4.75	3.0	10	5	0.00	105	2.37
1000	7.5	7.5	21	3.40	3.40	7.5	8	8	0.00	162	3.64
1000	7.5	6.5	20	*2.80	3.24	7.5	8	7	0.00	133	3.00
1000	8.5	5.5	19	*2.25	3.48	3.0	7	7	0.00	120	2.74
1000	9.5	4.5	21	*2.04	4.30	3.0	8	6	0.00	121	2.77
1000	11.0	3.5	24	*1.90	5.70	3.0	10	5	0.00	126	2.85
1250	7.5	7.5	21	*3.40	3.40	7.5	8	8	0.00	162	3.64
1250	8.5	6.5	21	*2.94	3.85	7.5	8	7	0.00	158	3.58
1250	9.0	5.5	23	*2.73	4.47	7.5	8	7	0.00	155	3.51
1250	10.5	4.5	23	*2.23	5.21	3.0	9	6	0.00	147	3.35
1250	12.0	3.5	27	*2.04	6.99	3.0	11	5	0.00	151	3.50
1500	8.0	8.0	22	*3.80	3.80	7.5	8	8	0.00	194	4.34
1500	8.5	7.0	21	*3.17	3.85	7.5	7	7	0.00	171	3.85
1500	9.5	6.0	23	*2.98	4.71	7.5	8	7	0.00	179	4.04
1500	10.5	5.0	24	*2.87	5.44	7.5	10	6	0.00	181	3.88
1500	12.0	4.0	27	*2.33	6.99	3.0	9	6	0.00	174	4.00
2000	9.0	9.0	22	*4.27	4.27	7.5	8	8	0.02	247	5.50
2000	9.5	7.5	23	*3.72	4.71	7.5	8	8	0.00	226	5.05
2000	10.0	6.5	25	*3.51	5.40	7.5	9	8	0.00	223	5.01
2000	11.0	5.5	26	*3.11	6.17	7.5	8	7	0.00	216	4.85
2000	12.5	4.5	28	*2.99	7.56	7.5	10	6	0.00	225	4.86

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	16	1.90	1.90	3.0	7	7	0.00	64	1.49
250	6.0	6.0	17	2.20	2.20	3.0	7	7	0.00	82	1.88
250	6.5	5.0	15	*1.62	2.10	3.0	7	6	0.00	65	1.50
250	7.0	4.5	16	*1.59	2.41	3.0	7	6	0.00	68	1.55
250	9.0	3.5	20	*1.58	3.88	3.0	9	5	0.00	85	1.94
250	10.0	3.0	22	*1.58	4.75	3.0	10	4	0.00	91	2.03
500	6.5	6.5	17	2.38	2.38	3.0	7	7	0.00	97	2.21
500	7.0	5.5	16	*1.90	2.41	3.0	7	6	0.00	83	1.90
500	8.5	4.5	19	*1.84	3.48	3.0	8	6	0.00	97	2.24
500	9.0	4.0	20	*1.80	3.88	3.0	8	6	0.00	98	2.22
500	11.5	3.0	26	*1.68	6.45	3.0	10	4	0.00	118	2.76
750	7.0	7.0	17	*2.57	2.57	3.0	7	7	0.00	113	2.57
750	7.5	6.0	17	*2.20	2.75	3.0	7	7	0.00	104	2.36
750	8.5	5.0	19	*2.05	3.48	3.0	8	6	0.00	109	2.49
750	10.0	4.0	22	*1.98	4.75	3.0	8	6	0.00	120	2.71
750	11.0	3.5	24	*1.95	5.70	3.0	10	5	0.00	128	2.85
1000	7.5	7.5	18	*2.91	2.91	3.0	7	7	0.00	138	3.12
1000	8.0	6.5	18	*2.52	3.11	3.0	8	7	0.00	128	2.88
1000	9.0	5.5	20	*2.37	3.88	3.0	7	7	0.00	134	3.05
1000	10.0	4.5	22	*2.17	4.75	3.0	9	6	0.00	135	3.05
1000	12.0	3.5	27	*2.04	6.99	3.0	11	5	0.00	151	3.50
1250	8.0	8.0	23	3.97	3.97	3.0	8	8	0.00	202	4.54
1250	8.0	7.0	21	*3.17	3.62	7.5	7	8	0.00	161	3.62
1250	9.0	6.0	20	*2.59	3.88	3.0	8	7	0.00	147	3.33
1250	10.0	5.0	22	*2.38	4.75	3.0	9	6	0.00	149	3.39
1250	11.5	4.0	26	*2.24	6.45	3.0	9	6	0.00	161	3.69
1500	8.0	8.0	23	*3.97	3.97	7.5	8	8	0.00	202	4.54
1500	9.0	7.0	22	*3.32	4.27	7.5	8	8	0.00	190	4.27
1500	9.5	6.0	24	*3.11	4.92	7.5	8	7	0.00	187	4.22
1500	11.0	5.0	24	*2.59	5.70	3.0	9	6	0.00	179	4.07
1500	12.5	4.0	28	*2.41	7.56	3.0	9	6	0.00	188	4.32
2000	9.0	9.0	24	*4.66	4.66	7.5	8	8	0.00	269	6.00
2000	9.5	7.5	23	*3.72	4.71	7.5	8	8	0.00	226	5.05
2000	10.5	6.5	25	*3.51	5.67	7.5	9	8	0.00	235	5.26
2000	11.5	5.5	26	*3.42	6.45	7.5	9	7	0.00	238	5.07
2000	12.5	4.5	28	*3.26	7.56	7.5	10	6	0.00	236	4.86

TABLE 2-2-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD
0	6.5	6.5	19	2.66	2.66	3.0	8	8	0.00	108	2.47
250	6.5	6.5	19	2.66	2.66	3.0	8	8	0.00	108	2.47
250	7.5	5.5	17	*2.02	2.75	3.0	7	7	0.00	95	2.16
250	8.5	4.5	19	*2.03	3.48	3.0	8	6	0.00	102	2.24
250	10.0	4.0	22	*2.04	4.75	3.0	8	6	0.00	122	2.71
250	13.0	3.0	29	*1.97	8.14	3.0	11	4	0.00	153	3.49
500	7.0	7.0	19	2.87	2.87	3.0	7	7	0.00	127	2.87
500	8.0	6.0	18	*2.33	3.11	3.0	7	7	0.00	117	2.66
500	9.0	5.0	20	*2.26	3.88	3.0	9	6	0.00	124	2.77
500	10.5	4.0	23	*2.23	5.21	3.0	9	6	0.00	138	2.98
500	12.0	3.5	27	*2.12	6.99	3.0	11	5	0.00	154	3.50
750	7.5	7.5	20	3.24	3.24	3.0	7	7	0.00	154	3.47
750	8.0	6.5	18	*2.52	3.11	3.0	8	7	0.00	128	2.88
750	9.0	5.5	20	*2.47	3.88	3.0	7	7	0.00	137	3.05
750	10.5	4.5	23	*2.42	5.21	3.0	9	6	0.00	153	3.35
750	13.0	3.5	29	*2.27	8.14	3.0	11	5	0.00	179	4.07
1000	8.0	8.0	20	*3.45	3.45	3.0	8	8	0.00	176	3.95
1000	8.5	7.0	19	*2.87	3.48	3.0	7	7	0.00	155	3.48
1000	9.5	6.0	21	*2.72	4.30	3.0	8	7	0.00	163	3.69
1000	10.5	5.0	23	*2.62	5.21	3.0	9	6	0.00	169	3.72
1000	12.5	4.0	28	*2.43	7.56	3.0	9	6	0.00	189	4.32
1250	8.0	8.0	20	*3.45	3.45	3.0	8	8	0.00	176	3.95
1250	9.0	7.0	20	*3.02	3.88	3.0	7	7	0.00	173	3.88
1250	10.0	6.0	22	*2.85	4.75	3.0	8	7	0.00	181	4.07
1250	11.0	5.0	24	*2.78	5.70	3.0	10	6	0.00	186	4.07
1250	13.0	4.0	29	*2.57	8.14	3.0	9	6	0.00	206	4.65
1500	8.5	8.5	20	*3.67	3.67	3.0	7	7	0.00	199	4.45
1500	9.5	7.0	21	*3.17	4.30	3.0	7	8	0.00	192	4.31
1500	10.5	6.0	23	*3.00	5.21	3.0	8	7	0.00	199	4.47
1500	12.0	5.0	27	*2.91	6.99	3.0	10	6	0.00	221	5.00
1500	14.0	4.0	31	*2.68	9.37	3.0	10	6	0.00	235	5.35
2000	9.0	9.0	26	5.05	5.05	7.5	8	8	0.00	292	6.50
2000	10.0	7.5	22	*3.56	4.75	3.0	8	7	0.00	228	5.09
2000	11.0	6.5	24	*3.36	5.70	3.0	9	8	0.00	236	5.29
2000	12.0	5.5	27	*3.20	6.99	3.0	9	7	0.00	244	5.50
2000	14.0	4.5	31	*3.01	9.37	3.0	10	6	0.00	266	6.02

FOOTING DESIGN TABLES

NOTES: 1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.

2. For load combinations which include wind, multiply loads by 0.75, then enter table.

3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).

4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 2000 PSI

TABLE 2-2-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	7.5	7.5	21	3.40	3.40	3.0	8	8	0.00	162	3.64
250	7.0	7.0	21	3.17	3.17	3.0	7	7	0.00	140	3.17
250	8.0	6.0	18	*2.48	3.11	3.0	7	7	0.00	121	2.66
250	10.0	5.0	22	*2.50	4.75	3.0	9	6	0.00	153	3.39
250	12.0	4.0	27	*2.41	6.99	3.0	9	6	0.00	177	4.00
250	14.0	3.5	31	*2.44	9.37	3.0	11	5	0.00	207	4.68
500	7.5	7.5	21	3.40	3.40	3.0	8	8	0.00	162	3.64
500	8.5	6.5	19	*2.71	3.48	3.0	8	7	0.00	145	3.23
500	9.5	5.5	21	*2.71	4.30	3.0	8	7	0.00	156	3.38
500	11.0	4.5	24	*2.70	5.70	3.0	10	6	0.00	174	3.66
500	14.0	3.5	31	*2.59	9.37	3.0	11	5	0.00	214	4.68
750	8.0	8.0	22	3.80	3.80	3.0	8	8	0.00	194	4.34
750	8.5	7.0	19	*2.95	3.48	3.0	7	7	0.00	157	3.48
750	9.5	6.0	21	*2.92	4.30	3.0	8	7	0.00	170	3.69
750	11.0	5.0	24	*2.88	5.70	3.0	10	6	0.00	190	4.07
750	13.0	4.0	29	*2.73	8.14	3.0	10	6	0.00	213	4.65
1000	8.5	8.5	22	4.03	4.03	3.0	7	7	0.00	219	4.90
1000	9.0	7.0	20	*3.15	3.88	3.0	7	7	0.00	177	3.88
1000	10.0	6.0	22	*3.10	4.75	3.0	8	7	0.00	189	4.07
1000	11.5	5.0	26	*2.90	6.45	3.0	10	6	0.00	207	4.61
1000	14.0	4.0	31	*2.86	9.37	3.0	10	6	0.00	243	5.35
1250	8.5	8.5	22	*4.03	4.03	3.0	7	7	0.00	219	4.90
1250	9.5	7.0	21	*3.33	4.30	3.0	8	8	0.00	197	4.31
1250	11.0	6.0	24	*3.25	5.70	3.0	9	7	0.00	222	4.88
1250	12.5	5.0	28	*3.04	7.56	3.0	10	6	0.00	240	5.40
1250	14.5	4.0	32	*3.00	10.02	3.0	10	6	0.00	262	5.72
1500	9.0	9.0	22	*4.27	4.27	3.0	8	8	0.00	247	5.50
1500	10.0	7.5	22	*3.56	4.75	3.0	8	7	0.00	228	5.09
1500	11.0	6.5	24	*3.42	5.70	3.0	9	8	0.00	238	5.29
1500	12.0	5.5	27	*3.21	6.99	3.0	9	7	0.00	244	5.50
1500	14.0	4.5	31	*3.15	9.37	3.0	10	6	0.00	272	6.02
2000	9.5	9.5	23	*4.71	4.71	3.0	8	8	0.00	289	6.40
2000	10.0	8.0	22	*3.90	4.75	3.0	8	7	0.00	247	5.43
2000	11.0	7.0	24	*3.79	5.70	3.0	8	8	0.00	261	5.70
2000	13.0	5.5	29	*3.48	8.14	3.0	9	7	0.00	286	6.39
2000	15.0	4.5	33	*3.38	10.69	3.0	11	6	0.00	312	6.87

TABLE 2-2-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	23	3.97	3.97	3.0	8	8	0.00	202	4.54
250	7.5	7.5	23	3.72	3.72	3.0	8	8	0.00	177	3.99
250	9.0	6.5	20	*2.94	3.88	3.0	8	7	0.00	164	3.61
250	10.0	5.5	22	*2.96	4.75	3.0	8	7	0.00	176	3.73
250	13.0	4.5	29	*2.88	8.14	3.0	10	6	0.00	233	5.23
250	17.0	3.5	38	*2.87	13.95	3.0	11	5	0.00	303	6.97
500	8.0	8.0	23	3.97	3.97	3.0	8	8	0.00	202	4.54
500	9.0	7.0	20	*3.16	3.88	3.0	7	7	0.00	177	3.88
500	10.0	6.0	22	*3.17	4.75	3.0	9	7	0.00	191	4.07
500	12.0	5.0	27	*3.02	6.99	3.0	10	6	0.00	225	5.00
500	15.0	4.0	33	*3.06	10.69	3.0	10	6	0.00	278	6.11
750	8.5	8.5	24	4.40	4.40	3.0	8	8	0.00	239	5.35
750	9.5	7.0	21	*3.37	4.30	3.0	8	8	0.00	198	4.31
750	10.5	6.0	23	*3.36	5.21	3.0	9	7	0.00	211	4.47
750	12.5	5.0	28	*3.18	7.56	3.0	10	6	0.00	245	5.40
750	15.0	4.0	33	*3.19	10.69	3.0	10	6	0.00	284	6.11
1000	8.5	8.5	24	4.40	4.40	3.0	8	8	0.00	239	5.35
1000	10.0	7.0	22	*3.56	4.75	3.0	8	7	0.00	220	4.75
1000	11.5	6.0	26	*3.36	6.45	3.0	9	7	0.00	246	5.53
1000	13.0	5.0	29	*3.34	8.14	3.0	11	6	0.00	266	5.81
1000	15.5	4.0	34	*3.32	11.38	3.0	11	6	0.00	305	6.50
1250	9.0	9.0	24	4.66	4.66	3.0	8	8	0.00	269	6.00
1250	10.0	7.5	22	*3.76	4.75	3.0	8	7	0.00	234	5.09
1250	11.0	6.5	24	*3.70	5.70	3.0	9	8	0.00	248	5.29
1250	12.5	5.5	28	*3.49	7.56	3.0	9	7	0.00	271	5.94
1250	14.5	4.5	32	*3.47	10.02	3.0	11	6	0.00	301	6.44
1500	9.5	9.5	25	5.13	5.13	3.0	8	8	0.00	314	6.96
1500	10.0	8.0	22	*3.96	4.75	3.0	8	7	0.00	249	5.43
1500	11.0	7.0	24	*3.89	5.70	3.0	8	8	0.00	265	5.70
1500	13.0	5.5	29	*3.63	8.14	3.0	9	7	0.00	293	6.39
1500	15.5	4.5	34	*3.58	11.38	3.0	11	6	0.00	337	7.31
2000	9.5	9.5	25	*5.13	5.13	3.0	8	8	0.00	314	6.96
2000	11.0	8.0	24	*4.25	5.70	3.0	9	8	0.00	297	6.51
2000	12.0	7.0	27	*4.08	6.99	3.0	8	8	0.00	314	7.00
2000	14.0	5.5	31	*3.89	9.37	3.0	9	7	0.00	338	7.36
2000	16.5	4.5	36	*3.80	12.83	3.0	11	6	0.00	382	8.25

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	6	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	7	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	8	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	7	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	8	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	7	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	8	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	7	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	8	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	7	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	33	6.77	10.33	7.5	10	9	0.06	639	14.03
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 2-3-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	7	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	6	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	7	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	6	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	7	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	6	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	28	4.53	7.25	7.5	9	8	0.06	350	7.77
1000	12.5	6.5	30	4.21	8.10	7.5	10	8	0.07	337	7.52
1000	14.0	5.0	32	*3.45	9.67	7.5	11	6	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	7	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	32	4.83	9.33	7.5	9	8	0.09	420	9.33
1500	15.0	5.5	33	*5.00	10.69	7.5	11	7	0.11	428	8.40
2000	12.0	12.0	27	*8.70	*6.99	7.5	9	8	0.11	614	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	31	6.02	9.03	7.5	9	9	0.10	528	11.62
2000	14.5	7.5	32	*5.18	10.02	7.5	9	8	0.11	485	10.74
2000	15.5	6.0	35	*5.47	11.71	7.5	11	7	0.13	498	10.04

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	6	6	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	6	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	6	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	25	3.78	5.67	7.5	8	8	0.07	254	5.67
750	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	6	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	28	*3.62	7.25	7.5	9	7	0.10	277	6.22
1000	13.0	5.0	29	*3.13	8.14	7.5	10	6	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*4.03	7.56	7.5	10	8	0.12	318	7.02
1250	13.5	5.0	31	*5.18	9.03	7.5	11	6	0.14	367	6.45
1500	11.0	11.0	24	*6.59	*5.70	7.5	9	8	0.11	439	8.96
1500	11.5	9.5	27	5.54	6.70	7.5	9	8	0.10	412	9.10
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	31	*4.35	8.70	7.5	10	8	0.12	362	8.08
1500	14.0	5.5	31	*4.70	9.37	7.5	10	7	0.14	375	7.36
2000	11.5	11.5	27	*7.41	*6.70	7.5	9	8	0.13	528	11.02
2000	12.0	10.0	30	6.48	7.77	7.5	9	9	0.12	504	11.11
2000	13.0	8.5	31	5.69	8.70	7.5	9	9	0.12	479	10.57
2000	14.0	7.0	32	*4.83	9.67	7.5	9	8	0.13	436	9.67
2000	15.0	5.5	35	*4.61	11.34	7.5	10	7	0.16	420	8.91

TABLE 2-3-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	*1.74	2.91	7.5	8	6	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	8.5	3.0	20	*1.63	3.67	7.5	9	4	0.13	75	1.57
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.45
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.30
500	9.0	5.0	22	*2.37	4.27	7.5	9	6	0.13	134	3.05
500	10.0	4.0	22	*2.57	4.75	7.5	9	6	0.14	139	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.0	7.5	23	3.72	4.47	7.5	8	8	0.12	214	4.79
750	9.5	6.5	24	3.36	4.92	7.5	9	8	0.12	203	4.57
750	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.14	187	4.24
750	11.0	4.5	25	*2.43	5.94	7.5	9	6	0.14	167	3.81
1000	9.5	9.5	21	*4.47	*4.30	7.5	8	8	0.12	269	5.84
1000	10.0	8.0	24	4.14	5.18	7.5	8	8	0.11	266	5.92
1000	10.5	7.0	25	3.78	5.67	7.5	8	8	0.11	254	5.67
1000	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.13	225	5.07
1000	12.0	4.5	28	*2.80	7.25	7.5	10	6	0.16	208	4.66
1250	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.12	321	7.09
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.88
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.62
1250	11.5	6.0	29	*3.75	7.20	7.5	9	7	0.16	275	6.17
1250	12.5	5.0	29	*3.40	7.83	7.5	11	6	0.17	258	5.59
1500	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.13	370	8.16
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.94
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.45
1500	12.0	6.5	30	*4.21	7.77	7.5	10	8	0.15	323	7.22
1500	13.0	5.0	32	*3.76	8.98	7.5	11	6	0.19	297	6.41
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.93
2000	12.0	8.5	31	5.69	8.03	7.5	9	9	0.15	441	9.75
2000	13.0	7.0	31	*4.68	8.70	7.5	9	8	0.17	391	8.70
2000	14.0	5.5	33	*5.62	9.97	7.5	11	7	0.20	427	7.84

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	14	*1.66	1.66	7.5	6	6	0.16	56	1.30
250	5.5	4.5	16	*1.55	1.90	7.5	7	6	0.21	52	1.22
250	6.0	4.0	15	*1.29	1.94	7.5	7	6	0.18	47	1.11
250	6.5	3.0	16	*1.03	2.24	7.5	8	4	0.20	40	0.96
250	7.0	2.5	16	*0.86	2.41	7.5	8	4	0.19	35	0.86
500	7.0	7.0	17	*2.65	*2.57	7.5	7	7	0.17	115	2.57
500	7.0	6.0	20	*2.59	3.02	7.5	8	7	0.19	113	2.59
500	7.5	5.0	21	2.26	3.40	7.5	8	6	0.19	106	2.43
500	8.0	4.0	21	*1.84	3.62	7.5	8	6	0.23	90	2.07
500	8.5	3.5	21	*1.66	3.85	7.5	9	5	0.22	84	1.92
750	8.0	8.0	19	*3.79	*3.28	7.5	8	7	0.17	180	3.75
750	8.5	7.0	21	3.17	3.85	7.5	7	7	0.14	171	3.85
750	8.5	6.0	23	*2.98	4.22	7.5	8	7	0.19	160	3.62
750	9.0	5.0	24	*2.59	4.66	7.5	9	6	0.20	146	3.33
750	10.0	4.0	23	*2.32	4.96	7.5	9	6	0.21	134	2.83
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.0	7.5	24	3.88	4.66	7.5	8	8	0.17	223	5.00
1000	9.5	6.5	25	3.51	5.13	7.5	9	8	0.17	212	4.76
1000	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.20	187	4.24
1000	10.5	4.5	27	*2.63	6.12	7.5	9	6	0.22	172	3.93
1250	9.5	9.5	22	*4.51	4.51	7.5	8	8	0.15	276	6.12
1250	10.0	8.0	24	*4.14	5.18	7.5	8	8	0.15	266	5.92
1250	10.0	7.0	27	4.08	5.83	7.5	8	8	0.18	260	5.83
1250	11.0	5.5	27	*3.20	6.41	7.5	9	7	0.20	223	5.04
1250	11.5	4.5	29	*3.30	7.20	7.5	10	6	0.24	221	4.63
1500	10.0	10.0	23	*4.96	*4.96	7.5	7	7	0.16	321	7.09
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.72	6.95	7.5	9	7	0.20	269	5.96
1500	12.0	5.0	30	*3.79	7.77	7.5	11	6	0.23	267	5.55
2000	11.0	11.0	24	*5.93	*5.70	7.5	8	8	0.15	415	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	11.5	8.0	30	*5.18	7.45	7.5	9	9	0.20	384	8.51
2000	12.5	6.5	31	*4.35	8.37	7.5	10	8	0.20	348	7.77
2000	13.0	5.5	33	*4.09	9.26	7.5	10	7	0.23	331	7.28

TABLE 2-3-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.Y
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.1
250	4.5	4.5	13	*1.26	*1.26	7.5	6	6	0.25	34	0.81
250	4.5	4.0	14	*1.20	1.36	7.5	6	6	0.29	32	0.77
250	5.0	3.5	15	*1.13	1.62	7.5	6	5	0.19	33	0.81
250	5.0	3.0	15	*0.97	1.62	7.5	6	4	0.25	28	0.6
250	5.5	2.5	16	*0.86	1.90	7.5	7	4	0.17	27	0.67
500	6.5	6.5	15	*2.10	*2.10	7.5	7	7	0.18	85	1.9
500	6.5	5.5	17	*2.01	2.38	7.5	7	7	0.22	81	1.87
500	7.0	4.5	18	*1.74	2.72	7.5	8	6	0.21	75	1.7
500	7.0	4.0	18	*1.55	2.72	7.5	7	6	0.26	66	1.5
500	7.5	3.0	18	*1.55	2.91	7.5	8	4	0.31	61	1.2
750	7.5	7.5	18	*2.91	*2.91	7.5	7	7	0.18	138	3.1
750	7.5	6.5	20	*2.80	3.24	7.5	8	7	0.22	133	3.0
750	8.0	5.5	21	*2.49	3.62	7.5	8	7	0.22	125	2.8
750	8.5	4.5	21	*2.04	3.85	7.5	8	6	0.24	108	2.47
750	9.0	3.5	21	*2.19	4.08	7.5	9	5	0.30	105	2.0
1000	8.0	8.0	21	*3.68	*3.62	7.5	8	8	0.23	186	4.1
1000	8.5	7.0	22	*3.32	4.03	7.5	8	7	0.21	179	4.0
1000	9.0	6.0	23	*2.98	4.47	7.5	8	7	0.21	169	3.8
1000	9.5	5.0	23	*2.48	4.71	7.5	9	6	0.24	148	3.37
1000	10.0	4.0	24	*2.52	5.18	7.5	9	6	0.28	143	2.9
1250	9.0	9.0	21	*4.08	*4.08	7.5	7	7	0.18	236	5.2
1250	9.0	7.5	25	*4.05	4.86	7.5	8	8	0.22	232	5.2
1250	9.5	6.5	25	*3.51	5.13	7.5	9	8	0.23	212	4.7
1250	10.0	5.5	26	*3.08	5.61	7.5	8	7	0.25	195	4.41
1250	11.0	4.5	25	*2.89	5.94	7.5	10	6	0.25	184	3.81
1500	9.5	9.5	22	*4.93	*4.51	7.5	8	8	0.19	289	6.1
1500	10.0	8.0	25	*4.32	5.40	7.5	9	8	0.18	277	6.17
1500	10.0	7.0	27	*4.08	5.83	7.5	8	8	0.23	260	5.8
1500	11.0	5.5	27	*3.32	6.41	7.5	9	7	0.24	228	5.0
1500	11.5	4.5	28	*3.84	6.95	7.5	10	6	0.29	238	4.47
2000	10.5	10.5	24	*5.44	*5.44	7.5	8	8	0.18	370	8.1
2000	10.5	9.0	28	*5.44	6.35	7.5	9	9	0.21	368	8.1
2000	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.20	335	7.4
2000	11.5	6.5	31	*4.35	7.70	7.5	10	8	0.25	320	7.1
2000	13.0	5.0	30	*4.06	8.42	7.5	11	6	0.26	301	6.01

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	3.0	3.0	10	0.64	0.64	3.0	4	4	0.00	11	0.27
250	4.0	4.0	15	1.29	1.29	7.5	6	6	0.00	30	0.74
250	4.5	3.5	15	*1.13	1.45	7.5	6	5	0.00	30	0.72
250	4.5	3.0	16	*1.03	1.55	7.5	6	4	0.00	27	0.66
250	5.0	2.5	17	*0.91	1.83	7.5	6	4	0.00	26	0.65
250	5.5	2.5	16	0.86	1.90	3.0	7	4	0.00	27	0.67
500	5.5	5.5	15	*1.78	*1.78	7.5	6	6	0.15	60	1.40
500	5.5	4.5	17	*1.65	2.01	7.5	7	6	0.20	55	1.29
500	6.0	4.0	18	*1.55	2.33	7.5	7	6	0.09	56	1.33
500	6.5	3.0	19	*1.23	2.66	7.5	8	4	0.05	47	1.14
500	7.0	2.5	20	*1.10	3.02	7.5	8	4	0.00	44	1.08
750	6.5	6.5	16	*2.26	*2.24	7.5	7	7	0.23	92	2.08
750	6.5	5.5	18	*2.13	2.52	7.5	7	7	0.29	86	1.98
750	7.0	4.5	20	*1.94	3.02	7.5	8	6	0.24	84	1.94
750	7.5	4.0	20	*1.72	3.24	7.5	8	6	0.19	79	1.85
750	8.0	3.0	21	*1.45	3.62	7.5	9	4	0.20	67	1.55
1000	7.5	7.5	17	*2.98	*2.75	7.5	7	7	0.22	136	2.95
1000	7.5	6.5	20	*2.80	3.24	7.5	8	7	0.25	133	3.00
1000	8.0	5.5	21	*2.49	3.62	7.5	8	7	0.22	125	2.85
1000	8.5	4.5	21	*2.04	3.85	7.5	8	6	0.23	108	2.47
1000	9.0	3.5	22	*1.79	4.27	7.5	9	5	0.26	95	2.13
1250	8.0	8.0	19	*3.71	*3.28	7.5	8	7	0.26	178	3.75
1250	8.0	7.0	22	*3.32	3.80	7.5	8	8	0.29	168	3.80
1250	8.5	6.0	23	*2.98	4.22	7.5	8	7	0.28	160	3.62
1250	9.0	5.0	23	*2.48	4.47	7.5	9	6	0.29	140	3.19
1250	9.5	4.0	23	*2.43	4.71	7.5	9	6	0.34	130	2.69
1500	8.5	8.5	21	*4.23	*3.85	7.5	8	7	0.27	220	4.68
1500	9.0	7.0	24	*3.62	4.66	7.5	8	8	0.26	208	4.66
1500	9.5	6.0	24	*3.11	4.92	7.5	8	7	0.27	187	4.22
1500	10.0	5.0	24	*2.85	5.18	7.5	10	6	0.30	171	3.70
1500	10.5	4.0	25	*2.75	5.67	7.5	10	6	0.34	161	3.24
2000	9.5	9.5	24	*4.92	*4.92	7.5	8	8	0.25	301	6.68
2000	10.0	8.0	26	*4.49	5.61	7.5	9	8	0.25	288	6.41
2000	10.5	7.0	27	*4.08	6.12	7.5	8	8	0.25	274	6.12
2000	11.5	5.5	27	*3.20	6.70	7.5	9	7	0.26	234	5.27
2000	12.0	4.5	27	*3.57	6.99	7.5	11	6	0.32	235	4.50

TABLE 2-3-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	11	0.83	0.83	3.0	5	5	0.00	16	0.41
250	4.5	4.5	12	*1.16	1.16	3.0	6	6	0.00	31	0.75
250	4.5	4.0	11	*1.01	1.06	3.0	6	6	0.00	26	0.61
250	4.5	3.5	11	*1.02	1.06	3.0	6	5	0.00	24	0.53
250	5.0	3.0	13	*0.88	1.40	3.0	6	4	0.00	25	0.60
250	6.0	2.5	14	*0.96	1.81	3.0	7	4	0.00	30	0.64
500	5.0	5.0	17	*1.83	1.83	7.5	6	6	0.00	56	1.31
500	5.5	4.0	18	*1.55	2.13	7.5	7	6	0.00	51	1.22
500	6.0	3.5	19	*1.43	2.46	7.5	7	5	0.00	52	1.23
500	6.5	3.0	20	*1.29	2.80	7.5	8	4	0.00	50	1.20
500	7.5	2.5	17	*1.19	2.75	3.0	8	4	0.00	47	0.98
750	6.0	6.0	17	*2.20	2.20	7.5	7	7	0.11	82	1.88
750	6.0	5.0	18	*1.94	2.33	7.5	7	6	0.16	72	1.66
750	6.5	4.5	19	*1.84	2.66	7.5	8	6	0.05	74	1.71
750	7.0	3.5	21	*1.58	3.17	7.5	8	5	0.00	67	1.58
750	7.5	3.0	22	*1.45	3.56	7.5	8	4	0.00	64	1.52
1000	6.5	6.5	18	*2.52	*2.52	7.5	8	8	0.27	103	2.34
1000	7.0	5.5	20	*2.37	3.02	7.5	7	7	0.20	104	2.37
1000	7.5	4.5	21	*2.04	3.40	7.5	8	6	0.16	94	2.18
1000	8.0	4.0	22	*1.90	3.80	7.5	8	6	0.08	93	2.17
1000	9.0	3.0	24	*1.71	4.66	7.5	9	4	0.00	89	2.00
1250	7.5	7.5	18	*3.06	*2.91	7.5	7	7	0.22	142	3.12
1250	7.5	6.5	20	*2.80	3.24	7.5	8	7	0.27	133	3.00
1250	8.0	5.5	22	*2.61	3.80	7.5	8	7	0.22	131	2.98
1250	8.5	4.5	23	*2.23	4.22	7.5	9	6	0.20	118	2.71
1250	9.5	3.5	24	*2.05	4.92	7.5	9	5	0.11	113	2.46
1500	8.0	8.0	19	*3.62	*3.28	7.5	8	7	0.27	176	3.75
1500	8.0	7.0	22	*3.32	3.80	7.5	8	8	0.30	168	3.80
1500	8.5	6.0	23	*2.98	4.22	7.5	8	7	0.27	160	3.62
1500	9.0	5.0	24	*2.59	4.66	7.5	9	6	0.26	146	3.33
1500	10.0	4.0	24	*2.41	5.18	7.5	9	6	0.20	139	2.96
2000	9.0	9.0	22	*4.27	*4.27	7.5	8	8	0.26	247	5.50
2000	9.5	7.5	24	*3.88	4.92	7.5	8	8	0.26	236	5.27
2000	10.0	6.5	25	*3.51	5.40	7.5	9	8	0.25	223	5.01
2000	10.5	5.5	26	*3.08	5.89	7.5	8	7	0.25	205	4.63
2000	11.0	4.5	26	*2.87	6.17	7.5	10	6	0.29	186	3.97

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	13	1.12	1.12	3.0	6	6	0.00	26	0.64
250	4.5	4.5	13	*1.26	1.26	3.0	6	6	0.00	34	0.81
250	5.0	4.0	12	*1.19	1.29	3.0	6	6	0.00	33	0.74
250	5.0	3.5	13	*1.07	1.40	3.0	6	5	0.00	30	0.70
250	6.0	3.0	14	*1.17	1.81	3.0	7	4	0.00	37	0.77
250	6.5	2.5	16	*1.07	2.24	3.0	8	4	0.00	37	0.80
500	5.0	5.0	18	*1.94	1.94	7.5	6	6	0.00	59	1.38
500	6.0	4.0	14	*1.49	1.81	3.0	7	6	0.00	49	1.03
500	6.5	3.5	15	*1.46	2.10	3.0	8	5	0.00	51	1.05
500	7.0	3.0	16	*1.44	2.41	3.0	8	4	0.00	52	1.03
500	8.0	2.5	19	*1.30	3.28	3.0	9	4	0.00	55	1.17
750	6.0	6.0	19	*2.46	2.46	7.5	7	7	0.00	92	2.11
750	6.0	5.0	18	*1.97	2.33	7.5	7	6	0.00	72	1.66
750	6.5	4.5	20	*1.94	2.80	7.5	8	6	0.00	77	1.80
750	7.5	3.5	21	*1.75	3.40	7.5	8	5	0.00	76	1.70
750	8.0	3.0	23	*1.49	3.97	3.0	9	4	0.00	71	1.70
1000	6.5	6.5	19	*2.66	2.66	7.5	8	8	0.02	108	2.47
1000	6.5	5.5	19	*2.29	2.66	7.5	7	7	0.07	92	2.09
1000	7.5	4.5	22	*2.13	3.56	7.5	8	6	0.00	99	2.29
1000	7.5	4.0	22	*1.93	3.56	7.5	8	6	0.00	88	2.03
1000	9.0	3.0	25	*1.77	4.86	7.5	9	4	0.00	92	2.08
1250	7.0	7.0	19	*2.87	2.87	7.5	7	7	0.16	127	2.87
1250	7.5	6.0	21	*2.72	3.40	7.5	8	7	0.08	128	2.91
1250	8.0	5.0	23	*2.48	3.97	7.5	9	6	0.01	124	2.83
1250	8.5	4.0	24	*2.11	4.40	7.5	9	6	0.00	110	2.51
1250	9.0	3.5	25	*2.04	4.86	7.5	9	5	0.00	108	2.43
1500	7.5	7.5	19	*3.37	*3.07	7.5	8	7	0.23	153	3.29
1500	8.0	6.5	22	*3.08	3.80	7.5	8	8	0.15	156	3.53
1500	8.5	5.5	23	*2.73	4.22	7.5	8	7	0.11	146	3.31
1500	9.0	4.5	24	*2.46	4.66	7.5	9	6	0.08	134	3.00
1500	10.0	3.5	26	*2.31	5.61	7.5	10	5	0.00	132	2.80
2000	8.5	8.5	21	*3.85	*3.85	7.5	7	7	0.26	209	4.68
2000	9.0	7.0	24	*3.62	4.66	7.5	8	8	0.24	208	4.66
2000	9.5	6.0	25	*3.24	5.13	7.5	9	7	0.21	195	4.39
2000	10.0	5.0	26	*2.83	5.61	7.5	10	6	0.20	177	4.01
2000	11.0	4.0	27	*2.80	6.41	7.5	10	6	0.13	176	3.66

TABLE 2-3-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	14	1.36	1.36	3.0	6	6	0.00	37	0.87
250	5.0	5.0	15	1.62	1.62	3.0	6	6	0.00	49	1.15
250	5.0	4.0	13	*1.25	1.40	3.0	6	6	0.00	35	0.80
250	6.0	3.5	15	*1.26	1.94	3.0	7	5	0.00	43	0.97
250	6.5	3.0	16	*1.27	2.24	3.0	8	4	0.00	45	0.96
250	7.5	2.5	18	*1.28	2.91	3.0	8	4	0.00	50	1.04
500	5.5	5.5	15	*1.78	1.78	3.0	6	6	0.00	60	1.40
500	6.0	4.5	14	*1.71	1.81	3.0	7	6	0.00	56	1.16
500	6.5	4.0	16	*1.54	2.24	3.0	7	6	0.00	58	1.28
500	7.5	3.0	18	*1.52	2.91	3.0	8	4	0.00	61	1.25
500	8.5	2.5	20	*1.51	3.67	3.0	9	4	0.00	66	1.31
750	6.0	6.0	20	*2.59	2.59	7.5	7	7	0.00	97	2.22
750	6.5	5.0	19	*2.05	2.66	3.0	8	6	0.00	82	1.90
750	6.5	4.5	21	*2.04	2.94	7.5	8	6	0.00	81	1.89
750	8.0	3.5	18	*1.87	3.11	3.0	9	5	0.00	79	1.55
750	8.5	3.0	20	*1.72	3.67	3.0	9	4	0.00	78	1.57
1000	6.5	6.5	21	*2.94	2.94	7.5	8	8	0.00	120	2.73
1000	6.5	5.5	20	*2.37	2.80	7.5	7	7	0.00	96	2.20
1000	7.5	4.5	22	*2.13	3.56	7.5	8	6	0.00	99	2.29
1000	8.0	4.0	23	*2.04	3.97	7.5	8	6	0.00	99	2.27
1000	9.5	3.0	21	*2.00	4.30	3.0	9	4	0.00	97	1.84
1250	7.0	7.0	21	*3.17	3.17	7.5	7	7	0.00	140	3.17
1250	7.0	6.0	20	*2.74	3.02	7.5	8	7	0.00	117	2.59
1250	7.5	5.0	23	*2.48	3.72	7.5	8	6	0.00	116	2.66
1250	8.5	4.0	24	*2.26	4.40	7.5	9	6	0.00	114	2.51
1250	9.5	3.5	26	*2.15	5.33	7.5	9	5	0.00	120	2.66
1500	7.5	7.5	21	*3.40	3.40	7.5	8	8	0.03	162	3.64
1500	7.5	6.5	21	*2.95	3.40	7.5	8	8	0.07	139	3.15
1500	8.0	5.5	24	*2.85	4.14	7.5	8	7	0.00	143	3.25
1500	9.0	4.5	25	*2.46	4.86	7.5	9	6	0.00	137	3.12
1500	10.0	3.5	27	*2.34	5.83	7.5	10	5	0.00	135	2.91
2000	8.0	8.0	21	*3.82	*3.62	7.5	8	8	0.25	190	4.14
2000	8.5	7.0	23	*3.47	4.22	7.5	8	8	0.19	188	4.22
2000	9.0	6.0	25	*3.24	4.86	7.5	9	7	0.13	184	4.16
2000	9.5	5.0	27	*2.91	5.54	7.5	9	6	0.08	174	3.95
2000	10.5	4.0	28	*2.77	6.35	7.5	10	6	0.00	170	3.62

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	15	1.45	1.45	3.0	6	6	0.00	39	0.93
250	5.0	5.0	16	1.72	1.72	3.0	6	6	0.00	52	1.23
250	6.0	4.0	15	*1.45	1.94	3.0	7	6	0.00	50	1.11
250	6.5	3.5	16	*1.46	2.24	3.0	8	5	0.00	52	1.12
250	7.0	3.0	17	*1.48	2.57	3.0	8	4	0.00	54	1.10
250	8.5	2.5	20	*1.50	3.67	3.0	9	4	0.00	65	1.31
500	5.5	5.5	16	*1.90	1.90	3.0	7	7	0.00	64	1.49
500	6.5	4.5	16	*1.73	2.24	3.0	8	6	0.00	66	1.44
500	7.0	4.0	17	*1.72	2.57	3.0	8	6	0.00	68	1.46
500	8.5	3.0	20	*1.71	3.67	3.0	9	4	0.00	77	1.57
500	9.5	2.5	22	*1.70	4.51	3.0	9	4	0.00	83	1.61
750	6.0	6.0	17	*2.20	2.20	3.0	7	7	0.00	82	1.88
750	6.5	5.0	16	*2.00	2.24	3.0	8	6	0.00	75	1.60
750	7.0	4.5	17	*1.99	2.57	3.0	8	6	0.00	79	1.65
750	8.5	3.5	19	*2.06	3.48	3.0	9	5	0.00	91	1.74
750	9.5	3.0	22	*1.90	4.51	3.0	9	4	0.00	96	1.93
1000	6.5	6.5	22	3.08	3.08	7.5	8	8	0.00	126	2.86
1000	7.0	5.5	21	*2.49	3.17	7.5	8	7	0.00	109	2.49
1000	8.0	4.5	19	*2.17	3.28	3.0	9	6	0.00	100	2.11
1000	8.5	4.0	19	*2.30	3.48	3.0	9	6	0.00	104	1.99
1000	10.0	3.0	23	*2.08	4.96	3.0	10	4	0.00	109	2.12
1250	7.0	7.0	22	*3.32	3.32	7.5	8	8	0.00	147	3.32
1250	7.0	6.0	21	*2.72	3.17	7.5	8	7	0.00	119	2.72
1250	8.0	5.0	24	*2.59	4.14	7.5	9	6	0.00	129	2.96
1250	9.0	4.0	21	*2.33	4.08	3.0	9	6	0.00	116	2.33
1250	10.0	3.5	22	*2.40	4.75	3.0	10	5	0.00	126	2.37
1500	7.0	7.0	22	*3.32	3.32	7.5	8	8	0.00	147	3.32
1500	7.5	6.0	22	*2.90	3.56	7.5	8	7	0.00	135	3.05
1500	8.5	5.0	25	*2.70	4.59	7.5	9	6	0.00	143	3.27
1500	9.5	4.0	26	*2.59	5.33	7.5	9	6	0.00	143	3.04
1500	10.5	3.5	25	*2.30	5.67	3.0	10	5	0.00	136	2.83
2000	8.0	8.0	22	*3.80	3.80	7.5	8	8	0.08	194	4.34
2000	8.5	7.0	23	*3.53	4.22	7.5	8	8	0.02	189	4.22
2000	9.0	6.0	26	*3.36	5.05	7.5	9	7	0.00	192	4.33
2000	9.5	5.0	27	*2.91	5.54	7.5	9	6	0.00	174	3.95
2000	11.0	4.0	28	*3.00	6.65	7.5	10	6	0.00	186	3.80

TABLE 2-3-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	18	2.13	2.13	3.0	7	7	0.00	72	1.68
250	5.5	5.5	18	2.13	2.13	3.0	7	7	0.00	72	1.68
250	6.0	4.5	15	*1.85	1.94	3.0	7	6	0.00	61	1.25
250	7.0	4.0	18	*1.74	2.72	3.0	8	6	0.00	71	1.55
250	8.5	3.0	21	*1.81	3.85	3.0	9	4	0.00	82	1.65
250	10.0	2.5	24	*1.85	5.18	3.0	10	4	0.00	95	1.85
500	6.0	6.0	19	2.46	2.46	3.0	7	7	0.00	92	2.11
500	6.5	5.0	16	*2.14	2.24	3.0	8	6	0.00	78	1.60
500	7.0	4.5	18	*1.97	2.72	3.0	8	6	0.00	80	1.75
500	8.5	3.5	20	*2.14	3.67	3.0	9	5	0.00	95	1.83
500	9.5	3.0	23	*2.03	4.71	3.0	9	4	0.00	102	2.02
750	6.5	6.5	19	*2.66	2.66	3.0	8	8	0.00	108	2.47
750	7.0	5.5	17	*2.38	2.57	3.0	7	7	0.00	96	2.02
750	8.0	4.5	20	*2.21	3.45	3.0	9	6	0.00	103	2.22
750	8.5	4.0	20	*2.35	3.67	3.0	9	6	0.00	107	2.09
750	10.5	3.0	25	*2.21	5.67	3.0	10	4	0.00	123	2.43
1000	6.5	6.5	19	*2.66	2.66	3.0	8	8	0.00	108	2.47
1000	7.5	5.5	18	*2.61	2.91	3.0	8	7	0.00	111	2.29
1000	8.5	4.5	21	*2.42	3.85	3.0	9	6	0.00	118	2.47
1000	9.5	4.0	22	*2.53	4.51	3.0	9	6	0.00	131	2.58
1000	11.5	3.0	26	*2.47	6.45	3.0	10	4	0.00	147	2.76
1250	7.0	7.0	19	*2.87	2.87	3.0	7	7	0.00	127	2.87
1250	7.5	6.0	18	*2.86	2.91	3.0	8	7	0.00	122	2.50
1250	8.5	5.0	21	*2.61	3.85	3.0	9	6	0.00	130	2.75
1250	10.0	4.0	23	*2.70	4.96	3.0	10	6	0.00	146	2.83
1250	11.0	3.5	25	*2.66	5.94	3.0	10	5	0.00	155	2.97
1500	7.5	7.5	24	*3.88	3.88	7.5	8	8	0.00	185	4.16
1500	7.5	6.5	23	*3.22	3.72	7.5	8	8	0.00	152	3.46
1500	8.5	5.5	21	*2.82	3.85	3.0	8	7	0.00	142	3.03
1500	9.5	4.5	23	*2.77	4.71	3.0	9	6	0.00	149	3.03
1500	11.5	3.5	26	*2.81	6.45	3.0	10	5	0.00	171	3.22
2000	8.0	8.0	25	*4.32	4.32	7.5	9	9	0.00	220	4.93
2000	8.5	7.0	24	*3.62	4.40	7.5	8	8	0.00	196	4.40
2000	9.0	6.0	26	*3.36	5.05	7.5	9	7	0.00	192	4.33
2000	10.0	5.0	28	*3.20	6.04	7.5	10	6	0.00	196	4.32
2000	11.5	4.0	26	*3.14	6.45	3.0	10	6	0.00	194	3.69

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 2000 PSI

TABLE 2-3-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	6.0	6.0	20	2.59	2.59	3.0	7	7	0.00	97	2.22
250	6.0	6.0	20	2.59	2.59	3.0	7	7	0.00	97	2.22
250	6.5	5.0	17	*2.09	2.38	3.0	8	6	0.00	79	1.70
250	7.0	4.5	18	*2.12	2.72	3.0	8	6	0.00	84	1.75
250	9.0	3.5	22	*2.23	4.27	3.0	9	5	0.00	108	2.13
250	11.0	3.0	26	*2.29	6.17	3.0	10	4	0.00	134	2.64
500	6.5	6.5	21	2.94	2.94	3.0	8	8	0.00	120	2.73
500	7.0	5.5	18	*2.35	2.72	3.0	7	7	0.00	98	2.13
500	8.0	4.5	20	*2.39	3.45	3.0	9	6	0.00	108	2.22
500	9.0	4.0	21	*2.57	4.08	3.0	9	6	0.00	123	2.33
500	11.0	3.0	27	*2.35	6.41	3.0	10	4	0.00	138	2.75
750	6.5	6.5	21	2.94	2.94	3.0	8	8	0.00	120	2.73
750	7.5	5.5	19	*2.60	3.07	3.0	8	7	0.00	114	2.41
750	9.0	4.5	22	*2.61	4.27	3.0	9	6	0.00	133	2.75
750	9.5	4.0	23	*2.62	4.71	3.0	9	6	0.00	136	2.69
750	12.0	3.0	28	*2.63	7.25	3.0	11	4	0.00	164	3.11
1000	7.0	7.0	21	*3.17	3.17	3.0	7	7	0.00	140	3.17
1000	7.5	6.0	19	*2.83	3.07	3.0	8	7	0.00	125	2.63
1000	8.5	5.0	21	*2.81	3.85	3.0	9	6	0.00	135	2.75
1000	10.0	4.0	24	*2.80	5.18	3.0	10	6	0.00	152	2.96
1000	11.5	3.5	27	*2.79	6.70	3.0	10	5	0.00	172	3.35
1250	7.5	7.5	21	*3.40	3.40	3.0	8	8	0.00	162	3.64
1250	8.0	6.5	19	*3.24	3.28	3.0	9	7	0.00	149	3.04
1250	8.5	5.5	21	*3.02	3.85	3.0	8	7	0.00	147	3.03
1250	10.0	4.5	24	*2.98	5.18	3.0	10	6	0.00	166	3.33
1250	12.0	3.5	28	*2.94	7.25	3.0	11	5	0.00	189	3.62
1500	7.5	7.5	21	*3.40	3.40	3.0	8	8	0.00	162	3.64
1500	8.0	6.5	19	*3.47	3.28	3.0	9	7	0.00	155	3.04
1500	9.0	5.5	22	*3.20	4.27	3.0	9	7	0.00	165	3.36
1500	10.5	4.5	24	*3.31	5.44	3.0	10	6	0.00	186	3.50
1500	12.5	3.5	29	*3.08	7.83	3.0	11	5	0.00	205	3.91
2000	8.0	8.0	27	*4.66	4.66	7.5	9	9	0.00	238	5.33
2000	8.5	7.0	24	*3.62	4.40	3.0	8	8	0.00	196	4.40
2000	9.5	6.0	23	*3.55	4.71	3.0	9	7	0.00	197	4.04
2000	10.5	5.0	25	*3.49	5.67	3.0	10	6	0.00	205	4.05
2000	12.5	4.0	28	*3.52	7.56	3.0	11	6	0.00	234	4.32

TABLE 2-3-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC (CU.Y
0	6.5	6.5	22	3.08	3.08	3.0	8	8	0.00	126	2.8
250	6.5	6.5	22	3.08	3.08	3.0	8	8	0.00	126	2.8
250	7.0	5.5	19	*2.32	2.87	3.0	7	7	0.00	100	2.2
250	8.5	4.5	21	*2.61	3.85	3.0	9	6	0.00	123	2.4
250	10.0	4.0	23	*2.82	4.96	3.0	10	6	0.00	150	2.8
250	13.0	3.0	30	*2.78	8.42	3.0	11	4	0.00	190	3.6
500	7.0	7.0	23	3.47	3.47	3.0	8	8	0.00	153	3.4
500	7.0	6.0	20	*2.59	3.02	3.0	8	7	0.00	113	2.5
500	8.5	5.0	21	*2.80	3.85	3.0	9	6	0.00	135	2.7
500	10.0	4.0	24	*2.86	5.18	3.0	10	6	0.00	154	2.9
500	11.0	3.5	27	*2.76	6.41	3.0	10	5	0.00	164	3.2
750	7.0	7.0	23	3.47	3.47	3.0	8	8	0.00	153	3.4
750	8.0	6.0	20	*3.00	3.45	3.0	8	7	0.00	141	2.9
750	9.0	5.0	23	*2.85	4.47	3.0	9	6	0.00	151	3.1
750	10.5	4.0	25	*3.05	5.67	3.0	10	6	0.00	171	3.2
750	12.0	3.5	28	*3.06	7.25	3.0	11	5	0.00	194	3.6
1000	7.5	7.5	23	*3.72	3.72	3.0	8	8	0.00	177	3.9
1000	8.0	6.5	20	*3.20	3.45	3.0	9	8	0.00	152	3.2
1000	9.0	5.5	22	*3.21	4.27	3.0	9	7	0.00	165	3.3
1000	10.5	4.5	25	*3.22	5.67	3.0	10	6	0.00	186	3.6
1000	12.5	3.5	29	*3.22	7.83	3.0	11	5	0.00	211	3.9
1250	7.5	7.5	23	*3.72	3.72	3.0	8	8	0.00	177	3.9
1250	8.5	6.5	20	*3.64	3.67	3.0	9	7	0.00	174	3.4
1250	9.5	5.5	24	*3.23	4.92	3.0	9	7	0.00	182	3.8
1250	11.0	4.5	25	*3.56	5.94	3.0	10	6	0.00	208	3.8
1250	13.0	3.5	31	*3.24	8.70	3.0	11	5	0.00	226	4.3
1500	8.0	8.0	23	*3.97	3.97	3.0	8	8	0.00	202	4.5
1500	8.5	7.0	21	*3.62	3.85	3.0	8	7	0.00	183	3.8
1500	9.5	6.0	23	*3.59	4.71	3.0	9	7	0.00	198	4.0
1500	10.5	5.0	25	*3.57	5.67	3.0	10	6	0.00	208	4.0
1500	12.5	4.0	29	*3.52	7.83	3.0	11	6	0.00	237	4.4
2000	8.5	8.5	24	*4.40	4.40	3.0	8	8	0.00	239	5.3
2000	9.0	7.0	22	*3.99	4.27	3.0	8	8	0.00	210	4.2
2000	10.0	6.0	25	*3.74	5.40	3.0	9	7	0.00	221	4.6
2000	11.5	5.0	27	*3.86	6.70	3.0	10	6	0.00	247	4.7
2000	13.5	4.0	31	*3.78	9.03	3.0	11	6	0.00	275	5.1

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	6	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	7	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	8	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	7	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	8	0.02	452	20.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	7	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	8	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	7	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	8	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	7	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	33	6.77	10.33	7.5	10	9	0.06	639	14.03
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 2-4-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	7	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	6	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	7	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	6	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	7	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	6	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	28	4.53	7.25	7.5	9	8	0.06	350	7.77
1000	12.5	6.5	30	4.21	8.10	7.5	10	8	0.07	337	7.52
1000	14.0	5.0	32	*3.45	9.67	7.5	11	6	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	7	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	32	4.83	9.33	7.5	9	8	0.09	420	9.33
1500	15.0	5.5	33	*5.00	10.69	7.5	11	7	0.11	428	8.40
2000	12.0	12.0	27	*8.70	*6.99	7.5	9	8	0.11	614	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	31	6.02	9.03	7.5	9	9	0.10	528	11.62
2000	14.5	7.5	32	*5.18	10.02	7.5	9	8	0.11	485	10.74
2000	15.5	6.0	35	*5.47	11.71	7.5	11	7	0.13	498	10.04

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H •D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	6	6	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	6	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	6	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	25	3.78	5.67	7.5	8	8	0.07	254	5.67
750	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	6	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	28	*3.62	7.25	7.5	9	7	0.10	277	6.22
1000	13.0	5.0	29	*3.13	8.14	7.5	10	6	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*4.03	7.56	7.5	10	8	0.12	318	7.02
1250	13.5	5.0	31	*5.18	9.03	7.5	11	6	0.14	367	6.45
1500	11.0	11.0	24	*6.59	*5.70	7.5	9	8	0.11	439	8.96
1500	11.5	9.5	27	5.54	6.70	7.5	9	8	0.10	412	9.10
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	31	*4.35	8.70	7.5	10	8	0.12	362	8.08
1500	14.0	5.5	31	*4.70	9.37	7.5	10	7	0.14	375	7.36
2000	11.5	11.5	27	*7.41	*6.70	7.5	9	8	0.13	528	11.02
2000	12.0	10.0	30	6.48	7.77	7.5	9	9	0.12	504	11.11
2000	13.0	8.5	31	5.69	8.70	7.5	9	9	0.12	479	10.57
2000	14.0	7.0	32	*4.83	9.67	7.5	9	8	0.13	436	9.67
2000	15.0	5.5	35	*4.61	11.34	7.5	10	7	0.16	420	8.91

TABLE 2-4-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.Y
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.1
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.0
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.0
250	7.5	4.5	18	*1.74	2.91	7.5	8	6	0.10	81	1.8
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.7
250	8.5	3.0	20	*1.63	3.67	7.5	9	4	0.13	75	1.5
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.5
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.4
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.3
500	9.0	5.0	22	*2.37	4.27	7.5	9	6	0.13	134	3.0
500	10.0	4.0	22	*2.57	4.75	7.5	9	6	0.14	139	2.7
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.0
750	9.0	7.5	23	3.72	4.47	7.5	8	8	0.12	214	4.7
750	9.5	6.5	24	3.36	4.92	7.5	9	8	0.12	203	4.5
750	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.14	187	4.2
750	11.0	4.5	25	*2.43	5.94	7.5	9	6	0.14	167	3.8
1000	9.5	9.5	21	*4.47	*4.30	7.5	8	8	0.12	269	5.8
1000	10.0	8.0	24	4.14	5.18	7.5	8	8	0.11	266	5.9
1000	10.5	7.0	25	3.78	5.67	7.5	8	8	0.11	254	5.6
1000	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.13	225	5.0
1000	12.0	4.5	28	*2.80	7.25	7.5	10	6	0.16	208	4.6
1250	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.12	321	7.0
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.8
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.6
1250	11.5	6.0	29	*3.75	7.20	7.5	9	7	0.16	275	6.1
1250	12.5	5.0	29	*3.40	7.83	7.5	11	6	0.17	258	5.5
1500	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.13	370	8.1
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.9
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.4
1500	12.0	6.5	30	*4.21	7.77	7.5	10	8	0.15	323	7.2
1500	13.0	5.0	32	*3.76	8.98	7.5	11	6	0.19	297	6.4
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.6
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.9
2000	12.0	8.5	31	5.69	8.03	7.5	9	9	0.15	441	9.7
2000	13.0	7.0	31	*4.68	8.70	7.5	9	8	0.17	391	8.7
2000	14.0	5.5	33	*5.62	9.97	7.5	11	7	0.20	427	7.8

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H * D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	14	*1.66	1.66	7.5	6	6	0.16	56	1.30
250	5.5	4.5	16	*1.55	1.90	7.5	7	6	0.21	52	1.22
250	6.0	4.0	15	*1.29	1.94	7.5	7	6	0.18	47	1.11
250	6.0	3.0	17	*1.10	2.20	7.5	7	4	0.28	39	0.94
250	6.5	2.5	16	*1.17	2.24	7.5	8	4	0.28	39	0.80
500	7.0	7.0	17	*2.65	*2.57	7.5	7	7	0.17	115	2.57
500	7.0	6.0	20	*2.59	3.02	7.5	8	7	0.19	113	2.59
500	7.5	5.0	21	2.26	3.40	7.5	8	6	0.19	106	2.43
500	8.0	4.0	21	*1.84	3.62	7.5	8	6	0.23	90	2.07
500	8.5	3.5	21	*1.66	3.85	7.5	9	5	0.22	84	1.92
750	8.0	8.0	19	*3.79	*3.28	7.5	8	7	0.17	180	3.75
750	8.5	7.0	21	3.17	3.85	7.5	7	7	0.14	171	3.85
750	8.5	6.0	23	*2.98	4.22	7.5	8	7	0.19	160	3.62
750	9.0	5.0	24	*2.59	4.66	7.5	9	6	0.20	146	3.33
750	9.5	4.0	25	*2.49	5.13	7.5	9	6	0.24	137	2.93
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.0	7.5	24	3.88	4.66	7.5	8	8	0.17	223	5.00
1000	9.5	6.5	25	3.51	5.13	7.5	9	8	0.17	212	4.76
1000	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.20	187	4.24
1000	10.5	4.5	27	*2.63	6.12	7.5	9	6	0.22	172	3.93
1250	9.5	9.5	22	*4.51	4.51	7.5	8	8	0.15	276	6.12
1250	10.0	8.0	24	*4.14	5.18	7.5	8	8	0.15	266	5.92
1250	10.0	7.0	27	4.08	5.83	7.5	8	8	0.18	260	5.83
1250	11.0	5.5	27	*3.20	6.41	7.5	9	7	0.20	223	5.04
1250	11.5	4.5	29	*3.30	7.20	7.5	10	6	0.24	221	4.63
1500	10.0	10.0	23	*4.96	*4.96	7.5	7	7	0.16	321	7.09
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.72	6.95	7.5	9	7	0.20	269	5.96
1500	12.0	5.0	30	*3.79	7.77	7.5	11	6	0.23	267	5.55
2000	11.0	11.0	24	*5.93	*5.70	7.5	8	8	0.15	415	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	11.5	8.0	30	*5.18	7.45	7.5	9	9	0.20	384	8.51
2000	12.5	6.5	31	*4.35	8.37	7.5	10	8	0.20	348	7.77
2000	13.0	5.5	33	*4.09	9.26	7.5	10	7	0.23	331	7.28

TABLE 2-4-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	4.5	4.5	13	*1.26	*1.26	7.5	6	6	0.25	34	0.81
250	4.5	4.0	14	*1.20	1.36	7.5	6	6	0.29	32	0.77
250	4.5	3.5	15	*1.13	1.45	7.5	6	5	0.35	30	0.72
250	5.0	3.0	15	*0.97	1.62	7.5	6	4	0.25	28	0.69
250	5.5	2.5	16	*0.86	1.90	7.5	7	4	0.17	27	0.67
500	6.0	6.0	17	*2.20	*2.20	7.5	7	7	0.28	82	1.88
500	6.5	5.0	18	*1.94	2.52	7.5	8	6	0.25	78	1.80
500	6.5	4.5	19	*1.84	2.66	7.5	8	6	0.29	74	1.71
500	7.0	3.5	19	*1.46	2.87	7.5	8	5	0.32	61	1.43
500	7.5	3.0	18	*1.55	2.91	7.5	8	4	0.31	61	1.25
750	7.5	7.5	18	*2.91	*2.91	7.5	7	7	0.18	138	3.12
750	7.5	6.5	20	*2.80	3.24	7.5	8	7	0.22	133	3.00
750	8.0	5.5	21	*2.49	3.62	7.5	8	7	0.22	125	2.85
750	8.0	4.5	23	*2.23	3.97	7.5	9	6	0.30	111	2.55
750	9.0	3.5	21	*2.19	4.08	7.5	9	5	0.30	105	2.04
1000	8.0	8.0	21	*3.68	*3.62	7.5	8	8	0.23	186	4.14
1000	8.5	7.0	22	*3.32	4.03	7.5	8	7	0.21	179	4.04
1000	8.5	6.0	25	*3.24	4.59	7.5	9	7	0.26	174	3.93
1000	9.0	5.0	25	*2.70	4.86	7.5	9	6	0.28	152	3.47
1000	10.0	4.0	24	*2.52	5.18	7.5	9	6	0.28	143	2.96
1250	9.0	9.0	21	*4.08	*4.08	7.5	7	7	0.18	236	5.25
1250	9.0	7.5	25	*4.05	4.86	7.5	8	8	0.22	232	5.20
1250	9.5	6.5	25	*3.51	5.13	7.5	9	8	0.23	212	4.76
1250	10.0	5.5	26	*3.08	5.61	7.5	8	7	0.25	195	4.41
1250	10.5	4.5	27	*2.96	6.12	7.5	10	6	0.29	184	3.93
1500	9.5	9.5	22	*4.93	*4.51	7.5	8	8	0.19	289	6.12
1500	9.5	8.0	27	*4.66	5.54	7.5	9	9	0.22	284	6.33
1500	10.0	7.0	27	*4.08	5.83	7.5	8	8	0.23	260	5.83
1500	11.0	5.5	27	*3.32	6.41	7.5	9	7	0.24	228	5.04
1500	11.5	4.5	28	*3.84	6.95	7.5	10	6	0.29	238	4.47
2000	10.5	10.5	24	*5.44	*5.44	7.5	8	8	0.18	370	8.16
2000	10.5	9.0	28	*5.44	6.35	7.5	9	9	0.21	368	8.16
2000	11.0	7.5	30	*4.86	7.12	7.5	9	8	0.23	343	7.63
2000	11.5	6.5	31	*4.35	7.70	7.5	10	8	0.25	320	7.15
2000	12.5	5.0	32	*4.21	8.64	7.5	11	6	0.29	304	6.17

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	4.0	4.0	15	1.29	1.29	7.5	6	6	0.00	30	0.74
250	4.0	3.5	15	*1.13	1.29	7.5	6	5	0.00	26	0.64
250	4.0	3.0	16	*1.03	1.38	7.5	6	4	0.00	24	0.59
250	4.5	2.5	17	*0.91	1.65	7.5	6	4	0.00	23	0.59
250	5.0	2.5	17	*0.91	1.83	7.5	6	4	0.00	26	0.65
500	5.0	5.0	16	*1.72	1.72	7.5	6	6	0.33	52	1.23
500	5.5	4.0	18	*1.55	2.13	7.5	7	6	0.24	51	1.22
500	5.5	3.5	18	*1.36	2.13	7.5	7	5	0.31	44	1.06
500	6.0	3.0	19	*1.23	2.46	7.5	7	4	0.19	43	1.05
500	6.5	2.5	20	*1.08	2.80	7.5	8	4	0.09	41	1.00
750	6.0	6.0	18	*2.33	*2.33	7.5	7	7	0.37	87	2.00
750	6.5	5.0	19	*2.05	2.66	7.5	8	6	0.33	82	1.90
750	6.5	4.5	20	*1.94	2.80	7.5	8	6	0.38	77	1.80
750	7.0	3.5	21	*1.58	3.17	7.5	8	5	0.37	67	1.58
750	7.5	3.0	22	*1.42	3.56	7.5	8	4	0.31	64	1.52
1000	7.0	7.0	19	*2.93	*2.87	7.5	7	7	0.32	128	2.87
1000	7.5	6.0	21	*2.72	3.40	7.5	8	7	0.28	128	2.91
1000	7.5	5.0	22	*2.37	3.56	7.5	8	6	0.37	111	2.54
1000	8.0	4.0	22	*2.07	3.80	7.5	8	6	0.40	98	2.17
1000	8.5	3.5	22	*1.93	4.03	7.5	9	5	0.37	93	2.02
1250	8.0	8.0	19	*3.71	*3.28	7.5	8	7	0.26	178	3.75
1250	8.0	7.0	22	*3.32	3.80	7.5	8	8	0.29	168	3.80
1250	8.5	6.0	23	*2.98	4.22	7.5	8	7	0.28	160	3.62
1250	8.5	5.0	25	*2.70	4.59	7.5	9	6	0.37	143	3.27
1250	9.5	4.0	23	*2.43	4.71	7.5	9	6	0.34	130	2.69
1500	8.5	8.5	21	*4.23	*3.85	7.5	8	7	0.27	220	4.68
1500	9.0	7.0	24	*3.62	4.66	7.5	8	8	0.26	208	4.66
1500	9.0	6.0	26	*3.36	5.05	7.5	9	7	0.33	192	4.33
1500	9.5	5.0	26	*2.81	5.33	7.5	9	6	0.36	167	3.81
1500	10.5	4.0	25	*2.75	5.67	7.5	10	6	0.34	161	3.24
2000	9.5	9.5	24	*4.92	*4.92	7.5	8	8	0.25	301	6.68
2000	10.0	8.0	26	*4.49	5.61	7.5	9	8	0.25	288	6.41
2000	10.0	7.0	29	*4.38	6.26	7.5	9	8	0.30	280	6.26
2000	11.0	5.5	28	*3.51	6.65	7.5	9	7	0.32	238	5.22
2000	11.5	4.5	29	*3.54	7.20	7.5	10	6	0.37	230	4.63

TABLE 2-4-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD
0	3.0	3.0	11	0.71	0.71	3.0	4	4	0.00	12	0.30
250	4.0	4.0	12	*1.03	1.03	3.0	6	6	0.00	24	0.59
250	4.0	3.5	11	*0.89	0.95	3.0	6	5	0.00	20	0.47
250	4.5	3.0	12	*0.88	1.16	3.0	6	4	0.00	22	0.50
250	5.0	2.5	14	*0.79	1.51	3.0	6	4	0.00	22	0.54
250	5.5	2.5	14	*0.88	1.66	3.0	7	4	0.00	26	0.59
500	4.5	4.5	17	*1.65	1.65	7.5	6	6	0.13	44	1.06
500	5.0	4.0	18	*1.55	1.94	7.5	6	6	0.00	46	1.11
500	5.0	3.5	19	*1.43	2.05	7.5	6	5	0.00	42	1.02
500	5.5	3.0	19	*1.23	2.25	7.5	7	4	0.00	40	0.96
500	6.0	2.5	21	*1.13	2.72	7.5	7	4	0.00	39	0.97
750	5.5	5.5	18	*2.13	2.13	7.5	7	7	0.28	72	1.68
750	6.0	4.5	19	*1.84	2.46	7.5	7	6	0.19	68	1.58
750	6.0	4.0	20	*1.72	2.59	7.5	7	6	0.23	63	1.48
750	7.0	3.0	22	*1.42	3.32	7.5	8	4	0.00	59	1.42
750	7.5	2.5	24	*1.29	3.88	7.5	8	4	0.00	57	1.38
1000	6.5	6.5	18	*2.52	*2.52	7.5	8	8	0.27	103	2.34
1000	6.5	5.5	20	*2.37	2.80	7.5	7	7	0.34	96	2.20
1000	7.0	4.5	22	*2.13	3.32	7.5	8	6	0.28	92	2.13
1000	7.0	4.0	22	*1.90	3.32	7.5	8	6	0.35	81	1.90
1000	8.0	3.0	24	*1.60	4.14	7.5	9	4	0.18	76	1.77
1250	7.0	7.0	19	*3.09	*2.87	7.5	7	7	0.36	131	2.87
1250	7.5	6.0	22	*2.85	3.56	7.5	8	7	0.29	134	3.05
1250	7.5	5.0	23	*2.48	3.72	7.5	8	6	0.39	116	2.66
1250	8.0	4.0	24	*2.07	4.14	7.5	8	6	0.39	102	2.37
1250	8.5	3.5	25	*1.89	4.59	7.5	9	5	0.32	98	2.29
1500	7.5	7.5	21	*3.59	*3.40	7.5	8	8	0.38	166	3.64
1500	8.0	6.5	23	*3.22	3.97	7.5	9	8	0.33	163	3.6
1500	8.5	5.5	24	*2.85	4.40	7.5	8	7	0.31	152	3.4
1500	9.0	4.5	24	*2.34	4.66	7.5	9	6	0.33	131	3.0
1500	9.5	3.5	26	*2.11	5.33	7.5	9	5	0.35	119	2.6
2000	8.5	8.5	24	*4.44	*4.40	7.5	8	8	0.37	240	5.3
2000	9.0	-7.0	26	*3.93	5.05	7.5	8	8	0.37	225	5.0
2000	9.5	6.0	27	*3.49	5.54	7.5	9	7	0.36	210	4.7
2000	10.0	5.0	27	*3.08	5.83	7.5	10	6	0.39	189	4.1
2000	11.0	4.0	27	*2.84	6.41	7.5	10	6	0.35	177	3.6

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	12	0.90	0.90	3.0	5	5	0.00	18	0.45
250	4.0	4.0	13	*1.12	1.12	3.0	6	6	0.00	26	0.64
250	4.5	3.5	12	*1.06	1.16	3.0	6	5	0.00	26	0.58
250	5.0	3.0	14	*0.96	1.51	3.0	6	4	0.00	27	0.64
250	5.5	2.5	15	*0.98	1.78	3.0	7	4	0.00	28	0.63
250	6.0	2.5	16	*0.98	2.07	3.0	7	4	0.00	32	0.74
500	4.5	4.5	18	*1.74	1.74	7.5	6	6	0.00	47	1.12
500	5.0	4.0	18	*1.55	1.94	7.5	6	6	0.00	46	1.11
500	5.5	3.5	19	*1.43	2.25	7.5	7	5	0.00	47	1.12
500	6.0	3.0	16	*1.25	2.07	3.0	7	4	0.00	41	0.88
500	6.5	2.5	18	*1.15	2.52	3.0	8	4	0.00	40	0.90
750	5.5	5.5	19	*2.25	2.25	7.5	7	7	0.00	76	1.77
750	5.5	4.5	19	*1.84	2.25	7.5	7	6	0.00	62	1.45
750	6.0	4.0	21	*1.81	2.72	7.5	7	6	0.00	66	1.55
750	7.0	3.0	23	*1.49	3.47	7.5	8	4	0.00	62	1.49
750	7.5	2.5	25	*1.35	4.05	7.5	8	4	0.00	59	1.44
1000	6.0	6.0	19	*2.46	2.46	7.5	7	7	0.19	92	2.11
1000	6.5	5.0	21	*2.26	2.94	7.5	8	6	0.08	91	2.10
1000	6.5	4.5	22	*2.13	3.08	7.5	8	6	0.11	85	1.98
1000	7.0	3.5	23	*1.74	3.47	7.5	8	5	0.02	74	1.73
1000	8.0	3.0	25	*1.64	4.32	7.5	9	4	0.00	78	1.85
1250	6.5	6.5	20	*2.80	2.80	7.5	8	8	0.32	114	2.60
1250	7.0	5.5	22	*2.61	3.32	7.5	8	7	0.23	114	2.61
1250	7.5	4.5	23	*2.23	3.72	7.5	8	6	0.17	103	2.39
1250	7.5	4.0	24	*2.07	3.88	7.5	8	6	0.21	95	2.22
1250	8.5	3.0	27	*1.77	4.95	7.5	9	4	0.01	90	2.12
1500	7.0	7.0	21	*3.17	*3.17	7.5	7	7	0.37	140	3.17
1500	7.5	6.0	23	*2.98	3.72	7.5	8	7	0.30	140	3.19
1500	8.0	5.0	24	*2.59	4.14	7.5	9	6	0.26	129	2.96
1500	8.5	4.0	25	*2.25	4.59	7.5	9	6	0.24	115	2.62
1500	9.0	3.5	26	*2.18	5.05	7.5	9	5	0.16	114	2.52
2000	8.0	8.0	22	*4.13	*3.80	7.5	8	8	0.40	202	4.34
2000	8.5	7.0	24	*3.62	4.40	7.5	8	8	0.34	196	4.40
2000	9.0	6.0	26	*3.36	5.05	7.5	9	7	0.30	192	4.33
2000	9.5	5.0	27	*2.91	5.54	7.5	9	6	0.29	174	3.95
2000	10.0	4.0	28	*2.55	6.04	7.5	9	6	0.31	154	3.45

TABLE 2-4-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	14	1.20	1.20	3.0	6	6	0.00	28	0.69
250	4.5	4.5	14	*1.36	1.36	3.0	6	6	0.00	37	0.87
250	4.5	4.0	13	*1.12	1.26	3.0	6	6	0.00	30	0.72
250	4.5	3.5	13	*1.11	1.26	3.0	6	5	0.00	28	0.63
250	5.0	3.0	15	*1.03	1.62	3.0	6	4	0.00	29	0.69
250	6.0	2.5	17	*1.07	2.20	3.0	7	4	0.00	35	0.78
500	5.0	5.0	15	*1.62	1.62	3.0	6	6	0.00	49	1.15
500	5.0	4.0	14	*1.42	1.51	3.0	6	6	0.00	39	0.86
500	5.5	3.5	16	*1.30	1.90	3.0	7	5	0.00	41	0.95
500	6.5	3.0	17	*1.43	2.38	3.0	8	4	0.00	49	1.02
500	7.0	2.5	19	*1.33	2.87	3.0	8	4	0.00	49	1.02
750	5.5	5.5	20	*2.37	2.37	7.5	7	7	0.00	80	1.86
750	5.5	4.5	20	*1.94	2.37	7.5	7	6	0.00	65	1.52
750	6.0	4.0	21	*1.81	2.72	7.5	7	6	0.00	66	1.55
750	7.0	3.0	19	*1.55	2.87	3.0	8	4	0.00	58	1.23
750	8.0	2.5	22	*1.44	3.80	3.0	9	4	0.00	62	1.35
1000	6.0	6.0	20	*2.59	2.59	7.5	7	7	0.00	97	2.22
1000	6.0	5.0	21	*2.26	2.72	7.5	7	6	0.00	84	1.94
1000	6.5	4.5	22	*2.13	3.08	7.5	8	6	0.00	85	1.98
1000	7.5	3.5	24	*1.82	3.88	7.5	8	5	0.00	83	1.94
1000	8.0	3.0	26	*1.69	4.49	7.5	9	4	0.00	81	1.92
1250	6.5	6.5	20	*2.80	2.80	7.5	8	8	0.08	114	2.60
1250	6.5	5.5	21	*2.49	2.94	7.5	8	7	0.13	101	2.31
1250	7.0	4.5	24	*2.33	3.62	7.5	8	6	0.00	100	2.33
1250	7.5	4.0	24	*2.11	3.88	7.5	8	6	0.00	96	2.22
1250	8.5	3.0	27	*1.89	4.95	7.5	9	4	0.00	93	2.12
1500	7.0	7.0	20	*3.10	*3.02	7.5	7	7	0.18	135	3.02
1500	7.0	6.0	22	*2.85	3.32	7.5	8	7	0.23	125	2.85
1500	7.5	5.0	24	*2.59	3.88	7.5	8	6	0.14	121	2.77
1500	8.5	4.0	25	*2.42	4.59	7.5	9	6	0.00	120	2.62
1500	9.0	3.5	27	*2.21	5.24	7.5	9	5	0.00	117	2.62
2000	7.5	7.5	22	*3.56	*3.56	7.5	8	8	0.41	169	3.81
2000	8.0	6.5	25	*3.51	4.32	7.5	9	8	0.32	177	4.01
2000	8.5	5.5	26	*3.08	4.77	7.5	8	7	0.28	165	3.75
2000	9.0	4.5	27	*2.70	5.24	7.5	9	6	0.25	149	3.37
2000	10.0	3.5	30	*2.44	6.48	7.5	10	5	0.10	145	3.24

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	15	1.29	1.29	3.0	6	6	0.00	30	0.74
250	4.5	4.5	15	*1.45	1.45	3.0	6	6	0.00	39	0.93
250	4.5	4.0	14	*1.20	1.36	3.0	6	6	0.00	32	0.77
250	5.0	3.5	15	*1.18	1.62	3.0	6	5	0.00	34	0.81
250	6.0	3.0	17	*1.24	2.20	3.0	7	4	0.00	41	0.94
250	6.5	2.5	18	*1.27	2.52	3.0	8	4	0.00	43	0.90
500	5.0	5.0	16	*1.72	1.72	3.0	6	6	0.00	52	1.23
500	5.5	4.0	16	*1.47	1.90	3.0	7	6	0.00	47	1.08
500	6.0	3.5	17	*1.48	2.20	3.0	7	5	0.00	50	1.10
500	7.0	3.0	19	*1.51	2.87	3.0	8	4	0.00	57	1.23
500	7.5	2.5	21	*1.42	3.40	3.0	8	4	0.00	57	1.21
750	5.5	5.5	21	2.49	2.49	7.5	7	7	0.00	84	1.96
750	6.0	4.5	16	*1.87	2.07	3.0	7	6	0.00	63	1.33
750	6.5	4.0	18	*1.72	2.52	3.0	8	6	0.00	65	1.44
750	7.5	3.0	20	*1.72	3.24	3.0	8	4	0.00	68	1.38
750	8.5	2.5	23	*1.63	4.22	3.0	9	4	0.00	73	1.50
1000	6.0	6.0	21	*2.72	2.72	7.5	7	7	0.00	101	2.33
1000	6.0	5.0	21	*2.26	2.72	7.5	7	6	0.00	84	1.94
1000	6.5	4.5	23	*2.23	3.22	7.5	8	6	0.00	89	2.07
1000	7.5	3.5	21	*1.81	3.40	3.0	8	5	0.00	78	1.70
1000	8.5	3.0	22	*1.91	4.03	3.0	9	4	0.00	86	1.73
1250	6.0	6.0	21	*2.72	2.72	7.5	7	7	0.00	101	2.33
1250	7.0	5.0	23	*2.48	3.47	7.5	8	6	0.00	108	2.48
1250	7.0	4.5	24	*2.33	3.62	7.5	8	6	0.00	100	2.33
1250	8.0	3.5	26	*2.08	4.49	7.5	9	5	0.00	99	2.24
1250	9.0	3.0	28	*1.81	5.44	3.0	9	4	0.00	98	2.33
1500	6.5	6.5	21	*2.94	2.94	7.5	8	8	0.13	120	2.73
1500	7.0	5.5	23	*2.73	3.47	7.5	8	7	0.00	119	2.73
1500	8.0	4.5	25	*2.46	4.32	7.5	9	6	0.00	121	2.77
1500	8.0	4.0	26	*2.32	4.49	7.5	9	6	0.00	112	2.56
1500	9.5	3.0	30	*2.10	6.15	7.5	9	4	0.00	116	2.63
2000	7.5	7.5	22	*3.56	*3.56	7.5	8	8	0.23	169	3.81
2000	8.0	6.5	24	*3.36	4.14	7.5	9	8	0.14	170	3.85
2000	8.0	5.5	26	*3.08	4.49	7.5	8	7	0.20	155	3.53
2000	9.0	4.5	28	*2.72	5.44	7.5	9	6	0.00	152	3.50
2000	10.0	3.5	30	*2.58	6.48	7.5	10	5	0.00	149	3.24

TABLE 2-4-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.Y
0	4.5	4.5	17	1.65	1.65	3.0	6	6	0.00	44	1.0
250	5.0	5.0	18	1.94	1.94	3.0	6	6	0.00	59	1.3
250	5.5	4.0	16	*1.53	1.90	3.0	7	6	0.00	48	1.0
250	6.0	3.5	17	*1.57	2.20	3.0	7	5	0.00	51	1.1
250	7.0	3.0	19	*1.64	2.87	3.0	8	4	0.00	60	1.2
250	8.0	2.5	22	*1.59	3.80	3.0	9	4	0.00	66	1.3
500	5.5	5.5	18	*2.13	2.13	3.0	7	7	0.00	72	1.6
500	6.0	4.5	17	*1.81	2.20	3.0	7	6	0.00	63	1.4
500	6.5	4.0	18	*1.83	2.52	3.0	8	6	0.00	67	1.4
500	8.0	3.0	22	*1.78	3.80	3.0	9	4	0.00	77	1.6
500	9.0	2.5	25	*1.73	4.86	3.0	9	4	0.00	83	1.7
750	5.5	5.5	18	*2.13	2.13	3.0	7	7	0.00	72	1.6
750	6.5	4.5	18	*2.06	2.52	3.0	8	6	0.00	76	1.6
750	7.0	4.0	20	*1.94	3.02	3.0	8	6	0.00	79	1.7
750	8.5	3.0	23	*1.99	4.22	3.0	9	4	0.00	90	1.8
750	10.0	2.5	27	*1.91	5.83	3.0	10	4	0.00	101	2.0
1000	6.0	6.0	19	*2.46	2.46	3.0	7	7	0.00	92	2.1
1000	6.5	5.0	18	*2.30	2.52	3.0	8	6	0.00	85	1.8
1000	7.0	4.5	20	*2.15	3.02	3.0	8	6	0.00	88	1.9
1000	8.5	3.5	23	*2.16	4.22	3.0	9	5	0.00	102	2.1
1000	9.5	3.0	25	*2.17	5.13	3.0	9	4	0.00	110	2.1
1250	6.5	6.5	24	*3.36	3.36	7.5	8	8	0.00	137	3.1
1250	6.5	5.5	22	*2.65	3.08	7.5	8	7	0.00	106	2.4
1250	7.5	4.5	21	*2.36	3.40	3.0	8	6	0.00	102	2.1
1250	8.0	4.0	22	*2.36	3.80	3.0	9	6	0.00	105	2.1
1250	10.0	3.0	26	*2.34	5.61	3.0	10	4	0.00	123	2.4
1500	6.5	6.5	24	*3.36	3.36	7.5	8	8	0.00	137	3.1
1500	7.0	5.5	24	*2.85	3.62	7.5	8	7	0.00	124	2.8
1500	8.0	4.5	27	*2.62	4.66	7.5	9	6	0.00	130	3.0
1500	8.5	4.0	23	*2.53	4.22	3.0	9	6	0.00	119	2.4
1500	10.5	3.0	28	*2.38	6.35	3.0	10	4	0.00	135	2.7
2000	7.5	7.5	24	*3.88	3.88	7.5	8	8	0.00	185	4.1
2000	7.5	6.5	24	*3.36	3.88	7.5	8	8	0.00	159	3.6
2000	8.0	5.5	27	*3.20	4.66	7.5	9	7	0.00	161	3.6
2000	9.0	4.5	29	*2.82	5.63	7.5	9	6	0.00	158	3.6
2000	10.5	3.5	32	*2.75	7.25	7.5	10	5	0.00	167	3.6

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 2000 PSI

TABLE 2-4-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	19	2.05	2.05	3.0	6	6	0.00	62	1.46
250	5.0	5.0	19	2.05	2.05	3.0	6	6	0.00	62	1.46
250	6.5	4.0	19	*1.81	2.66	3.0	8	6	0.00	68	1.52
250	7.0	3.5	20	*1.86	3.02	3.0	8	5	0.00	72	1.51
250	8.0	3.0	23	*1.84	3.97	3.0	9	4	0.00	80	1.70
250	10.0	2.5	27	*1.96	5.83	3.0	10	4	0.00	103	2.08
500	5.5	5.5	20	2.37	2.37	3.0	7	7	0.00	80	1.86
500	6.5	4.5	19	*2.03	2.66	3.0	8	6	0.00	77	1.71
500	7.0	4.0	20	*2.06	3.02	3.0	8	6	0.00	81	1.72
500	9.0	3.0	25	*2.08	4.86	3.0	9	4	0.00	101	2.08
500	10.0	2.5	28	*2.04	6.04	3.0	10	4	0.00	107	2.16
750	6.0	6.0	20	*2.59	2.59	3.0	7	7	0.00	97	2.22
750	6.5	5.0	18	*2.41	2.52	3.0	8	6	0.00	87	1.80
750	7.0	4.5	20	*2.28	3.02	3.0	8	6	0.00	91	1.94
750	8.5	3.5	23	*2.34	4.22	3.0	9	5	0.00	107	2.11
750	9.5	3.0	26	*2.26	5.33	3.0	9	4	0.00	114	2.28
1000	6.5	6.5	21	*2.94	2.94	3.0	8	8	0.00	120	2.73
1000	6.5	5.5	18	*2.64	2.52	3.0	8	7	0.00	97	1.98
1000	7.5	4.5	22	*2.35	3.56	3.0	8	6	0.00	104	2.29
1000	8.5	4.0	23	*2.52	4.22	3.0	9	6	0.00	119	2.41
1000	10.0	3.0	28	*2.33	6.04	3.0	10	4	0.00	126	2.59
1250	6.5	6.5	21	*2.94	2.94	3.0	8	8	0.00	120	2.73
1250	7.0	5.5	20	*2.69	3.02	3.0	8	7	0.00	111	2.37
1250	8.0	4.5	23	*2.55	3.97	3.0	9	6	0.00	119	2.55
1250	9.0	4.0	24	*2.71	4.66	3.0	9	6	0.00	134	2.66
1250	11.0	3.0	29	*2.60	6.89	3.0	10	4	0.00	151	2.95
1500	7.0	7.0	21	*3.17	3.17	3.0	7	7	0.00	140	3.17
1500	7.0	6.0	19	*3.10	2.87	3.0	8	7	0.00	122	2.46
1500	8.0	5.0	23	*2.73	3.97	3.0	9	6	0.00	130	2.83
1500	9.5	4.0	25	*2.89	5.13	3.0	9	6	0.00	149	2.93
1500	10.0	3.5	27	*2.75	5.83	3.0	10	5	0.00	148	2.91
2000	7.5	7.5	26	*4.21	4.21	7.5	8	8	0.00	200	4.51
2000	7.5	6.5	25	*3.51	4.05	7.5	8	8	0.00	166	3.76
2000	8.5	5.5	28	*3.32	5.14	7.5	9	7	0.00	178	4.04
2000	9.5	4.5	25	*3.23	5.13	3.0	9	6	0.00	163	3.29
2000	11.0	3.5	29	*3.05	6.89	3.0	10	5	0.00	179	3.44

TABLE 2-4-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	21	2.49	2.49	3.0	7	7	0.00	84	1.96
250	5.5	5.5	21	2.49	2.49	3.0	7	7	0.00	84	1.96
250	6.5	4.5	19	*2.13	2.66	3.0	8	6	0.00	79	1.71
250	7.0	4.0	21	*2.06	3.17	3.0	8	6	0.00	83	1.81
250	10.0	3.0	27	*2.32	5.83	3.0	10	4	0.00	124	2.50
250	12.0	2.5	32	*2.35	8.29	3.0	11	4	0.00	148	2.96
500	6.0	6.0	22	2.85	2.85	3.0	7	7	0.00	106	2.44
500	6.5	5.0	19	*2.35	2.66	3.0	8	6	0.00	88	1.90
500	7.0	4.5	21	*2.26	3.17	3.0	8	6	0.00	93	2.04
500	9.0	3.5	25	*2.43	4.86	3.0	9	5	0.00	119	2.43
500	10.0	3.0	28	*2.38	6.04	3.0	10	4	0.00	128	2.59
750	6.5	6.5	22	*3.08	3.08	3.0	8	8	0.00	126	2.86
750	6.5	5.5	20	*2.40	2.80	3.0	7	7	0.00	96	2.20
750	8.0	4.5	23	*2.52	3.97	3.0	9	6	0.00	118	2.55
750	8.5	4.0	24	*2.56	4.40	3.0	9	6	0.00	122	2.51
750	10.5	3.0	29	*2.55	6.57	3.0	10	4	0.00	143	2.81
1000	6.5	6.5	22	*3.08	3.08	3.0	8	8	0.00	126	2.86
1000	7.0	5.5	20	*2.81	3.02	3.0	8	7	0.00	113	2.37
1000	8.5	4.5	24	*2.73	4.40	3.0	9	6	0.00	134	2.83
1000	9.0	4.0	25	*2.76	4.86	3.0	9	6	0.00	137	2.77
1000	11.5	3.0	31	*2.73	7.70	3.0	10	4	0.00	168	3.30
1250	7.0	7.0	23	*3.47	3.47	3.0	8	8	0.00	153	3.47
1250	7.0	6.0	20	*3.02	3.02	3.0	8	7	0.00	123	2.59
1250	8.0	5.0	23	*2.89	3.97	3.0	9	6	0.00	134	2.83
1250	9.5	4.0	26	*2.94	5.33	3.0	9	6	0.00	153	3.04
1250	10.5	3.5	29	*2.85	6.57	3.0	10	5	0.00	164	3.28
1500	7.0	7.0	23	*3.47	3.47	3.0	8	8	0.00	153	3.47
1500	7.5	6.0	21	*3.24	3.40	3.0	8	7	0.00	140	2.91
1500	8.5	5.0	24	*3.08	4.40	3.0	9	6	0.00	151	3.14
1500	10.0	4.0	27	*3.11	5.83	3.0	10	6	0.00	170	3.33
1500	11.0	3.5	30	*3.00	7.12	3.0	10	5	0.00	180	3.56
2000	7.5	7.5	23	*3.72	3.72	3.0	8	8	0.00	177	3.99
2000	8.0	6.5	22	*3.61	3.80	3.0	9	8	0.00	169	3.53
2000	9.0	5.5	25	*3.42	4.86	3.0	9	7	0.00	181	3.81
2000	10.0	4.5	27	*3.42	5.83	3.0	10	6	0.00	190	3.75
2000	12.0	3.5	32	*3.28	8.29	3.0	11	5	0.00	213	4.14

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	6	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	7	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	8	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	7	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.30
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	8	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	7	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	8	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	7	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	8	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	7	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	33	6.77	10.33	7.5	10	9	0.06	639	14.03
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590.	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 2-5-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC (CU.Y
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.1
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.0
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.6
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.4
250	11.0	5.5	24	2.85	5.70	7.5	8	7	0.00	198	4.4
250	11.5	4.5	26	2.52	6.45	7.5	9	6	0.00	182	4.1
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.8
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.9
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.7
500	12.0	5.5	27	3.20	6.99	7.5	9	7	0.02	244	5.5
500	13.0	4.5	29	2.81	8.14	7.5	10	6	0.02	230	5.2
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.9
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.9
750	12.5	6.0	28	3.62	7.56	7.5	9	7	0.05	289	6.4
750	13.5	5.0	30	3.24	8.74	7.5	10	6	0.04	277	6.2
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.1
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.3
1000	12.0	7.5	28	4.53	7.25	7.5	9	8	0.06	350	7.7
1000	12.5	6.5	30	4.21	8.10	7.5	10	8	0.07	337	7.5
1000	14.0	5.0	32	*3.45	9.67	7.5	11	6	0.08	306	6.9
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.3
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.1
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.6
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.1
1250	14.5	5.5	32	*3.80	10.02	7.5	9	7	0.08	351	7.8
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.6
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.0
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.8
1500	13.5	7.0	32	4.83	9.33	7.5	9	8	0.09	420	9.
1500	15.0	5.5	33	*5.00	10.69	7.5	11	7	0.11	428	8.4
2000	12.0	12.0	27	*8.70	*6.99	7.5	9	8	0.11	614	12.0
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.
2000	13.5	9.0	31	6.02	9.03	7.5	9	9	0.10	528	11.0
2000	14.5	7.5	32	*5.18	10.02	7.5	9	8	0.11	485	10.
2000	15.5	6.0	35	*5.47	11.71	7.5	11	7	0.13	498	10.0

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-3 AXIAL LOAD: -5 KIPS

M+ HxD	DIMENSIONS			STEEL AREA		X-BAR COVER	MAX. BAR SIZE		OVER-BURDEN	QUANTITIES	
(IN-K)	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)	(IN.)	X	Y	(KSF)	STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	6	6	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	6	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	7	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	6	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	25	3.78	5.67	7.5	8	8	0.07	254	5.67
750	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	6	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	28	*3.62	7.25	7.5	9	7	0.10	277	6.22
1000	13.0	5.0	29	*3.13	8.14	7.5	10	6	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*4.03	7.56	7.5	10	8	0.12	318	7.02
1250	13.5	5.0	31	*5.18	9.03	7.5	11	6	0.14	367	6.45
1500	11.0	11.0	24	*6.59	*5.70	7.5	9	8	0.11	439	8.96
1500	11.5	9.5	27	5.54	6.70	7.5	9	8	0.10	412	9.10
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	31	*4.35	8.70	7.5	10	8	0.12	362	8.08
1500	14.0	5.5	31	*4.70	9.37	7.5	10	7	0.14	375	7.36
2000	11.5	11.5	27	*7.41	*6.70	7.5	9	8	0.13	528	11.02
2000	12.0	10.0	30	6.48	7.77	7.5	9	9	0.12	504	11.11
2000	13.0	8.5	31	5.69	8.70	7.5	9	9	0.12	479	10.57
2000	14.0	7.0	32	*4.83	9.67	7.5	9	8	0.13	436	9.67
2000	15.0	5.5	35	*4.61	11.34	7.5	10	7	0.16	420	8.91

TABLE 2-5-4 AXIAL LOAD: 0 KIPS

M+ HxD	DIMENSIONS			STEEL AREA		X-BAR COVER	MAX. BAR SIZE		OVER-BURDEN	QUANTITIES	
(IN-K)	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)	(IN.)	X	Y	(KSF)	STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	*1.74	2.91	7.5	8	6	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	8.5	3.0	20	*1.63	3.67	7.5	9	4	0.13	75	1.57
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.45
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.30
500	9.0	5.0	22	*2.37	4.27	7.5	9	6	0.13	134	3.05
500	10.0	4.0	22	*2.57	4.75	7.5	9	6	0.14	139	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.0	7.5	23	3.72	4.47	7.5	8	8	0.12	214	4.79
750	9.5	6.5	24	3.36	4.92	7.5	9	8	0.12	203	4.57
750	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.14	187	4.24
750	11.0	4.5	25	*2.43	5.94	7.5	9	6	0.14	167	3.81
1000	9.5	9.5	21	*4.47	*4.30	7.5	8	8	0.12	269	5.84
1000	10.0	8.0	24	4.14	5.18	7.5	8	8	0.11	266	5.92
1000	10.5	7.0	25	3.78	5.67	7.5	8	8	0.11	254	5.67
1000	11.5	5.5	26	*3.08	6.45	7.5	8	7	0.13	225	5.07
1000	12.0	4.5	28	*2.80	7.25	7.5	10	6	0.16	208	4.66
1250	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.12	321	7.09
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.88
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.62
1250	11.5	6.0	29	*3.75	7.20	7.5	9	7	0.16	275	6.17
1250	12.5	5.0	29	*3.40	7.83	7.5	11	6	0.17	258	5.59
1500	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.13	370	8.16
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.94
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.45
1500	12.0	6.5	30	*4.21	7.77	7.5	10	8	0.15	323	7.22
1500	13.0	5.0	32	*3.76	8.98	7.5	11	6	0.19	297	6.41
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.93
2000	12.0	8.5	31	5.69	8.03	7.5	9	9	0.15	441	9.75
2000	13.0	7.0	31	*4.68	8.70	7.5	9	8	0.17	391	8.70
2000	14.0	5.5	33	*5.62	9.97	7.5	11	7	0.20	427	7.84

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	14	*1.66	1.66	7.5	6	6	0.16	56	1.30
250	5.5	4.5	16	*1.55	1.90	7.5	7	6	0.21	52	1.22
250	5.5	4.0	17	*1.46	2.01	7.5	7	6	0.24	49	1.15
250	6.0	3.0	17	*1.10	2.20	7.5	7	4	0.28	39	0.94
250	6.5	2.5	16	*1.17	2.24	7.5	8	4	0.28	39	0.80
500	7.0	7.0	17	*2.65	*2.57	7.5	7	7	0.17	115	2.57
500	7.0	6.0	20	*2.59	3.02	7.5	8	7	0.19	113	2.59
500	7.5	5.0	21	2.26	3.40	7.5	8	6	0.19	106	2.43
500	8.0	4.0	21	*1.84	3.62	7.5	8	6	0.23	90	2.07
500	8.5	3.5	21	*1.66	3.85	7.5	9	5	0.22	84	1.92
750	8.0	8.0	19	*3.79	*3.28	7.5	8	7	0.17	180	3.75
750	8.5	7.0	21	3.17	3.85	7.5	7	7	0.14	171	3.85
750	8.5	6.0	23	*2.98	4.22	7.5	8	7	0.19	160	3.62
750	9.0	5.0	24	*2.59	4.66	7.5	9	6	0.20	146	3.33
750	9.5	4.0	25	*2.49	5.13	7.5	9	6	0.24	137	2.93
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.0	7.5	24	3.88	4.66	7.5	8	8	0.17	223	5.00
1000	9.5	6.5	25	3.51	5.13	7.5	9	8	0.17	212	4.76
1000	10.0	5.5	25	*2.97	5.40	7.5	8	7	0.20	187	4.24
1000	10.5	4.5	27	*2.63	6.12	7.5	9	6	0.22	172	3.93
1250	9.5	9.5	22	*4.51	4.51	7.5	8	8	0.15	276	6.12
1250	10.0	8.0	24	*4.14	5.18	7.5	8	8	0.15	266	5.92
1250	10.0	7.0	27	4.08	5.83	7.5	8	8	0.18	260	5.83
1250	11.0	5.5	27	*3.20	6.41	7.5	9	7	0.20	223	5.04
1250	11.5	4.5	29	*3.30	7.20	7.5	10	6	0.24	221	4.63
1500	10.0	10.0	23	*4.96	*4.96	7.5	7	7	0.16	321	7.09
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.72	6.95	7.5	9	7	0.20	269	5.96
1500	12.0	5.0	30	*3.79	7.77	7.5	11	6	0.23	267	5.55
2000	11.0	11.0	24	*5.93	*5.70	7.5	8	8	0.15	415	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	11.5	8.0	30	*5.18	7.45	7.5	9	9	0.20	384	8.51
2000	12.5	6.5	31	*4.35	8.37	7.5	10	8	0.20	348	7.77
2000	13.0	5.5	33	*4.09	9.26	7.5	10	7	0.23	331	7.28

TABLE 2-5-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	4.5	4.5	13	*1.26	*1.26	7.5	6	6	0.25	34	0.81
250	4.5	4.0	14	*1.20	1.36	7.5	6	6	0.29	32	0.77
250	4.5	3.5	15	*1.13	1.45	7.5	6	5	0.35	30	0.72
250	4.5	3.0	16	*1.03	1.55	7.5	6	4	0.43	27	0.66
250	5.0	2.5	16	*0.86	1.72	7.5	6	4	0.33	24	0.61
500	6.0	6.0	17	*2.20	*2.20	7.5	7	7	0.28	82	1.88
500	6.5	5.0	18	*1.94	2.52	7.5	8	6	0.25	78	1.80
500	6.5	4.5	19	*1.84	2.66	7.5	8	6	0.29	74	1.71
500	7.0	3.5	19	*1.46	2.87	7.5	8	5	0.32	61	1.43
500	7.0	3.0	20	*1.53	3.02	7.5	8	4	0.40	59	1.29
750	7.0	7.0	20	*3.31	*3.02	7.5	7	7	0.27	140	3.02
750	7.5	6.0	21	*2.72	3.40	7.5	8	7	0.25	128	2.91
750	8.0	5.0	22	*2.37	3.80	7.5	9	6	0.25	118	2.71
750	8.5	4.0	22	*2.01	4.03	7.5	8	6	0.29	102	2.30
750	8.5	3.5	23	*2.30	4.22	7.5	9	5	0.36	105	2.11
1000	8.0	8.0	21	*3.68	*3.62	7.5	8	8	0.23	186	4.14
1000	8.5	7.0	22	*3.32	4.03	7.5	8	7	0.21	179	4.04
1000	8.5	6.0	25	*3.24	4.59	7.5	9	7	0.26	174	3.93
1000	9.0	5.0	25	*2.70	4.86	7.5	9	6	0.28	152	3.47
1000	9.5	4.0	26	*2.70	5.33	7.5	9	6	0.33	146	3.04
1250	9.0	9.0	21	*4.08	*4.08	7.5	7	7	0.18	236	5.25
1250	9.0	7.5	25	*4.05	4.86	7.5	8	8	0.22	232	5.20
1250	9.5	6.5	25	*3.51	5.13	7.5	9	8	0.23	212	4.76
1250	10.0	5.5	26	*3.08	5.61	7.5	8	7	0.25	195	4.41
1250	10.5	4.5	27	*2.96	6.12	7.5	10	6	0.29	184	3.93
1500	9.5	9.5	22	*4.93	*4.51	7.5	8	8	0.19	289	6.12
1500	9.5	8.0	27	*4.66	5.54	7.5	9	9	0.22	284	6.33
1500	10.0	7.0	27	*4.08	5.83	7.5	8	8	0.23	260	5.83
1500	11.0	5.5	27	*3.32	6.41	7.5	9	7	0.24	228	5.04
1500	11.5	4.5	28	*3.84	6.95	7.5	10	6	0.29	238	4.47
2000	10.5	10.5	24	*5.44	*5.44	7.5	8	8	0.18	370	8.16
2000	10.5	9.0	28	*5.44	6.35	7.5	9	9	0.21	368	8.16
2000	11.0	7.5	30	*4.86	7.12	7.5	9	8	0.23	343	7.63
2000	11.5	6.5	31	*4.35	7.70	7.5	10	8	0.25	320	7.15
2000	12.5	5.0	32	*4.21	8.64	7.5	11	6	0.29	304	6.17

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	DIMENSIONS Y (FT)	DIMENSIONS T (IN)	STEEL AREA X (SQ.IN.)	STEEL AREA Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	MAX. BAR SIZE Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	QUANTITIES CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	3.5	3.5	15	1.13	1.13	7.5	5	5	0.12	23	0.56
250	3.5	3.0	16	1.03	1.20	7.5	5	4	0.16	20	0.51
250	4.0	2.5	17	*0.91	1.46	7.5	6	4	0.00	20	0.52
250	4.5	2.5	17	*0.91	1.65	7.5	6	4	0.00	23	0.59
250	5.0	2.5	17	*0.91	1.83	7.5	6	4	0.00	26	0.65
500	5.0	5.0	16	*1.72	1.72	7.5	6	6	0.33	52	1.23
500	5.0	4.0	18	*1.55	1.94	7.5	6	6	0.44	46	1.11
500	5.5	3.5	18	*1.36	2.13	7.5	7	5	0.31	44	1.06
500	5.5	3.0	19	*1.23	2.25	7.5	7	4	0.38	40	0.96
500	6.0	2.5	20	*1.08	2.59	7.5	7	4	0.26	37	0.92
750	6.0	6.0	18	*2.33	*2.33	7.5	7	7	0.37	87	2.00
750	6.0	5.0	20	*2.16	2.59	7.5	7	6	0.47	80	1.85
750	6.5	4.5	20	*1.94	2.80	7.5	8	6	0.38	77	1.80
750	7.0	3.5	21	*1.58	3.17	7.5	8	5	0.37	67	1.58
750	7.0	3.0	22	*1.42	3.32	7.5	8	4	0.47	59	1.42
1000	7.0	7.0	19	*2.93	*2.87	7.5	7	7	0.32	128	2.87
1000	7.0	6.0	22	*2.85	3.32	7.5	8	7	0.38	125	2.85
1000	7.5	5.0	22	*2.37	3.56	7.5	8	6	0.37	111	2.54
1000	8.0	4.0	22	*2.07	3.80	7.5	8	6	0.40	98	2.17
1000	8.0	3.5	23	*2.06	3.97	7.5	9	5	0.43	93	1.98
1250	7.5	7.5	22	*3.60	*3.56	7.5	8	8	0.35	170	3.81
1250	8.0	6.5	23	*3.22	3.97	7.5	9	8	0.32	163	3.69
1250	8.5	5.5	24	*2.85	4.40	7.5	8	7	0.32	152	3.46
1250	8.5	4.5	26	*2.52	4.77	7.5	9	6	0.43	133	3.06
1250	9.5	3.5	24	*2.46	4.92	7.5	9	5	0.41	125	2.46
1500	8.5	8.5	21	*4.23	*3.85	7.5	8	7	0.27	220	4.68
1500	8.5	7.0	25	*3.78	4.59	7.5	8	8	0.33	204	4.59
1500	9.0	6.0	26	*3.36	5.05	7.5	9	7	0.33	192	4.33
1500	9.5	5.0	26	*2.81	5.33	7.5	9	6	0.36	167	3.81
1500	10.0	4.0	26	*3.04	5.61	7.5	10	6	0.42	165	3.20
2000	9.5	9.5	24	*4.92	*4.92	7.5	8	8	0.25	301	6.68
2000	9.5	8.0	28	*4.83	5.74	7.5	9	9	0.31	294	6.56
2000	10.0	7.0	29	*4.38	6.26	7.5	9	8	0.30	280	6.26
2000	10.5	5.5	30	*3.67	6.80	7.5	9	7	0.37	240	5.34
2000	11.0	4.5	31	*3.74	7.36	7.5	10	6	0.43	233	4.73

TABLE 2-5-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	DIMENSIONS Y (FT)	DIMENSIONS T (IN)	STEEL AREA X (SQ.IN.)	STEEL AREA Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	MAX. BAR SIZE Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	QUANTITIES CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	3.5	3.5	16	1.20	1.20	7.5	5	5	0.00	24	0.60
250	4.0	3.0	12	*0.78	1.03	3.0	6	4	0.00	18	0.44
250	4.5	2.5	13	*0.79	1.26	3.0	6	4	0.00	19	0.45
250	5.0	2.5	14	*0.79	1.51	3.0	6	4	0.00	22	0.54
250	5.5	2.5	14	*0.88	1.66	3.0	7	4	0.00	26	0.59
500	4.5	4.5	17	*1.65	1.65	7.5	6	6	0.13	44	1.06
500	4.5	4.0	18	*1.55	1.74	7.5	6	6	0.16	42	1.00
500	4.5	3.5	18	*1.36	1.74	7.5	6	5	0.22	36	0.87
500	5.0	3.0	19	*1.23	2.05	7.5	6	4	0.00	36	0.87
500	5.5	2.5	21	*1.13	2.49	7.5	7	4	0.00	36	0.89
750	5.5	5.5	18	*2.13	2.13	7.5	7	7	0.28	72	1.68
750	5.5	4.5	19	*1.84	2.25	7.5	7	6	0.38	62	1.45
750	5.5	4.0	21	*1.81	2.49	7.5	7	6	0.43	60	1.42
750	6.5	3.0	22	*1.42	3.08	7.5	8	4	0.15	55	1.32
750	7.0	2.5	24	*1.29	3.62	7.5	8	4	0.02	53	1.29
1000	6.0	6.0	19	*2.46	*2.46	7.5	7	7	0.47	92	2.11
1000	6.5	5.0	21	*2.26	2.94	7.5	8	6	0.39	91	2.10
1000	6.5	4.5	22	*2.13	3.08	7.5	8	6	0.45	85	1.98
1000	7.0	3.5	23	*1.73	3.47	7.5	8	5	0.43	73	1.73
1000	7.5	3.0	24	*1.55	3.88	7.5	8	4	0.34	70	1.66
1250	7.0	7.0	19	*3.09	*2.87	7.5	7	7	0.36	131	2.87
1250	7.0	6.0	22	*2.85	3.32	7.5	8	7	0.42	125	2.85
1250	7.5	5.0	23	*2.48	3.72	7.5	8	6	0.39	116	2.66
1250	8.0	4.0	24	*2.07	4.14	7.5	8	6	0.39	102	2.37
1250	8.0	3.5	25	*1.89	4.32	7.5	9	5	0.47	92	2.16
1500	7.5	7.5	21	*3.59	*3.40	7.5	8	8	0.38	166	3.64
1500	7.5	6.5	24	*3.36	3.88	7.5	8	8	0.45	159	3.61
1500	8.0	5.5	25	*2.97	4.32	7.5	8	7	0.42	149	3.39
1500	8.5	4.5	25	*2.43	4.59	7.5	9	6	0.44	128	2.95
1500	9.0	3.5	27	*2.06	5.24	7.5	9	5	0.47	113	2.62
2000	8.5	8.5	24	*4.44	*4.40	7.5	8	8	0.37	240	5.35
2000	9.0	7.0	26	*3.93	5.05	7.5	8	8	0.37	225	5.05
2000	9.5	6.0	27	*3.49	5.54	7.5	9	7	0.36	210	4.75
2000	10.0	5.0	27	*3.08	5.83	7.5	10	6	0.39	189	4.16
2000	10.5	4.0	28	*2.94	6.35	7.5	10	6	0.44	175	3.62

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.0	3.0	12	0.77	0.77	3.0	4	4	0.00	13	0.33
250	3.5	3.5	12	*0.90	0.90	3.0	5	5	0.00	18	0.45
250	4.0	3.0	13	*0.84	1.12	3.0	6	4	0.00	19	0.48
250	4.5	2.5	14	*0.86	1.36	3.0	6	4	0.00	21	0.48
250	5.0	2.5	15	*0.88	1.62	3.0	6	4	0.00	24	0.57
250	5.5	2.5	15	*0.98	1.78	3.0	7	4	0.00	28	0.63
500	4.5	4.5	18	*1.74	1.74	7.5	6	6	0.00	47	1.12
500	4.5	4.0	18	*1.55	1.74	7.5	6	6	0.00	42	1.00
500	4.5	3.5	19	*1.43	1.84	7.5	6	5	0.00	38	0.92
500	5.0	3.0	20	*1.29	2.16	7.5	6	4	0.00	38	0.92
500	5.5	2.5	22	*1.18	2.61	7.5	7	4	0.00	37	0.93
750	5.0	5.0	19	*2.05	2.05	7.5	6	6	0.16	62	1.46
750	5.5	4.0	20	*1.72	2.37	7.5	7	6	0.00	57	1.35
750	5.5	3.5	21	*1.58	2.49	7.5	7	5	0.02	52	1.24
750	6.0	3.0	22	*1.42	2.85	7.5	7	4	0.00	50	1.22
750	6.5	2.5	24	*1.29	3.36	7.5	8	4	0.00	49	1.20
1000	5.5	5.5	20	*2.37	2.37	7.5	7	7	0.43	80	1.86
1000	6.0	4.5	22	*2.13	2.85	7.5	7	6	0.30	78	1.83
1000	6.5	4.0	23	*1.98	3.22	7.5	8	6	0.14	79	1.84
1000	7.0	3.0	25	*1.62	3.78	7.5	8	4	0.05	67	1.62
1000	7.5	2.5	27	*1.45	4.37	7.5	8	4	0.00	64	1.56
1250	6.5	6.5	20	*2.80	2.80	7.5	8	8	0.32	114	2.60
1250	6.5	5.5	22	*2.61	3.08	7.5	8	7	0.39	105	2.42
1250	7.0	4.5	24	*2.33	3.62	7.5	8	6	0.31	100	2.33
1250	7.0	4.0	24	*2.07	3.62	7.5	8	6	0.39	89	2.07
1250	8.0	3.0	27	*1.74	4.66	7.5	9	4	0.16	84	2.00
1500	7.0	7.0	21	*3.17	*3.17	7.5	7	7	0.37	140	3.17
1500	7.0	6.0	23	*2.98	3.47	7.5	8	7	0.46	131	2.98
1500	7.5	5.0	25	*2.70	4.05	7.5	8	6	0.39	126	2.89
1500	8.0	4.0	26	*2.24	4.49	7.5	9	6	0.37	110	2.56
1500	8.5	3.5	27	*2.04	4.95	7.5	9	5	0.29	106	2.47
2000	8.0	8.0	22	*4.13	*3.80	7.5	8	8	0.40	202	4.34
2000	8.0	7.0	25	*3.78	4.32	7.5	8	8	0.46	192	4.32
2000	8.5	6.0	26	*3.36	4.77	7.5	9	7	0.42	181	4.09
2000	9.0	5.0	27	*2.91	5.24	7.5	9	6	0.41	164	3.75
2000	9.5	4.0	28	*2.53	5.74	7.5	9	6	0.44	1/6	3.28

TABLE 2-5-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.Y
0	3.5	3.5	13	0.98	0.98	3.0	5	5	0.00	20	0.4
250	4.0	4.0	14	*1.20	1.20	3.0	6	6	0.00	28	0.6
250	4.0	3.5	13	*0.98	1.12	3.0	6	5	0.00	23	0.5
250	4.5	3.0	14	*1.00	1.36	3.0	6	4	0.00	25	0.5
250	5.0	2.5	16	*0.94	1.72	3.0	6	4	0.00	26	0.6
250	5.5	2.5	16	*1.05	1.90	3.0	7	4	0.00	30	0.6
500	4.5	4.5	19	1.84	1.84	7.5	6	6	0.00	50	1.1
500	4.5	4.0	18	*1.55	1.74	7.5	6	6	0.00	42	1.0
500	5.0	3.5	15	*1.30	1.62	3.0	6	5	0.00	36	0.8
500	5.5	3.0	17	*1.21	2.01	3.0	7	4	0.00	37	0.8
500	6.0	2.5	19	*1.14	2.46	3.0	7	4	0.00	38	0.8
750	5.0	5.0	20	*2.16	2.16	7.5	6	6	0.00	66	1.5
750	5.5	4.0	21	*1.81	2.49	7.5	7	6	0.00	60	1.4
750	6.0	3.5	22	*1.66	2.85	7.5	7	5	0.00	60	1.4
750	6.5	3.0	23	*1.51	3.22	7.5	8	4	0.00	58	1.3
750	7.0	2.5	21	*1.37	3.17	3.0	8	4	0.00	51	1.1
1000	5.5	5.5	20	*2.37	2.37	7.5	7	7	0.10	80	1.8
1000	6.0	4.5	22	*2.13	2.85	7.5	7	6	0.00	78	1.8
1000	6.0	4.0	23	*1.98	2.98	7.5	7	6	0.00	72	1.7
1000	7.0	3.0	25	*1.64	3.78	7.5	8	4	0.00	68	1.6
1000	8.0	2.5	28	*1.52	4.83	7.5	9	4	0.00	71	1.7
1250	6.0	6.0	21	*2.72	2.72	7.5	7	7	0.27	101	2.3
1250	6.5	5.0	23	*2.48	3.22	7.5	8	6	0.14	100	2.3
1250	6.5	4.5	24	*2.33	3.36	7.5	8	6	0.18	93	2.1
1250	7.5	3.5	25	*1.99	4.05	7.5	8	5	0.00	88	2.0
1250	8.0	3.0	27	*1.83	4.66	7.5	9	4	0.00	86	2.0
1500	6.5	6.5	21	*2.94	2.94	7.5	8	8	0.37	120	2.7
1500	7.0	5.5	23	*2.73	3.47	7.5	8	7	0.26	119	2.7
1500	7.0	4.5	25	*2.43	3.78	7.5	8	6	0.36	105	2.4
1500	7.5	4.0	26	*2.24	4.21	7.5	8	6	0.23	103	2.4
1500	8.5	3.0	29	*1.94	5.32	7.5	9	4	0.00	98	2.2
2000	7.5	7.5	22	*3.56	*3.56	7.5	8	8	0.41	169	3.8
2000	7.5	6.5	25	*3.51	4.05	7.5	8	8	0.48	166	3.7
2000	8.0	5.5	27	*3.20	4.66	7.5	9	7	0.42	161	3.6
2000	8.5	4.5	28	*2.72	5.14	7.5	9	6	0.39	144	3.3
2000	9.5	3.5	30	*2.38	6.15	7.5	9	5	0.23	135	3.0

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	14	1.05	1.05	3.0	5	5	0.00	21	0.52
250	4.0	4.0	15	*1.29	1.29	3.0	6	6	0.00	30	0.74
250	4.5	3.5	14	*1.14	1.36	3.0	6	5	0.00	29	0.68
250	5.0	3.0	16	*1.08	1.72	3.0	6	4	0.00	31	0.74
250	5.5	2.5	17	*1.12	2.01	3.0	7	4	0.00	32	0.72
250	6.0	2.5	18	*1.15	2.33	3.0	7	4	0.00	37	0.83
500	4.5	4.5	15	*1.45	1.45	3.0	6	6	0.00	39	0.93
500	5.0	4.0	15	*1.45	1.62	3.0	6	6	0.00	41	0.92
500	5.5	3.5	17	*1.35	2.01	3.0	7	5	0.00	43	1.01
500	6.0	3.0	18	*1.38	2.33	3.0	7	4	0.00	45	1.00
500	6.5	2.5	20	*1.31	2.80	3.0	8	4	0.00	45	1.00
750	5.0	5.0	21	*2.26	2.26	7.5	6	6	0.00	69	1.62
750	5.5	4.0	22	*1.90	2.61	7.5	7	6	0.00	63	1.49
750	6.0	3.5	18	*1.61	2.33	3.0	7	5	0.00	53	1.16
750	6.5	3.0	20	*1.51	2.80	3.0	8	4	0.00	54	1.20
750	7.5	2.5	22	*1.53	3.56	3.0	8	4	0.00	60	1.27
1000	5.5	5.5	21	*2.49	2.49	7.5	7	7	0.00	84	1.96
1000	6.0	4.5	22	*2.13	2.85	7.5	7	6	0.00	78	1.83
1000	6.0	4.0	23	*1.98	2.98	7.5	7	6	0.00	72	1.70
1000	7.5	3.0	24	*1.55	3.88	3.0	8	4	0.00	70	1.66
1000	8.0	2.5	24	*1.63	4.14	3.0	9	4	0.00	69	1.48
1250	6.0	6.0	21	*2.72	2.72	7.5	7	7	0.00	101	2.33
1250	6.0	5.0	22	*2.37	2.85	7.5	7	6	0.03	88	2.03
1250	6.5	4.5	24	*2.33	3.36	7.5	8	6	0.00	93	2.16
1250	7.5	3.5	26	*1.99	4.21	7.5	8	5	0.00	90	2.10
1250	8.0	3.0	28	*1.86	4.83	7.5	9	4	0.00	88	2.07
1500	6.5	6.5	21	*2.94	2.94	7.5	8	8	0.13	120	2.73
1500	6.5	5.5	23	*2.73	3.22	7.5	8	7	0.18	110	2.53
1500	7.0	4.5	25	*2.43	3.78	7.5	8	6	0.05	105	2.43
1500	7.5	4.0	26	*2.24	4.21	7.5	8	6	0.00	103	2.40
1500	8.5	3.0	29	*2.05	5.32	7.5	9	4	0.00	101	2.28
2000	7.0	7.0	23	*3.47	3.47	7.5	8	8	0.43	153	3.47
2000	7.5	6.0	25	*3.24	4.05	7.5	8	7	0.32	152	3.47
2000	8.0	5.0	27	*2.91	4.66	7.5	9	6	0.24	145	3.33
2000	8.5	4.0	29	*2.50	5.32	7.5	9	6	0.17	131	3.04
2000	9.0	3.5	30	*2.46	5.83	7.5	9	5	0.07	130	2.91

TABLE 2-5-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	17	1.46	1.46	3.0	6	6	0.00	34	0.83
250	4.5	4.5	17	1.65	1.65	3.0	6	6	0.00	44	1.06
250	4.5	4.0	16	*1.38	1.55	3.0	6	6	0.00	37	0.88
250	5.0	3.5	16	*1.35	1.72	3.0	6	5	0.00	38	0.86
250	5.5	3.0	18	*1.31	2.13	3.0	7	4	0.00	40	0.91
250	6.5	2.5	20	*1.41	2.80	3.0	8	4	0.00	47	1.00
500	5.0	5.0	18	*1.94	1.94	3.0	6	6	0.00	59	1.38
500	5.5	4.0	17	*1.65	2.01	3.0	7	6	0.00	52	1.15
500	6.0	3.5	19	*1.57	2.46	3.0	7	5	0.00	54	1.23
500	6.5	3.0	20	*1.61	2.80	3.0	8	4	0.00	56	1.20
500	7.5	2.5	23	*1.58	3.72	3.0	8	4	0.00	63	1.33
750	5.0	5.0	18	*1.94	1.94	3.0	6	6	0.00	59	1.38
750	6.0	4.0	19	*1.79	2.46	3.0	7	6	0.00	62	1.40
750	6.5	3.5	20	*1.82	2.80	3.0	8	5	0.00	65	1.40
750	7.5	3.0	22	*1.85	3.56	3.0	8	4	0.00	74	1.52
750	8.5	2.5	25	*1.80	4.59	3.0	9	4	0.00	80	1.63
1000	5.5	5.5	23	*2.73	2.73	7.5	7	7	0.00	92	2.14
1000	6.0	4.5	19	*1.99	2.46	3.0	7	6	0.00	70	1.58
1000	6.5	4.0	20	*2.01	2.80	3.0	8	6	0.00	74	1.60
1000	8.0	3.0	24	*1.95	4.14	3.0	9	4	0.00	85	1.77
1000	9.0	2.5	27	*1.88	5.24	3.0	9	4	0.00	90	1.87
1250	6.0	6.0	23	*2.98	2.98	7.5	7	7	0.00	111	2.55
1250	6.0	5.0	23	*2.48	2.98	7.5	7	6	0.00	92	2.12
1250	6.5	4.5	25	*2.43	3.51	7.5	8	6	0.00	97	2.25
1250	7.5	3.5	23	*2.11	3.72	3.0	8	5	0.00	88	1.86
1250	8.5	3.0	25	*2.13	4.59	3.0	9	4	0.00	97	1.96
1500	6.0	6.0	23	*2.98	2.98	7.5	7	7	0.00	111	2.55
1500	6.5	5.0	25	*2.70	3.51	7.5	8	6	0.00	108	2.50
1500	7.0	4.5	26	*2.52	3.93	7.5	8	6	0.00	109	2.52
1500	8.0	3.5	29	*2.24	5.01	7.5	9	5	0.00	108	2.50
1500	9.0	3.0	27	*2.18	5.24	3.0	9	4	0.00	107	2.25
2000	7.0	7.0	24	*3.62	3.62	7.5	8	8	0.01	160	3.62
2000	7.0	6.0	25	*3.24	3.78	7.5	8	7	0.05	142	3.24
2000	7.5	5.0	28	*3.02	4.53	7.5	8	6	0.00	141	3.24
2000	8.5	4.0	29	*2.74	5.32	7.5	9	6	0.00	138	3.04
2000	9.0	3.5	31	*2.59	6.02	7.5	9	5	0.00	136	3.01

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 2000 PSI

TABLE 2-5-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	19	1.84	1.84	3.0	6	6	0.00	50	1.18
250	5.0	5.0	19	2.05	2.05	3.0	6	6	0.00	62	1.46
250	5.0	4.0	17	*1.50	1.83	3.0	6	6	0.00	44	1.04
250	6.0	3.5	19	*1.64	2.46	3.0	7	5	0.00	55	1.23
250	6.5	3.0	21	*1.61	2.94	3.0	8	4	0.00	57	1.26
250	8.0	2.5	24	*1.75	4.14	3.0	9	4	0.00	73	1.48
500	5.0	5.0	19	*2.05	2.05	3.0	6	6	0.00	62	1.46
500	6.0	4.0	19	*1.86	2.46	3.0	7	6	0.00	64	1.40
500	6.5	3.5	21	*1.79	2.94	3.0	8	5	0.00	66	1.47
500	7.5	3.0	23	*1.89	3.72	3.0	8	4	0.00	76	1.59
500	8.5	2.5	26	*1.87	4.77	3.0	9	4	0.00	83	1.70
750	5.5	5.5	20	*2.37	2.37	3.0	7	7	0.00	80	1.86
750	6.0	4.5	19	*2.07	2.46	3.0	7	6	0.00	72	1.58
750	6.5	4.0	21	*1.98	2.94	3.0	8	6	0.00	75	1.68
750	8.0	3.0	25	*1.99	4.32	3.0	9	4	0.00	87	1.85
750	9.5	2.5	29	*1.99	5.95	3.0	9	4	0.00	101	2.12
1000	6.0	6.0	20	*2.59	2.59	3.0	7	7	0.00	97	2.22
1000	6.0	5.0	19	*2.29	2.46	3.0	7	6	0.00	80	1.75
1000	6.5	4.5	21	*2.18	2.94	3.0	8	6	0.00	84	1.89
1000	8.0	3.5	24	*2.26	4.14	3.0	9	5	0.00	100	2.07
1000	8.5	3.0	26	*2.18	4.77	3.0	9	4	0.00	100	2.04
1250	6.0	6.0	20	*2.59	2.59	3.0	7	7	0.00	97	2.22
1250	6.5	5.0	20	*2.52	2.80	3.0	8	6	0.00	94	2.00
1250	7.0	4.5	22	*2.39	3.32	3.0	8	6	0.00	98	2.13
1250	8.5	3.5	25	*2.46	4.59	3.0	9	5	0.00	113	2.29
1250	9.5	3.0	28	*2.37	5.74	3.0	9	4	0.00	121	2.46
1500	6.5	6.5	25	*3.51	3.51	7.5	8	8	0.00	143	3.26
1500	6.5	5.5	24	*2.85	3.36	7.5	8	7	0.00	115	2.64
1500	7.5	4.5	23	*2.59	3.72	3.0	8	6	0.00	112	2.39
1500	8.0	4.0	24	*2.61	4.14	3.0	9	6	0.00	116	2.37
1500	10.0	3.0	29	*2.53	6.26	3.0	10	4	0.00	135	2.68
2000	7.0	7.0	26	*3.93	3.93	7.5	8	8	0.00	173	3.93
2000	7.0	6.0	25	*3.28	3.78	7.5	8	7	0.00	143	3.24
2000	8.0	5.0	29	*3.13	5.01	7.5	9	6	0.00	156	3.58
2000	9.0	4.0	26	*2.94	5.05	3.0	9	6	0.00	145	2.88
2000	9.5	3.5	28	*2.82	5.74	3.0	9	5	0.00	145	2.87

TABLE 2-5-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	20	2.16	2.16	3.0	6	6	0.00	66	1.54
250	5.0	5.0	20	2.16	2.16	3.0	6	6	0.00	66	1.54
250	6.0	4.0	20	*1.80	2.59	3.0	7	6	0.00	64	1.48
250	6.5	3.5	21	*1.88	2.94	3.0	8	5	0.00	68	1.47
250	8.0	3.0	24	*2.06	4.14	3.0	9	4	0.00	87	1.77
250	9.0	2.5	28	*1.98	5.44	3.0	9	4	0.00	94	1.94
500	5.5	5.5	21	*2.49	2.49	3.0	7	7	0.00	84	1.96
500	6.0	4.5	19	*2.15	2.46	3.0	7	6	0.00	73	1.58
500	6.5	4.0	21	*2.08	2.94	3.0	8	6	0.00	77	1.68
500	8.5	3.0	26	*2.17	4.77	3.0	9	4	0.00	99	2.04
500	9.5	2.5	30	*2.08	6.15	3.0	9	4	0.00	105	2.19
750	5.5	5.5	21	*2.49	2.49	3.0	7	7	0.00	84	1.96
750	6.5	4.5	21	*2.27	2.94	3.0	8	6	0.00	86	1.89
750	7.0	4.0	23	*2.19	3.47	3.0	8	6	0.00	90	1.98
750	9.0	3.0	27	*2.36	5.24	3.0	9	4	0.00	113	2.25
750	10.5	2.5	32	*2.28	7.25	3.0	10	4	0.00	127	2.59
1000	6.0	6.0	22	*2.85	2.85	3.0	7	7	0.00	106	2.44
1000	6.5	5.0	21	*2.45	2.94	3.0	8	6	0.00	95	2.10
1000	7.0	4.5	22	*2.50	3.32	3.0	8	6	0.00	100	2.13
1000	8.5	3.5	26	*2.49	4.77	3.0	9	5	0.00	116	2.38
1000	9.5	3.0	29	*2.44	5.95	3.0	9	4	0.00	125	2.55
1250	6.0	6.0	22	*2.85	2.85	3.0	7	7	0.00	106	2.44
1250	7.0	5.0	22	*2.68	3.32	3.0	8	6	0.00	110	2.37
1250	7.5	4.5	24	*2.58	3.88	3.0	8	6	0.00	114	2.50
1250	9.0	3.5	27	*2.68	5.24	3.0	9	5	0.00	131	2.62
1250	10.0	3.0	30	*2.61	6.48	3.0	10	4	0.00	139	2.77
1500	6.5	6.5	22	*3.08	3.08	3.0	8	8	0.00	126	2.86
1500	7.0	5.5	22	*2.87	3.32	3.0	8	7	0.00	120	2.61
1500	8.0	4.5	25	*2.78	4.32	3.0	9	6	0.00	129	2.77
1500	8.5	4.0	26	*2.80	4.77	3.0	9	6	0.00	133	2.72
1500	10.5	3.0	32	*2.67	7.25	3.0	10	4	0.00	152	3.11
2000	7.0	7.0	27	*4.08	4.08	7.5	8	8	0.00	180	4.08
2000	7.5	6.0	24	*3.11	3.88	3.0	8	7	0.00	146	3.33
2000	8.0	5.0	25	*3.11	4.32	3.0	9	6	0.00	145	3.08
2000	9.5	4.0	28	*3.14	5.74	3.0	9	6	0.00	164	3.28
2000	10.5	3.5	31	*3.04	7.03	3.0	10	5	0.00	175	3.51

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	7	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	8	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	9	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	8	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	9	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	8	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	9	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	8	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	9	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	8	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	32	*6.56	10.02	7.5	9	9	0.07	619	13.60
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 3-1-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	8	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	7	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	8	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	7	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	8	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	7	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.08	337	7.50
1000	12.5	6.5	29	*4.41	7.83	7.5	10	8	0.08	340	7.27
1000	14.0	5.0	32	*3.45	9.67	7.5	11	7	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	8	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	31	*4.85	9.03	7.5	9	9	0.11	414	9.04
1500	15.0	5.5	33	*4.90	10.69	7.5	10	8	0.11	423	8.40
2000	12.0	12.0	27	*8.53	*6.99	7.5	9	8	0.11	607	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	30	*5.83	8.74	7.5	9	9	0.11	511	11.25
2000	14.5	7.5	32	*5.18	10.02	7.5	9	9	0.11	485	10.74
2000	15.5	6.0	35	*5.37	11.71	7.5	11	8	0.13	493	10.04

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	DIMENSIONS Y (FT)	DIMENSIONS T (IN)	STEEL AREA X (SQ.IN.)	STEEL AREA Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	MAX. BAR SIZE Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	QUANTITIES CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	7	7	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	7	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	7	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.09	243	5.44
750	11.5	5.5	26	*3.08	6.45	7.5	3	8	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	7	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	27	*4.26	6.99	7.5	10	8	0.11	298	6.00
1000	13.0	5.0	29	*3.13	8.14	7.5	10	7	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*3.97	7.56	7.5	9	8	0.12	316	7.02
1250	14.0	5.0	31	*3.34	9.37	7.5	11	7	0.10	297	6.69
1500	11.0	11.0	24	*6.46	*5.70	7.5	9	8	0.11	434	8.96
1500	11.5	9.5	26	*5.33	6.45	7.5	9	8	0.11	397	8.76
1500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.10	390	8.64
1500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.10	364	8.12
1500	14.0	5.5	31	*4.61	9.37	7.5	10	8	0.14	371	7.36
2000	12.0	12.0	27	6.99	6.99	7.5	8	8	0.08	547	12.00
2000	12.0	10.5	28	*6.35	7.25	7.5	9	8	0.13	495	10.88
2000	13.0	9.0	29	*5.63	8.14	7.5	9	8	0.11	475	10.47
2000	14.0	7.5	31	5.02	9.37	7.5	9	9	0.11	453	10.04
2000	15.0	6.0	33	*4.27	10.69	7.5	10	8	0.13	411	9.16

TABLE 3-1-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	DIMENSIONS Y (FT)	DIMENSIONS T (IN)	STEEL AREA X (SQ.IN.)	STEEL AREA Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	MAX. BAR SIZE Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	QUANTITIES CONC. (CU.Y
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.0
250	7.5	4.5	18	1.74	2.91	7.5	8	7	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	9.0	3.0	20	1.29	3.88	7.5	9	5	0.09	70	1.66
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.5	7.0	19	2.87	3.48	7.5	7	7	0.09	155	3.48
500	9.0	6.0	20	2.59	3.88	7.5	8	7	0.09	147	3.3
500	9.5	5.0	21	2.26	4.30	7.5	9	7	0.10	135	3.07
500	10.0	4.0	22	*2.51	4.75	7.5	9	6	0.14	137	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.5	7.5	21	3.40	4.30	7.5	8	8	0.10	206	4.61
750	10.0	6.5	22	3.08	4.75	7.5	8	7	0.10	196	4.41
750	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.12	181	4.09
750	11.5	4.5	26	2.52	6.45	7.5	9	7	0.09	182	4.15
1000	9.5	9.5	21	*4.38	*4.30	7.5	8	8	0.12	266	5.84
1000	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.12	255	5.67
1000	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.13	243	5.44
1000	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.13	225	5.07
1000	12.5	4.5	28	2.72	7.56	7.5	10	7	0.12	214	4.86
1250	10.0	10.0	22	*6.54	*5.05	7.5	9	8	0.14	374	6.79
1250	11.0	8.5	24	4.40	5.70	7.5	8	8	0.10	312	6.9
1250	11.5	7.5	26	4.21	6.45	7.5	9	8	0.09	311	6.9
1250	12.0	6.0	27	*3.49	6.99	7.5	9	8	0.14	267	6.00
1250	13.0	5.0	29	3.13	8.14	7.5	10	7	0.13	257	5.81
1500	10.5	10.5	23	*6.74	*5.21	7.5	9	8	0.14	407	7.8
1500	11.5	9.0	26	5.05	6.45	7.5	8	8	0.09	375	8.30
1500	12.0	7.5	27	4.37	6.99	7.5	9	8	0.12	337	7.50
1500	12.5	6.5	28	*3.93	7.56	7.5	9	8	0.14	314	7.0
1500	14.0	5.0	31	3.34	9.37	7.5	11	7	0.12	297	6.69
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	12.0	10.0	27	5.83	6.99	7.5	8	8	0.12	454	10.00
2000	13.0	8.5	29	5.32	8.14	7.5	9	8	0.10	448	9.89
2000	14.0	7.0	31	4.68	9.37	7.5	9	9	0.09	422	9.37
2000	15.0	5.5	33	3.92	10.69	7.5	9	8	0.12	375	8.40

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.0	6.0	14	1.81	1.81	7.5	6	6	0.07	67	1.55
250	6.0	5.0	14	1.51	1.81	7.5	7	6	0.12	56	1.29
250	6.5	4.5	15	1.45	2.10	7.5	7	7	0.07	58	1.35
250	7.0	3.5	16	1.20	2.41	7.5	9	6	0.08	51	1.20
250	7.5	3.0	17	1.10	2.75	7.5	9	5	0.05	49	1.18
500	7.5	7.5	17	2.75	2.75	7.5	7	7	0.09	131	2.95
500	8.0	6.5	18	2.52	3.11	7.5	8	7	0.07	128	2.88
500	8.5	5.5	19	2.25	3.48	7.5	7	7	0.07	120	2.74
500	9.0	4.5	20	1.94	3.88	7.5	8	7	0.08	109	2.50
500	10.0	3.5	22	1.66	4.75	7.5	11	6	0.05	102	2.37
750	8.5	8.5	19	3.48	3.48	7.5	7	7	0.10	189	4.23
750	9.0	7.0	20	3.02	3.88	7.5	7	7	0.11	173	3.88
750	9.5	6.0	21	2.72	4.30	7.5	8	8	0.11	163	3.69
750	10.0	5.0	22	2.37	4.75	7.5	9	7	0.12	149	3.39
750	11.0	4.0	24	2.07	5.70	7.5	8	6	0.10	142	3.25
1000	9.5	9.5	21	4.30	4.30	7.5	8	8	0.07	263	5.84
1000	9.5	8.0	21	*3.62	4.30	7.5	8	8	0.13	221	4.92
1000	10.0	7.0	22	3.32	4.75	7.5	8	7	0.12	212	4.75
1000	11.0	5.5	24	2.85	5.70	7.5	8	8	0.11	198	4.48
1000	12.0	4.5	27	2.62	6.99	7.5	9	7	0.08	197	4.50
1250	10.0	10.0	22	4.75	4.75	7.5	7	7	0.09	307	6.79
1250	10.5	8.5	23	4.22	5.21	7.5	8	8	0.10	285	6.33
1250	11.0	7.5	24	3.88	5.70	7.5	8	8	0.09	274	6.11
1250	11.5	6.0	26	3.36	6.45	7.5	9	8	0.12	246	5.53
1250	12.5	5.0	28	3.02	7.56	7.5	10	7	0.10	239	5.40
1500	10.5	10.5	23	5.21	5.21	7.5	8	8	0.09	355	7.82
1500	11.0	9.0	24	4.66	5.70	7.5	8	8	0.10	331	7.33
1500	11.5	7.5	26	4.21	6.45	7.5	9	8	0.12	311	6.92
1500	12.5	6.5	28	3.93	7.56	7.5	9	8	0.08	314	7.02
1500	13.5	5.0	30	3.24	8.74	7.5	10	7	0.09	277	6.25
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
2000	11.5	10.0	26	5.61	6.45	7.5	8	8	0.13	418	9.22
2000	12.5	8.5	28	5.14	7.56	7.5	8	9	0.10	415	9.18
2000	13.5	7.0	30	4.53	8.74	7.5	9	9	0.09	394	8.75
2000	14.5	5.5	32	3.80	10.02	7.5	9	8	0.11	351	7.87

TABLE 3-1-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	10	0.75	0.75	3.0	6	6	0.00	15	0.37
250	5.5	5.5	13	*1.54	1.54	7.5	6	6	0.00	52	1.21
250	6.0	4.5	14	*1.36	1.81	7.5	7	6	0.00	50	1.16
250	6.5	4.0	15	*1.29	2.10	7.5	7	6	0.00	51	1.20
250	7.5	3.0	17	*1.10	2.75	7.5	9	5	0.00	49	1.18
250	8.5	2.5	19	1.02	3.48	3.0	8	4	0.00	51	1.24
500	7.0	7.0	16	2.41	2.41	7.5	6	6	0.08	107	2.41
500	7.5	6.0	17	2.20	2.75	7.5	7	7	0.05	104	2.36
500	8.0	5.0	18	1.94	3.11	7.5	8	7	0.04	97	2.22
500	9.0	4.0	20	1.72	3.88	7.5	8	6	0.00	96	2.22
500	9.5	3.5	21	1.58	4.30	7.5	10	6	0.00	92	2.15
750	8.0	8.0	18	3.11	3.11	7.5	7	7	0.10	158	3.55
750	8.5	7.0	19	2.87	3.48	7.5	7	7	0.08	155	3.48
750	9.0	6.0	20	2.59	3.88	7.5	8	7	0.07	147	3.33
750	10.0	5.0	22	2.37	4.75	7.5	9	7	0.02	149	3.39
750	10.5	4.0	23	1.98	5.21	7.5	8	6	0.04	129	2.98
1000	9.0	9.0	20	3.88	3.88	7.5	7	7	0.08	224	5.00
1000	9.5	7.5	21	3.40	4.30	7.5	8	8	0.08	206	4.61
1000	10.0	6.5	22	3.08	4.75	7.5	8	7	0.08	196	4.41
1000	10.5	5.5	23	2.73	5.21	7.5	8	8	0.08	181	4.09
1000	11.5	4.5	26	2.52	6.45	7.5	9	7	0.04	182	4.15
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.11	263	5.84
1250	10.5	8.0	23	3.97	5.21	7.5	8	8	0.06	268	5.96
1250	11.0	7.0	24	3.62	5.70	7.5	8	8	0.06	255	5.70
1250	12.0	5.5	27	3.20	6.99	7.5	9	8	0.03	244	5.50
1250	13.0	4.5	29	2.81	8.14	7.5	10	7	0.01	230	5.23
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.12	307	6.79
1500	11.0	8.5	24	4.40	5.70	7.5	8	8	0.07	312	6.92
1500	11.5	7.5	26	4.21	6.45	7.5	9	8	0.06	311	6.92
1500	12.5	6.0	28	3.62	7.56	7.5	9	8	0.05	289	6.48
1500	13.0	5.0	29	3.13	8.14	7.5	10	7	0.07	257	5.81
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.11	407	8.96
2000	11.5	9.5	26	5.33	6.45	7.5	9	8	0.11	397	8.76
2000	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
2000	13.5	6.5	30	4.21	8.74	7.5	10	8	0.07	364	8.12
2000	14.5	5.5	32	3.80	10.02	7.5	9	8	0.05	351	7.87

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	10	0.97	0.97	3.0	6	6	0.00	26	0.62
250	6.0	6.0	14	1.81	1.81	3.0	6	6	0.00	67	1.55
250	6.5	5.0	15	1.62	2.10	3.0	7	7	0.00	65	1.50
250	7.0	4.5	16	1.55	2.41	3.0	7	6	0.00	67	1.55
250	8.5	3.5	19	1.43	3.48	3.0	10	6	0.00	74	1.74
250	9.5	3.0	21	1.36	4.30	3.0	10	5	0.00	78	1.84
500	7.0	7.0	16	2.41	2.41	7.5	6	6	0.00	107	2.41
500	7.5	6.0	17	*2.20	2.75	7.5	7	7	0.00	104	2.36
500	8.5	5.0	19	2.05	3.48	3.0	8	7	0.00	109	2.49
500	9.5	4.0	21	1.81	4.30	3.0	8	6	0.00	106	2.46
500	10.5	3.5	23	1.73	5.21	3.0	11	6	0.00	112	2.60
750	8.0	8.0	18	3.11	3.11	7.5	7	7	0.00	158	3.55
750	8.5	7.0	19	2.87	3.48	7.5	7	7	0.00	155	3.48
750	9.0	6.0	20	2.59	3.88	7.5	8	7	0.00	147	3.33
750	10.0	5.0	22	2.37	4.75	7.5	9	7	0.00	149	3.39
750	11.0	4.0	24	2.07	5.70	7.5	8	6	0.00	142	3.25
1000	8.5	8.5	19	3.48	3.48	7.5	7	7	0.02	189	4.23
1000	9.5	7.0	21	3.17	4.30	7.5	7	8	0.00	192	4.31
1000	10.0	6.0	22	2.85	4.75	7.5	8	7	0.00	181	4.07
1000	11.0	5.0	24	2.59	5.70	7.5	9	7	0.00	179	4.07
1000	12.5	4.0	28	2.41	7.56	7.5	9	6	0.00	188	4.32
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.00	263	5.84
1250	10.0	8.0	22	3.80	4.75	7.5	8	7	0.00	244	5.43
1250	10.5	7.0	23	3.47	5.21	7.5	8	8	0.00	233	5.21
1250	11.5	5.5	26	3.08	6.45	7.5	8	8	0.00	225	5.07
1250	13.0	4.5	29	2.81	8.14	7.5	10	7	0.00	230	5.23
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.02	307	6.79
1500	10.5	8.5	23	4.22	5.21	7.5	8	8	0.02	285	6.33
1500	11.0	7.5	24	3.88	5.70	7.5	8	8	0.00	274	6.11
1500	12.0	6.0	27	3.49	6.99	7.5	9	8	0.00	267	6.00
1500	13.0	5.0	29	3.13	8.14	7.5	10	7	0.00	257	5.81
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.03	407	8.96
2000	11.5	9.5	26	5.33	6.45	7.5	9	8	0.02	397	8.76
2000	12.0	8.0	27	4.66	6.99	7.5	9	8	0.03	361	8.00
2000	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
2000	14.5	5.5	32	3.80	10.02	7.5	9	8	0.00	351	7.87

TABLE 3-1-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	12	1.42	1.42	3.0	6	6	0.00	48	1.12
250	6.5	6.5	15	2.10	2.10	3.0	7	7	0.00	85	1.95
250	7.0	5.5	16	1.90	2.41	3.0	7	6	0.00	83	1.90
250	8.5	4.5	19	1.84	3.48	3.0	8	7	0.00	97	2.24
250	9.0	4.0	20	1.72	3.88	3.0	8	6	0.00	96	2.22
250	11.5	3.0	26	1.68	6.45	3.0	11	5	0.00	118	2.76
500	7.5	7.5	17	2.75	2.75	3.0	7	7	0.00	131	2.95
500	8.0	6.5	18	2.52	3.11	3.0	8	7	0.00	128	2.88
500	9.0	5.5	20	2.37	3.88	3.0	7	7	0.00	134	3.05
500	10.0	4.5	22	2.13	4.75	3.0	9	7	0.00	133	3.05
500	12.0	3.5	27	2.04	6.99	3.0	11	6	0.00	151	3.50
750	8.0	8.0	18	3.11	3.11	7.5	7	7	0.00	158	3.55
750	8.5	7.0	19	2.87	3.48	3.0	7	7	0.00	155	3.48
750	9.5	6.0	21	2.72	4.30	3.0	8	8	0.00	163	3.69
750	11.0	5.0	24	2.59	5.70	3.0	9	7	0.00	179	4.07
750	12.5	4.0	28	2.41	7.56	3.0	9	6	0.00	188	4.32
1000	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
1000	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
1000	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
1000	11.0	5.5	24	2.85	5.70	3.0	8	8	0.00	198	4.48
1000	12.5	4.5	28	2.72	7.56	3.0	10	7	0.00	214	4.86
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.00	263	5.84
1250	10.0	8.0	22	3.80	4.75	7.5	8	7	0.00	244	5.43
1250	10.5	7.0	23	3.47	5.21	7.5	8	8	0.00	233	5.21
1250	12.0	5.5	27	3.20	6.99	3.0	9	8	0.00	244	5.50
1250	14.0	4.5	31	3.01	9.37	3.0	10	7	0.00	266	6.02
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.00	307	6.79
1500	10.5	8.5	23	4.22	5.21	7.5	8	8	0.00	285	6.33
1500	11.0	7.5	24	3.88	5.70	7.5	8	8	0.00	274	6.11
1500	12.5	6.0	28	3.62	7.56	7.5	9	8	0.00	289	6.48
1500	14.0	5.0	31	3.34	9.37	3.0	11	7	0.00	297	6.69
2000	10.5	10.5	23	5.21	5.21	7.5	8	8	0.01	355	7.82
2000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.00	375	8.30
2000	12.5	7.5	28	4.53	7.56	7.5	9	9	0.00	365	8.10
2000	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
2000	15.5	5.0	34	3.67	11.38	7.5	11	7	0.00	361	8.13

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	15	2.10	2.10	3.0	7	7	0.00	85	1.95
250	7.0	7.0	16	2.41	2.41	3.0	6	6	0.00	107	2.41
250	8.0	6.0	18	2.33	3.11	3.0	7	7	0.00	117	2.66
250	9.0	5.0	20	2.16	3.88	3.0	9	7	0.00	122	2.77
250	10.5	4.0	23	1.98	5.21	3.0	8	6	0.00	129	2.98
250	12.0	3.5	27	2.04	6.99	3.0	11	6	0.00	151	3.50
500	8.0	8.0	18	3.11	3.11	3.0	7	7	0.00	158	3.55
500	8.5	7.0	19	2.87	3.48	3.0	7	7	0.00	155	3.48
500	9.5	6.0	21	2.72	4.30	3.0	8	8	0.00	163	3.69
500	10.5	5.0	23	2.48	5.21	3.0	9	7	0.00	164	3.72
500	12.5	4.0	28	2.41	7.56	3.0	9	6	0.00	188	4.32
750	8.5	8.5	19	3.48	3.48	3.0	7	7	0.00	189	4.23
750	9.5	7.0	21	3.17	4.30	3.0	7	8	0.00	192	4.31
750	10.5	6.0	23	2.98	5.21	3.0	8	8	0.00	199	4.47
750	12.0	5.0	27	2.91	6.99	3.0	10	7	0.00	221	5.00
750	14.0	4.0	31	2.67	9.37	3.0	10	6	0.00	234	5.35
1000	9.0	9.0	20	3.88	3.88	3.0	7	7	0.00	224	5.00
1000	10.0	7.5	22	3.56	4.75	3.0	8	7	0.00	228	5.09
1000	11.0	6.5	24	3.36	5.70	3.0	9	8	0.00	236	5.29
1000	12.0	5.5	27	3.20	6.99	3.0	9	8	0.00	244	5.50
1000	14.0	4.5	31	3.01	9.37	3.0	10	7	0.00	266	6.02
1250	9.5	9.5	21	4.30	4.30	7.5	8	8	0.00	263	5.84
1250	10.5	8.0	23	3.97	5.21	3.0	8	8	0.00	268	5.96
1250	11.5	7.0	26	3.93	6.45	3.0	8	8	0.00	289	6.45
1250	13.0	5.5	29	3.44	8.14	3.0	9	8	0.00	285	6.39
1250	15.0	4.5	33	3.20	10.69	3.0	10	7	0.00	303	6.87
1500	10.0	10.0	22	4.75	4.75	7.5	7	7	0.00	307	6.79
1500	11.0	8.5	24	4.40	5.70	7.5	8	8	0.00	312	6.92
1500	11.5	7.5	26	4.21	6.45	3.0	9	8	0.00	311	6.92
1500	13.5	6.0	30	3.88	8.74	3.0	9	8	0.00	335	7.50
1500	15.0	5.0	33	3.56	10.69	3.0	11	7	0.00	339	7.63
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
2000	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
2000	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
2000	14.0	6.5	31	4.35	9.37	3.0	10	8	0.00	391	8.70
2000	15.5	5.5	34	4.03	11.38	3.0	10	8	0.00	399	8.94

TABLE 3-1-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	7.5	7.5	17	2.75	2.75	3.0	7	7	0.00	131	2.95
250	7.5	7.5	17	2.75	2.75	3.0	7	7	0.00	131	2.95
250	8.5	6.5	19	2.66	3.48	3.0	8	7	0.00	143	3.23
250	9.5	5.5	21	2.49	4.30	3.0	8	8	0.00	149	3.38
250	11.0	4.5	24	2.33	5.70	3.0	9	7	0.00	160	3.66
250	14.0	3.5	31	2.34	9.37	3.0	11	6	0.00	203	4.68
500	8.5	8.5	19	3.48	3.48	3.0	7	7	0.00	189	4.23
500	9.0	7.0	20	3.02	3.88	3.0	7	7	0.00	173	3.88
500	10.0	6.0	22	2.85	4.75	3.0	8	7	0.00	181	4.07
500	11.5	5.0	26	2.80	6.45	3.0	10	7	0.00	203	4.61
500	14.0	4.0	31	2.67	9.37	3.0	10	6	0.00	234	5.35
750	9.0	9.0	20	3.88	3.88	3.0	7	7	0.00	224	5.00
750	10.0	7.5	22	3.56	4.75	3.0	8	7	0.00	228	5.09
750	11.0	6.5	24	3.36	5.70	3.0	9	8	0.00	236	5.29
750	12.0	5.5	27	3.20	6.99	3.0	9	8	0.00	244	5.50
750	14.0	4.5	31	3.01	9.37	3.0	10	7	0.00	266	6.02
1000	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
1000	10.0	8.0	22	3.80	4.75	3.0	8	7	0.00	244	5.43
1000	11.0	7.0	24	3.62	5.70	3.0	8	8	0.00	255	5.70
1000	13.0	5.5	29	3.44	8.14	3.0	9	8	0.00	285	6.39
1000	15.0	4.5	33	3.20	10.69	3.0	10	7	0.00	303	6.87
1250	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
1250	10.5	8.5	23	4.22	5.21	3.0	8	8	0.00	285	6.33
1250	11.5	7.5	26	4.21	6.45	3.0	9	8	0.00	311	6.92
1250	13.5	6.0	30	3.88	8.74	3.0	9	8	0.00	335	7.50
1250	15.0	5.0	33	3.56	10.69	3.0	11	7	0.00	339	7.63
1500	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
1500	11.5	8.5	26	4.77	6.45	3.0	8	8	0.00	354	7.84
1500	12.0	7.5	27	4.37	6.99	3.0	9	8	0.00	337	7.50
1500	14.0	6.0	31	4.01	9.37	3.0	10	8	0.00	360	8.03
1500	16.0	5.0	35	3.78	12.09	3.0	11	7	0.00	384	8.64
2000	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
2000	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
2000	13.0	8.0	29	5.01	8.14	3.0	9	8	0.00	420	9.30
2000	15.0	6.5	33	4.63	10.69	3.0	10	8	0.00	446	9.93
2000	16.5	5.5	36	4.27	12.83	3.0	10	8	0.00	451	10.08

FOOTING DE[illegible]N TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	18	3.11	3.11	3.0	7	7	0.00	158	3.55
250	8.0	8.0	18	3.11	3.11	3.0	7	7	0.00	158	3.55
250	9.0	7.0	20	3.02	3.88	3.0	7	7	0.00	173	3.88
250	10.0	6.0	22	2.85	4.75	3.0	8	7	0.00	181	4.07
250	12.0	5.0	27	2.91	6.99	3.0	10	7	0.00	221	5.00
250	15.0	4.0	33	2.85	10.69	3.0	10	6	0.00	268	6.11
500	8.5	8.5	19	3.48	3.48	3.0	7	7	0.00	189	4.23
500	10.0	7.0	22	3.32	4.75	3.0	8	7	0.00	212	4.75
500	11.5	6.0	26	3.36	6.45	3.0	9	8	0.00	246	5.53
500	13.0	5.0	29	3.13	8.14	3.0	10	7	0.00	257	5.81
500	15.5	4.0	34	2.93	11.38	3.0	10	6	0.00	285	6.50
750	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
750	10.0	8.0	22	3.80	4.75	3.0	8	7	0.00	244	5.43
750	11.0	7.0	24	3.62	5.70	3.0	8	8	0.00	255	5.70
750	13.0	5.5	29	3.44	8.14	3.0	9	8	0.00	285	6.39
750	15.5	4.5	34	3.30	11.38	3.0	11	7	0.00	323	7.31
1000	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
1000	11.0	8.0	24	4.14	5.70	3.0	8	8	0.00	293	6.51
1000	12.0	7.0	27	4.08	6.99	3.0	8	8	0.00	314	7.00
1000	14.0	5.5	31	3.68	9.37	3.0	9	8	0.00	328	7.36
1000	16.5	4.5	36	3.49	12.83	3.0	11	7	0.00	365	8.25
1250	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
1250	11.0	8.5	24	4.40	5.70	3.0	8	8	0.00	312	6.92
1250	12.0	7.5	27	4.37	6.99	3.0	9	8	0.00	337	7.50
1250	14.0	6.0	31	4.01	9.37	3.0	10	8	0.00	360	8.03
1250	16.0	5.0	35	3.78	12.09	3.0	11	7	0.00	384	8.64
1500	10.5	10.5	23	5.21	5.21	3.0	8	8	0.00	355	7.82
1500	11.5	9.0	26	5.05	6.45	3.0	8	8	0.00	375	8.30
1500	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
1500	14.0	6.5	31	4.35	9.37	3.0	10	8	0.00	391	8.70
1500	17.0	5.0	38	4.10	13.95	3.0	11	7	0.00	444	9.96
2000	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
2000	12.5	9.5	28	5.74	7.56	3.0	9	9	0.00	466	10.26
2000	13.5	8.0	30	5.18	8.74	3.0	9	9	0.00	452	10.00
2000	15.5	6.5	34	4.77	11.38	3.0	10	8	0.00	476	10.57
2000	17.5	5.5	39	4.63	14.74	3.0	10	8	0.00	518	11.58

TABLE 3-1-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	9.0	9.0	20	3.88	3.88	3.0	7	7	0.00	224	5.00
250	9.0	9.0	20	3.88	3.88	3.0	7	7	0.00	224	5.00
250	10.0	7.5	22	3.56	4.75	3.0	8	7	0.00	228	5.09
250	12.0	6.5	27	3.79	6.99	3.0	9	8	0.00	291	6.50
250	14.0	5.5	31	3.68	9.37	3.0	9	8	0.00	328	7.36
250	17.0	4.5	38	3.69	13.95	3.0	11	7	0.00	397	8.97
500	9.5	9.5	21	4.30	4.30	3.0	8	8	0.00	263	5.84
500	10.5	8.0	23	3.97	5.21	3.0	8	8	0.00	268	5.96
500	12.0	7.0	27	4.08	6.99	3.0	8	8	0.00	314	7.00
500	14.5	5.5	32	3.80	10.02	3.0	9	8	0.00	351	7.87
500	17.0	4.5	38	3.69	13.95	3.0	11	7	0.00	397	8.97
750	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
750	11.0	8.5	24	4.40	5.70	3.0	8	8	0.00	312	6.92
750	12.0	7.5	27	4.37	6.99	3.0	9	8	0.00	337	7.50
750	14.5	6.0	32	4.14	10.02	3.0	10	8	0.00	385	8.59
750	16.5	5.0	36	3.88	12.83	3.0	11	7	0.00	408	9.16
1000	10.5	10.5	23	5.21	5.21	3.0	8	8	0.00	355	7.82
1000	11.5	9.0	26	5.05	6.45	3.0	8	8	0.00	375	8.30
1000	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
1000	14.5	6.5	32	4.49	10.02	3.0	10	8	0.00	418	9.30
1000	17.5	5.0	39	4.21	14.74	3.0	11	7	0.00	469	10.53
1250	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
1250	11.5	9.5	26	5.33	6.45	3.0	9	8	0.00	397	8.76
1250	13.0	8.0	29	5.01	8.14	3.0	9	8	0.00	420	9.30
1250	15.0	6.5	33	4.63	10.69	3.0	10	8	0.00	446	9.93
1250	17.0	5.5	38	4.51	13.95	3.0	10	8	0.00	490	10.96
1500	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
1500	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
1500	14.0	8.0	31	5.35	9.37	3.0	10	9	0.00	485	10.71
1500	16.0	6.5	35	4.91	12.09	3.0	10	8	0.00	506	11.23
1500	18.0	5.5	40	4.75	15.55	3.0	10	8	0.00	547	12.22
2000	12.0	12.0	27	6.99	6.99	3.0	8	8	0.00	547	12.00
2000	12.5	10.5	28	6.35	7.56	3.0	9	9	0.00	516	11.34
2000	14.0	9.0	31	6.02	9.37	3.0	9	9	0.00	547	12.05
2000	15.5	7.5	34	5.50	11.38	3.0	10	9	0.00	552	12.19
2000	18.5	6.0	41	5.31	16.38	3.0	11	8	0.00	632	14.04

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 1000 PSF
CONC. = 3000 PSI

TABLE 3-1-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
250	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
250	11.0	8.5	24	4.40	5.70	3.0	8	8	0.00	312	6.92
250	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
250	16.0	6.0	35	4.53	12.09	3.0	10	8	0.00	465	10.37
250	20.0	5.0	44	4.75	19.00	3.0	11	7	0.00	606	13.58
500	10.0	10.0	22	4.75	4.75	3.0	7	7	0.00	307	6.79
500	11.5	8.5	26	4.77	6.45	3.0	8	8	0.00	354	7.84
500	13.0	7.5	29	4.69	8.14	3.0	9	8	0.00	393	8.72
500	16.0	6.0	35	4.53	12.09	3.0	10	8	0.00	465	10.37
500	20.0	5.0	44	4.75	19.00	3.0	11	7	0.00	606	13.58
750	10.5	10.5	23	5.21	5.21	3.0	8	8	0.00	355	7.82
750	12.0	9.0	27	5.24	6.99	3.0	8	8	0.00	407	9.00
750	14.0	7.5	31	5.02	9.37	3.0	9	9	0.00	453	10.04
750	15.5	6.5	34	4.77	11.38	3.0	10	8	0.00	476	10.57
750	20.0	5.0	44	4.75	19.00	3.0	11	7	0.00	606	13.58
1000	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
1000	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
1000	14.0	8.0	31	5.35	9.37	3.0	10	9	0.00	485	10.71
1000	16.5	6.5	36	5.05	12.83	3.0	11	8	0.00	537	11.91
1000	18.5	5.5	41	4.87	16.38	3.0	10	8	0.00	577	12.87
1250	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
1250	12.5	10.0	28	6.04	7.56	3.0	8	9	0.00	491	10.80
1250	14.0	8.5	31	5.69	9.37	3.0	9	9	0.00	516	11.38
1250	16.0	7.0	35	5.29	12.09	3.0	9	9	0.00	546	12.09
1250	19.5	5.5	43	5.10	18.11	3.0	11	8	0.00	638	14.23
1500	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
1500	13.0	10.0	29	6.26	8.14	3.0	8	8	0.00	529	11.63
1500	14.5	8.5	32	5.87	10.02	3.0	9	9	0.00	552	12.17
1500	17.0	7.0	38	5.74	13.95	3.0	10	9	0.00	631	13.95
1500	20.0	5.5	44	5.22	19.00	3.0	11	8	0.00	670	14.93
2000	12.5	12.5	28	7.56	7.56	3.0	9	9	0.00	617	13.50
2000	13.5	10.5	30	6.80	8.74	3.0	9	9	0.00	598	13.12
2000	15.0	9.0	33	6.41	10.69	3.0	9	9	0.00	625	13.75
2000	17.0	7.5	38	6.15	13.95	3.0	10	9	0.00	678	14.95
2000	20.0	6.0	44	5.70	19.00	3.0	11	8	0.00	734	16.29

TABLE 3-1-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
250	10.5	10.5	23	5.21	5.21	3.0	8	8	0.00	355	7.82
250	13.0	9.0	29	5.63	8.14	3.0	9	8	0.00	475	10.47
250	16.0	7.5	35	5.67	12.09	3.0	10	9	0.00	587	12.96
250	18.0	6.5	40	5.61	15.55	3.0	11	8	0.00	651	14.44
250	24.0	5.0	52	5.72	27.47	3.0	11	7	0.00	878	19.62
500	11.0	11.0	24	5.70	5.70	3.0	8	8	0.00	407	8.96
500	12.0	9.5	27	5.54	6.99	3.0	9	8	0.00	431	9.50
500	15.0	8.0	33	5.70	10.69	3.0	10	9	0.00	554	12.22
500	18.0	6.5	40	5.61	15.55	3.0	11	8	0.00	651	14.44
500	21.0	5.5	46	5.46	20.86	3.0	11	8	0.00	736	16.39
750	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
750	12.5	10.0	28	6.04	7.56	3.0	8	9	0.00	491	10.80
750	14.0	8.5	31	5.69	9.37	3.0	9	9	0.00	516	11.38
750	17.0	7.0	38	5.74	13.95	3.0	10	9	0.00	631	13.95
750	21.0	5.5	46	5.46	20.86	3.0	11	8	0.00	736	16.39
1000	11.5	11.5	26	6.45	6.45	3.0	8	8	0.00	483	10.61
1000	13.0	10.0	29	6.26	8.14	3.0	8	8	0.00	529	11.63
1000	15.0	8.5	33	6.05	10.69	3.0	9	9	0.00	590	12.98
1000	17.5	7.0	39	5.89	14.74	3.0	10	9	0.00	667	14.74
1000	21.0	5.5	46	5.46	20.86	3.0	11	8	0.00	736	16.39
1250	12.0	12.0	27	6.99	6.99	3.0	8	8	0.00	547	12.00
1250	13.0	10.5	29	6.57	8.14	3.0	9	8	0.00	556	12.21
1250	14.5	9.0	32	6.22	10.02	3.0	9	9	0.00	586	12.88
1250	17.0	7.5	38	6.15	13.95	3.0	10	9	0.00	678	14.95
1250	20.5	6.0	45	5.83	19.92	3.0	11	8	0.00	769	17.08
1500	12.5	12.5	28	7.56	7.56	3.0	9	9	0.00	617	13.50
1500	13.5	10.5	30	6.80	8.74	3.0	9	9	0.00	598	13.12
1500	15.5	9.0	34	6.60	11.38	3.0	9	9	0.00	666	14.63
1500	17.5	7.5	39	6.31	14.74	3.0	10	9	0.00	716	15.79
1500	21.0	6.0	46	5.96	20.86	3.0	11	8	0.00	806	17.88
2000	13.0	13.0	29	8.14	8.14	3.0	8	8	0.00	692	15.12
2000	14.0	11.0	31	7.36	9.37	3.0	9	9	0.00	673	14.73
2000	16.0	9.5	35	7.18	12.09	3.0	10	9	0.00	749	16.41
2000	18.0	8.0	40	6.91	15.55	3.0	11	9	0.00	808	17.77
2000	21.0	6.5	46	6.45	20.86	3.0	11	8	0.00	876	19.37

FOOTING DE N TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	7	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	8	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	9	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	8	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	9	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	8	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	9	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	8	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	9	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	8	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	32	*6.56	10.02	7.5	9	9	0.07	619	13.60
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 3-2-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	8	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	7	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	8	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	7	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	8	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	7	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.08	337	7.50
1000	12.5	6.5	29	*4.41	7.83	7.5	10	8	0.08	340	7.27
1000	14.0	5.0	32	*3.45	9.67	7.5	11	7	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	8	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	31	*4.85	9.03	7.5	9	9	0.11	414	9.04
1500	15.0	5.5	33	*4.90	10.69	7.5	10	8	0.11	423	8.40
2000	12.0	12.0	27	*8.53	*6.99	7.5	9	8	0.11	607	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	30	*5.83	8.74	7.5	9	9	0.11	511	11.25
2000	14.5	7.5	32	*5.18	10.02	7.5	9	9	0.11	485	10.74
2000	15.5	6.0	35	*5.37	11.71	7.5	11	8	0.13	493	10.04

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	7	7	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	7	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	7	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.09	243	5.44
750	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	7	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	27	*4.26	6.99	7.5	10	8	0.11	298	6.00
1000	13.0	5.0	29	*3.13	8.14	7.5	10	7	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*3.97	7.56	7.5	9	8	0.12	316	7.02
1250	13.5	5.0	31	*5.05	9.03	7.5	11	7	0.14	362	6.45
1500	11.0	11.0	24	*6.46	*5.70	7.5	9	8	0.11	434	8.96
1500	11.5	9.5	26	*5.33	6.45	7.5	9	8	0.11	397	8.76
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	30	*4.72	8.42	7.5	10	8	0.13	372	7.82
1500	14.0	5.5	31	*4.61	9.37	7.5	10	8	0.14	371	7.36
2000	11.5	11.5	27	*7.28	*6.70	7.5	8	8	0.13	523	11.02
2000	12.0	10.0	29	*6.26	7.51	7.5	8	9	0.14	488	10.74
2000	13.0	8.5	30	*5.50	8.42	7.5	9	9	0.13	463	10.23
2000	14.0	7.0	31	*5.74	9.37	7.5	10	9	0.14	471	9.37
2000	15.0	5.5	34	*7.08	11.01	7.5	11	8	0.17	537	8.65

TABLE 3-2-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	1.74	2.91	7.5	8	7	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	8.5	3.0	20	*1.59	3.67	7.5	10	5	0.13	74	1.57
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.45
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.30
500	9.0	5.0	22	*2.37	4.27	7.5	9	7	0.13	134	3.05
500	10.0	4.0	22	*2.51	4.75	7.5	9	6	0.14	137	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.0	7.5	22	*3.56	4.27	7.5	8	8	0.13	204	4.58
750	9.5	6.5	23	*3.22	4.71	7.5	9	8	0.13	195	4.38
750	10.0	5.5	24	*3.34	5.18	7.5	9	8	0.15	196	4.07
750	11.0	4.5	24	*3.86	5.70	7.5	11	7	0.15	215	3.66
1000	9.5	9.5	21	*4.38	*4.30	7.5	8	8	0.12	266	5.84
1000	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.12	255	5.67
1000	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.13	243	5.44
1000	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.13	225	5.07
1000	12.0	4.5	27	*4.20	6.99	7.5	11	7	0.17	259	4.50
1250	10.0	10.0	22	*6.54	*5.05	7.5	9	8	0.14	374	6.79
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.88
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.62
1250	11.5	6.0	28	*4.15	6.95	7.5	10	8	0.17	285	5.96
1250	12.5	5.0	28	*5.05	7.56	7.5	11	7	0.18	322	5.40
1500	10.5	10.5	23	*6.74	*5.21	7.5	9	8	0.14	407	7.82
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.94
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.45
1500	12.0	6.5	29	*4.07	7.51	7.5	10	8	0.17	312	6.98
1500	13.0	5.0	31	*5.45	8.70	7.5	11	7	0.20	365	6.21
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.93
2000	12.0	8.5	30	*5.50	7.77	7.5	9	9	0.16	427	9.44
2000	13.0	7.0	31	*4.68	8.70	7.5	9	9	0.17	391	8.70
2000	14.0	5.5	33	*5.50	9.97	7.5	11	8	0.20	422	7.84

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA (SQ.IN.) X	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	13	*1.73	*1.56	7.5	6	6	0.17	56	1.21
250	6.0	4.5	14	*1.36	1.81	7.5	7	6	0.15	50	1.16
250	6.0	4.0	15	*1.29	1.94	7.5	7	6	0.18	47	1.11
250	6.5	3.0	15	*1.09	2.10	7.5	8	5	0.21	40	0.90
250	7.0	2.5	16	*0.86	2.41	7.5	8	4	0.19	35	0.86
500	7.0	7.0	17	*2.59	*2.57	7.5	7	7	0.17	114	2.57
500	7.5	6.0	18	*2.33	2.91	7.5	7	7	0.15	110	2.50
500	8.0	5.0	18	*1.94	3.11	7.5	8	7	0.17	97	2.22
500	8.5	4.0	19	*1.76	3.48	7.5	8	6	0.19	89	1.99
500	9.0	3.5	20	*1.51	3.88	7.5	10	6	0.17	83	1.94
750	8.0	8.0	19	*3.70	*3.28	7.5	8	7	0.17	178	3.75
750	8.5	7.0	20	*3.02	3.67	7.5	7	7	0.16	163	3.67
750	9.0	6.0	21	*2.72	4.08	7.5	8	7	0.15	155	3.50
750	9.5	5.0	21	*2.56	4.30	7.5	9	7	0.18	144	3.07
750	10.0	4.0	22	*3.02	4.75	7.5	10	6	0.22	154	2.71
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.5	7.5	21	*3.40	4.30	7.5	8	8	0.15	206	4.61
1000	9.5	6.5	24	*3.36	4.92	7.5	9	8	0.18	203	4.57
1000	10.5	5.5	23	*2.75	5.21	7.5	8	8	0.17	182	4.09
1000	11.0	4.5	24	*3.26	5.70	7.5	10	7	0.21	194	3.66
1250	9.5	9.5	21	*5.53	*4.30	7.5	9	8	0.16	301	5.84
1250	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.17	255	5.67
1250	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.17	243	5.44
1250	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.16	225	5.07
1250	12.0	4.5	27	*3.13	6.99	7.5	10	7	0.21	217	4.50
1500	10.0	10.0	22	*6.86	*5.28	7.5	9	8	0.17	392	6.79
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.66	6.95	7.5	9	8	0.20	267	5.96
1500	12.5	5.0	28	*3.62	7.56	7.5	11	7	0.21	263	5.40
2000	11.0	11.0	24	*5.82	*5.70	7.5	8	8	0.15	411	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	12.0	8.0	28	*4.83	7.25	7.5	9	8	0.17	374	8.29
2000	12.5	6.5	30	*5.00	8.10	7.5	11	8	0.21	369	7.52
2000	13.5	5.5	30	*5.00	8.74	7.5	11	8	0.22	370	6.87

TABLE 3-2-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA (SQ.IN.) X	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.0	5.0	13	*1.40	1.40	7.5	7	7	0.10	42	1.00
250	5.0	4.0	13	*1.12	1.40	7.5	6	6	0.17	33	0.80
250	5.5	3.5	14	*1.05	1.66	7.5	8	6	0.09	34	0.83
250	5.5	3.0	14	*0.96	1.66	7.5	8	5	0.13	30	0.71
250	6.0	2.5	14	*1.01	1.81	7.5	8	4	0.08	31	0.64
500	6.5	6.5	15	*2.10	*2.10	7.5	7	7	0.18	85	1.95
500	6.5	5.5	16	*1.95	2.24	7.5	7	7	0.23	78	1.76
500	7.0	4.5	17	*1.65	2.57	7.5	7	7	0.22	71	1.65
500	7.5	4.0	17	*1.46	2.75	7.5	7	6	0.19	67	1.57
500	8.0	3.0	18	*1.25	3.11	7.5	9	5	0.22	58	1.33
750	7.5	7.5	17	*3.14	*2.75	7.5	7	7	0.20	140	2.95
750	8.0	6.5	18	*2.52	3.11	7.5	8	7	0.18	128	2.88
750	8.5	5.5	19	*2.25	3.48	7.5	7	7	0.17	120	2.74
750	9.0	4.5	20	*1.94	3.88	7.5	8	7	0.18	109	2.50
750	9.5	3.5	21	*1.65	4.30	7.5	10	6	0.22	94	2.15
1000	8.5	8.5	19	*3.48	3.48	7.5	7	7	0.16	189	4.23
1000	9.0	7.0	20	*3.02	3.88	7.5	7	7	0.17	173	3.88
1000	9.0	6.0	22	*2.85	4.27	7.5	8	8	0.22	162	3.66
1000	10.0	5.0	22	*2.37	4.75	7.5	9	7	0.19	149	3.39
1000	10.5	4.0	23	*2.15	5.21	7.5	9	6	0.23	135	2.98
1250	9.0	9.0	20	*4.81	*3.88	7.5	8	7	0.19	251	5.00
1250	9.5	7.5	22	*3.56	4.51	7.5	8	8	0.20	216	4.83
1250	10.0	6.5	23	*3.22	4.96	7.5	9	7	0.19	205	4.61
1250	10.5	5.5	23	*3.28	5.21	7.5	9	8	0.22	200	4.09
1250	11.5	4.5	26	*2.52	6.45	7.5	9	7	0.18	182	4.15
1500	9.5	9.5	22	*4.83	*4.51	7.5	8	8	0.19	286	6.12
1500	10.0	8.0	24	*4.14	5.18	7.5	8	8	0.20	266	5.92
1500	10.5	7.0	25	*3.78	5.67	7.5	8	8	0.19	254	5.67
1500	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.20	225	5.07
1500	12.0	4.5	27	*3.07	6.99	7.5	10	7	0.24	215	4.50
2000	10.5	10.5	23	*6.86	*5.22	7.5	9	8	0.19	411	7.82
2000	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.18	359	7.94
2000	11.5	7.5	27	*4.51	6.70	7.5	9	8	0.21	328	7.18
2000	12.0	6.5	28	*4.38	7.25	7.5	10	8	0.23	319	6.74
2000	13.5	5.0	30	*3.24	8.74	7.5	10	7	0.20	277	6.25

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	10	0.75	0.75	3.0	6	6	0.00	15	0.37
250	4.5	4.5	14	*1.36	1.36	7.5	7	7	0.00	37	0.87
250	5.0	4.0	13	*1.37	1.40	7.5	7	6	0.00	37	0.80
250	5.5	3.5	12	*0.90	1.42	3.0	8	6	0.00	29	0.71
250	6.0	3.0	14	*0.90	1.81	3.0	8	5	0.00	32	0.77
250	6.5	2.5	15	*0.81	2.10	3.0	7	4	0.00	30	0.75
500	6.0	6.0	15	*1.94	1.94	7.5	7	7	0.02	72	1.66
500	6.0	5.0	15	*1.71	1.94	7.5	8	7	0.07	61	1.38
500	6.5	4.5	16	*1.56	2.24	7.5	7	7	0.00	62	1.44
500	7.0	3.5	17	*1.44	2.57	7.5	9	6	0.00	58	1.28
500	7.5	3.0	17	*1.51	2.75	7.5	9	5	0.00	59	1.18
750	7.0	7.0	16	*2.41	2.41	7.5	6	6	0.12	107	2.41
750	7.0	6.0	16	*2.23	2.41	7.5	7	6	0.17	94	2.07
750	7.5	5.0	17	*2.02	2.75	7.5	8	7	0.14	90	1.96
750	8.0	4.0	18	*1.86	3.11	7.5	8	6	0.12	84	1.77
750	8.5	3.5	19	*1.73	3.48	7.5	10	6	0.07	82	1.74
1000	7.5	7.5	17	*2.91	*2.75	7.5	7	7	0.22	135	2.95
1000	8.0	6.5	18	*2.52	3.11	7.5	8	7	0.19	128	2.88
1000	8.5	5.5	19	*2.25	3.48	7.5	7	7	0.17	120	2.74
1000	9.0	4.5	20	*2.04	3.88	7.5	8	7	0.17	112	2.50
1000	10.0	3.5	22	*1.80	4.75	7.5	11	6	0.10	106	2.37
1250	8.5	8.5	19	*3.48	3.48	7.5	7	7	0.16	189	4.23
1250	8.5	7.0	20	*3.02	3.67	7.5	7	7	0.23	163	3.67
1250	9.0	6.0	20	*2.81	3.88	7.5	8	7	0.23	154	3.33
1250	10.0	5.0	22	*2.37	4.75	7.5	9	7	0.15	149	3.39
1250	10.5	4.0	23	*2.05	5.21	7.5	8	6	0.18	132	2.98
1500	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.18	224	5.00
1500	9.5	7.5	21	*3.40	4.30	7.5	8	8	0.19	206	4.61
1500	10.0	6.5	22	*3.08	4.75	7.5	8	7	0.18	196	4.41
1500	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.19	181	4.09
1500	11.0	4.5	24	*2.36	5.70	7.5	9	7	0.21	162	3.66
2000	10.0	10.0	22	*4.75	*4.75	7.5	7	7	0.19	307	6.79
2000	10.5	8.5	23	*4.22	5.21	7.5	8	8	0.19	285	6.33
2000	11.0	7.5	24	*3.88	5.70	7.5	8	8	0.19	274	6.11
2000	11.5	6.0	26	*3.36	6.45	7.5	9	8	0.22	246	5.53
2000	12.5	5.0	28	*3.02	7.56	7.5	10	7	0.18	239	5.40

TABLE 3-2-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	11	0.95	0.95	3.0	6	6	0.00	22	0.54
250	5.0	5.0	11	*1.18	*1.18	3.0	6	6	0.00	36	0.84
250	5.5	4.0	12	*1.07	1.42	3.0	6	6	0.00	35	0.81
250	6.0	3.5	14	*1.05	1.81	3.0	8	6	0.00	38	0.90
250	7.0	3.0	16	*1.03	2.41	3.0	8	5	0.00	43	1.03
250	7.5	2.5	17	*0.91	2.75	3.0	8	4	0.00	40	0.98
500	6.0	6.0	17	*2.20	2.20	7.5	7	7	0.00	82	1.88
500	6.0	5.0	15	*1.96	1.94	7.5	8	7	0.00	66	1.38
500	6.5	4.5	16	*1.80	2.24	7.5	8	7	0.00	67	1.44
500	7.5	3.5	17	*1.28	2.75	3.0	9	6	0.00	58	1.37
500	8.5	3.0	19	*1.23	3.48	3.0	9	5	0.00	63	1.49
750	6.5	6.5	17	*2.38	2.38	7.5	7	7	0.00	97	2.21
750	7.0	5.5	17	*2.15	2.57	7.5	7	7	0.00	91	2.02
750	7.5	4.5	18	*2.00	2.91	7.5	8	7	0.00	87	1.87
750	8.0	4.0	19	*1.89	3.28	7.5	8	6	0.00	87	1.87
750	9.5	3.0	21	*1.79	4.30	7.5	10	5	0.00	91	1.84
1000	7.0	7.0	16	*3.04	*2.41	7.5	7	6	0.15	120	2.41
1000	7.5	6.0	18	*2.47	2.91	7.5	7	7	0.09	113	2.50
1000	8.5	5.0	19	*2.40	3.48	7.5	9	7	0.00	118	2.49
1000	9.5	4.0	21	*2.11	4.30	7.5	9	6	0.00	116	2.46
1000	10.0	3.5	22	*2.01	4.75	7.5	11	6	0.00	113	2.37
1250	8.0	8.0	18	*3.11	*3.11	7.5	7	7	0.12	158	3.55
1250	8.0	7.0	18	*3.05	3.11	7.5	7	7	0.16	146	3.11
1250	8.5	6.0	20	*2.59	3.67	7.5	8	7	0.12	139	3.14
1250	9.5	5.0	21	*2.49	4.30	7.5	9	7	0.02	142	3.07
1250	10.5	4.0	23	*2.24	5.21	7.5	9	6	0.00	138	2.98
1500	8.5	8.5	19	*3.48	*3.48	7.5	7	7	0.16	189	4.23
1500	9.0	7.0	20	*3.05	3.88	7.5	7	7	0.15	174	3.88
1500	9.5	6.0	21	*2.86	4.30	7.5	8	8	0.13	168	3.69
1500	10.0	5.0	22	*2.70	4.75	7.5	10	7	0.12	160	3.39
1500	11.0	4.0	24	*2.46	5.70	7.5	9	6	0.05	155	3.25
2000	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.18	263	5.84
2000	10.0	8.0	22	*3.80	4.75	7.5	8	7	0.18	244	5.43
2000	10.5	7.0	23	*3.47	5.21	7.5	8	8	0.16	233	5.21
2000	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.11	225	5.07
2000	12.0	4.5	27	*2.65	6.99	7.5	9	7	0.13	199	4.50

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER- BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	12	1.16	*1.16	3.0	6	6	0.00	31	0.75
250	5.5	5.5	13	*1.54	1.54	3.0	6	6	0.00	52	1.21
250	6.0	4.5	14	*1.36	1.81	3.0	7	6	0.00	50	1.16
250	6.5	4.0	15	*1.29	2.10	3.0	7	6	0.00	51	1.20
250	8.0	3.0	18	*1.16	3.11	3.0	9	5	0.00	56	1.33
250	9.0	2.5	20	*1.12	3.88	3.0	9	4	0.00	58	1.38
500	6.0	6.0	14	*1.81	1.81	3.0	6	6	0.00	67	1.55
500	6.5	5.0	15	*1.62	2.10	3.0	7	7	0.00	65	1.50
500	7.0	4.5	16	*1.55	2.41	3.0	7	6	0.00	67	1.55
500	8.5	3.5	19	*1.43	3.48	3.0	10	6	0.00	74	1.74
500	9.5	3.0	21	*1.36	4.30	3.0	10	5	0.00	78	1.84
750	6.5	6.5	18	*2.52	2.52	7.5	8	8	0.00	103	2.34
750	7.0	5.5	17	*2.39	2.57	7.5	7	7	0.00	96	2.02
750	8.0	4.5	18	*1.74	3.11	3.0	8	7	0.00	86	2.00
750	8.5	4.0	19	*1.64	3.48	3.0	7	6	0.00	86	1.99
750	10.5	3.0	23	*1.49	5.21	3.0	10	5	0.00	95	2.23
1000	7.0	7.0	18	*2.72	2.72	7.5	7	7	0.00	120	2.72
1000	7.5	6.0	18	*2.68	2.91	7.5	8	7	0.00	118	2.50
1000	8.5	5.0	20	*2.39	3.67	7.5	9	7	0.00	121	2.62
1000	9.5	4.0	21	*2.38	4.30	7.5	9	6	0.00	124	2.46
1000	10.5	3.5	23	*1.73	5.21	3.0	11	6	0.00	112	2.60
1250	7.5	7.5	18	*3.14	*2.91	7.5	7	7	0.05	144	3.12
1250	8.0	6.5	18	*3.28	3.11	7.5	9	7	0.00	147	2.88
1250	9.0	5.5	20	*2.85	3.88	7.5	8	7	0.00	148	3.05
1250	10.0	4.5	22	*2.57	4.75	7.5	9	7	0.00	148	3.05
1250	11.5	3.5	26	*2.17	6.45	7.5	11	6	0.00	147	3.22
1500	8.0	8.0	18	*3.73	*3.11	7.5	8	7	0.12	174	3.55
1500	8.5	7.0	19	*3.47	3.48	7.5	8	7	0.07	171	3.48
1500	9.0	6.0	21	*3.01	4.08	7.5	8	7	0.02	163	3.50
1500	10.0	5.0	22	*2.92	4.75	7.5	10	7	0.00	167	3.39
1500	11.5	4.0	26	*2.40	6.45	7.5	9	6	0.00	166	3.69
2000	9.0	9.0	20	*4.07	*3.88	7.5	7	7	0.17	230	5.00
2000	9.5	7.5	21	*3.83	4.30	7.5	8	8	0.16	219	4.61
2000	10.5	6.5	23	*3.42	5.21	7.5	9	8	0.05	223	4.84
2000	11.0	5.5	24	*3.28	5.70	7.5	9	8	0.04	214	4.48
2000	12.0	4.5	27	*2.84	6.99	7.5	10	7	0.00	206	4.50

TABLE 3-2-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER- BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	14	1.51	1.51	3.0	7	7	0.00	46	1.08
250	5.5	5.5	14	*1.66	1.66	3.0	6	6	0.00	56	1.30
250	6.5	4.5	15	*1.45	2.10	3.0	7	7	0.00	58	1.35
250	7.0	4.0	16	*1.38	2.41	3.0	7	6	0.00	59	1.38
250	9.0	3.0	20	*1.33	3.88	3.0	9	5	0.00	71	1.66
250	10.0	2.5	22	*1.33	4.75	3.0	10	4	0.00	75	1.69
500	6.5	6.5	15	*2.10	2.10	3.0	7	7	0.00	85	1.95
500	6.5	5.5	15	*1.78	2.10	3.0	6	7	0.00	72	1.65
500	7.5	4.5	17	*1.65	2.75	3.0	7	7	0.00	76	1.77
500	8.5	4.0	19	*1.64	3.48	3.0	7	6	0.00	86	1.99
500	10.0	3.0	22	*1.53	4.75	3.0	10	5	0.00	90	2.03
750	7.0	7.0	16	*2.41	2.41	3.0	6	6	0.00	107	2.41
750	7.0	6.0	16	*2.07	2.41	3.0	7	6	0.00	91	2.07
750	8.0	5.0	18	*1.94	3.11	3.0	8	7	0.00	97	2.22
750	9.5	4.0	21	*1.81	4.30	3.0	8	6	0.00	106	2.46
750	10.0	3.5	22	*1.73	4.75	3.0	11	6	0.00	104	2.37
1000	7.5	7.5	20	*3.24	3.24	7.5	7	7	0.00	154	3.47
1000	7.5	6.5	18	*2.92	2.91	7.5	8	7	0.00	129	2.70
1000	8.5	5.5	19	*2.25	3.48	3.0	7	7	0.00	120	2.74
1000	9.5	4.5	21	*2.04	4.30	3.0	8	7	0.00	121	2.77
1000	11.0	3.5	24	*1.87	5.70	3.0	11	6	0.00	125	2.85
1250	7.5	7.5	20	*3.24	3.24	7.5	7	7	0.00	154	3.47
1250	8.5	6.5	19	*3.27	3.48	7.5	9	7	0.00	160	3.23
1250	9.0	5.5	21	*2.85	4.08	7.5	8	7	0.00	152	3.20
1250	10.5	4.5	23	*2.23	5.21	3.0	9	7	0.00	147	3.35
1250	12.0	3.5	27	*2.04	6.99	3.0	11	6	0.00	151	3.50
1500	8.0	8.0	20	*3.45	3.45	7.5	8	8	0.00	176	3.95
1500	8.5	7.0	19	*3.70	3.48	7.5	8	7	0.00	177	3.48
1500	9.5	6.0	21	*3.29	4.30	7.5	9	8	0.00	181	3.69
1500	10.5	5.0	23	*3.02	5.21	7.5	10	7	0.00	182	3.72
1500	12.0	4.0	27	*2.33	6.99	3.0	9	6	0.00	174	4.00
2000	9.0	9.0	20	*4.26	*3.88	7.5	8	7	0.04	235	5.00
2000	9.5	7.5	21	*4.05	4.30	7.5	8	8	0.02	226	4.61
2000	10.0	6.5	23	*3.56	4.96	7.5	9	7	0.00	216	4.61
2000	11.0	5.5	24	*3.48	5.70	7.5	9	8	0.00	221	4.48
2000	12.5	4.5	28	*2.94	7.56	7.5	10	7	0.00	223	4.86

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	15	1.78	1.78	3.0	6	6	0.00	60	1.40
250	6.0	6.0	15	*1.94	1.94	3.0	7	7	0.00	72	1.66
250	6.5	5.0	15	*1.62	2.10	3.0	7	7	0.00	65	1.50
250	7.0	4.5	16	*1.56	2.41	3.0	7	6	0.00	67	1.55
250	9.0	3.5	20	*1.56	3.88	3.0	10	6	0.00	84	1.94
250	10.0	3.0	22	*1.56	4.75	3.0	10	5	0.00	91	2.03
500	6.5	6.5	16	*2.24	2.24	3.0	7	7	0.00	91	2.08
500	7.0	5.5	16	*1.90	2.41	3.0	7	6	0.00	83	1.90
500	8.5	4.5	19	*1.84	3.48	3.0	8	7	0.00	97	2.24
500	9.0	4.0	20	*1.77	3.88	3.0	8	6	0.00	97	2.22
500	11.5	3.0	26	*1.68	6.45	3.0	11	5	0.00	118	2.76
750	7.0	7.0	16	*2.41	2.41	3.0	6	6	0.00	107	2.41
750	7.5	6.0	17	*2.20	2.75	3.0	7	7	0.00	104	2.36
750	8.5	5.0	19	*2.05	3.48	3.0	8	7	0.00	109	2.49
750	10.0	4.0	22	*1.96	4.75	3.0	8	6	0.00	119	2.71
750	11.0	3.5	24	*1.92	5.70	3.0	11	6	0.00	126	2.85
1000	7.5	7.5	17	*2.75	2.75	3.0	7	7	0.00	131	2.95
1000	8.0	6.5	18	*2.52	3.11	3.0	8	7	0.00	128	2.88
1000	9.0	5.5	20	*2.37	3.88	3.0	7	7	0.00	134	3.05
1000	10.0	4.5	22	*2.15	4.75	3.0	9	7	0.00	134	3.05
1000	12.0	3.5	27	*2.04	6.99	3.0	11	6	0.00	151	3.50
1250	8.0	8.0	21	*3.62	3.62	7.5	8	8	0.00	185	4.14
1250	8.0	7.0	20	*3.10	3.45	7.5	7	8	0.00	155	3.45
1250	9.0	6.0	20	*2.59	3.88	3.0	8	7	0.00	147	3.33
1250	10.0	5.0	22	*2.37	4.75	3.0	9	7	0.00	149	3.39
1250	11.5	4.0	26	*2.24	6.45	3.0	9	6	0.00	161	3.69
1500	8.0	8.0	21	*3.62	3.62	7.5	8	8	0.00	185	4.14
1500	9.0	7.0	20	*3.73	3.88	7.5	8	7	0.00	193	3.88
1500	9.5	6.0	22	*3.30	4.51	7.5	9	8	0.00	185	3.87
1500	11.0	5.0	24	*2.59	5.70	3.0	9	7	0.00	179	4.07
1500	12.5	4.0	28	*2.41	7.56	3.0	9	6	0.00	188	4.32
2000	9.0	9.0	22	*4.27	4.27	7.5	8	8	0.00	247	5.50
2000	9.5	7.5	21	*4.24	4.30	7.5	9	8	0.00	232	4.61
2000	10.5	6.5	23	*3.84	5.21	7.5	9	8	0.00	237	4.84
2000	11.5	5.5	26	*3.36	6.45	7.5	9	8	0.00	235	5.07
2000	12.5	4.5	28	*3.19	7.56	7.5	10	7	0.00	233	4.86

TABLE 3-2-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	17	2.38	2.38	3.0	7	7	0.00	97	2.21
250	6.5	6.5	17	*2.38	2.38	3.0	7	7	0.00	97	2.21
250	7.5	5.5	17	*2.01	2.75	3.0	7	7	0.00	94	2.16
250	8.5	4.5	19	*2.00	3.48	3.0	8	7	0.00	102	2.24
250	10.0	4.0	22	*2.02	4.75	3.0	8	6	0.00	121	2.71
250	13.0	3.0	29	*1.94	8.14	3.0	11	5	0.00	152	3.49
500	7.0	7.0	18	*2.72	2.72	3.0	7	7	0.00	120	2.72
500	8.0	6.0	18	*2.33	3.11	3.0	7	7	0.00	117	2.66
500	9.0	5.0	20	*2.23	3.88	3.0	9	7	0.00	124	2.77
500	10.5	4.0	23	*2.20	5.21	3.0	9	6	0.00	137	2.98
500	12.0	3.5	27	*2.10	6.99	3.0	11	6	0.00	153	3.50
750	7.5	7.5	18	*2.91	2.91	3.0	7	7	0.00	138	3.12
750	8.0	6.5	18	*2.52	3.11	3.0	8	7	0.00	128	2.88
750	9.0	5.5	20	*2.44	3.88	3.0	7	7	0.00	136	3.05
750	10.5	4.5	23	*2.39	5.21	3.0	9	7	0.00	152	3.35
750	13.0	3.5	29	*2.25	8.14	3.0	11	6	0.00	178	4.07
1000	8.0	8.0	18	*3.11	3.11	3.0	7	7	0.00	158	3.55
1000	8.5	7.0	19	*2.87	3.48	3.0	7	7	0.00	155	3.48
1000	9.5	6.0	21	*2.72	4.30	3.0	8	8	0.00	163	3.69
1000	10.5	5.0	23	*2.58	5.21	3.0	9	7	0.00	167	3.72
1000	12.5	4.0	28	*2.41	7.56	3.0	9	6	0.00	188	4.32
1250	8.0	8.0	18	*3.11	3.11	3.0	7	7	0.00	158	3.55
1250	9.0	7.0	20	*3.02	3.88	3.0	7	7	0.00	173	3.88
1250	10.0	6.0	22	*2.85	4.75	3.0	8	7	0.00	181	4.07
1250	11.0	5.0	24	*2.74	5.70	3.0	10	7	0.00	185	4.07
1250	13.0	4.0	29	*2.54	8.14	3.0	9	6	0.00	205	4.65
1500	8.5	8.5	19	*3.48	3.48	3.0	7	7	0.00	189	4.23
1500	9.5	7.0	21	*3.17	4.30	3.0	7	8	0.00	192	4.31
1500	10.5	6.0	23	*2.98	5.21	3.0	8	8	0.00	199	4.47
1500	12.0	5.0	27	*2.91	6.99	3.0	10	7	0.00	221	5.00
1500	14.0	4.0	31	*2.67	9.37	3.0	10	6	0.00	234	5.35
2000	9.0	9.0	24	*4.66	4.66	7.5	8	8	0.00	269	6.00
2000	10.0	7.5	22	*3.56	4.75	3.0	8	7	0.00	228	5.09
2000	11.0	6.5	24	*3.36	5.70	3.0	9	8	0.00	236	5.29
2000	12.0	5.5	27	*3.20	6.99	3.0	9	8	0.00	244	5.50
2000	14.0	4.5	31	*3.01	9.37	3.0	10	7	0.00	266	6.02

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 2000 PSF
CONC. = 3000 PSI

TABLE 3-2-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	7.5	7.5	20	3.24	3.24	3.0	7	7	0.00	154	3.47
250	7.0	7.0	19	*2.87	2.87	3.0	7	7	0.00	127	2.87
250	8.0	6.0	18	*2.44	3.11	3.0	7	7	0.00	120	2.66
250	10.0	5.0	22	*2.46	4.75	3.0	9	7	0.00	152	3.39
250	12.0	4.0	27	*2.38	6.99	3.0	9	6	0.00	176	4.00
250	14.0	3.5	31	*2.41	9.37	3.0	11	6	0.00	206	4.68
500	7.5	7.5	20	*3.24	3.24	3.0	7	7	0.00	154	3.47
500	8.5	6.5	19	*2.67	3.48	3.0	8	7	0.00	144	3.23
500	9.5	5.5	21	*2.67	4.30	3.0	8	8	0.00	155	3.38
500	11.0	4.5	24	*2.66	5.70	3.0	9	7	0.00	172	3.66
500	14.0	3.5	31	*2.55	9.37	3.0	11	6	0.00	213	4.68
750	8.0	8.0	20	*3.45	3.45	3.0	8	8	0.00	176	3.95
750	8.5	7.0	19	*2.91	3.48	3.0	7	7	0.00	156	3.48
750	9.5	6.0	21	*2.88	4.30	3.0	8	8	0.00	168	3.69
750	11.0	5.0	24	*2.84	5.70	3.0	10	7	0.00	188	4.07
750	13.0	4.0	29	*2.69	8.14	3.0	10	6	0.00	211	4.65
1000	8.5	8.5	20	*3.67	3.67	3.0	7	7	0.00	199	4.45
1000	9.0	7.0	20	*3.10	3.88	3.0	7	7	0.00	175	3.88
1000	10.0	6.0	22	*3.06	4.75	3.0	8	7	0.00	187	4.07
1000	11.5	5.0	26	*2.86	6.45	3.0	10	7	0.00	206	4.61
1000	14.0	4.0	31	*2.82	9.37	3.0	10	6	0.00	241	5.35
1250	8.5	8.5	20	*3.67	3.67	3.0	7	7	0.00	199	4.45
1250	9.5	7.0	21	*3.28	4.30	3.0	7	8	0.00	195	4.31
1250	11.0	6.0	24	*3.20	5.70	3.0	9	8	0.00	221	4.88
1250	12.5	5.0	28	*3.02	7.56	3.0	10	7	0.00	239	5.40
1250	14.5	4.0	32	*2.96	10.02	3.0	10	6	0.00	260	5.72
1500	9.0	9.0	20	*3.88	3.88	3.0	7	7	0.00	224	5.00
1500	10.0	7.5	22	*3.56	4.75	3.0	8	7	0.00	228	5.09
1500	11.0	6.5	24	*3.37	5.70	3.0	9	8	0.00	237	5.29
1500	12.0	5.5	27	*3.20	6.99	3.0	9	8	0.00	244	5.50
1500	14.0	4.5	31	*3.11	9.37	3.0	10	7	0.00	270	6.02
2000	9.5	9.5	21	*4.30	4.30	3.0	8	8	0.00	263	5.84
2000	10.0	8.0	22	*3.85	4.75	3.0	8	7	0.00	245	5.43
2000	11.0	7.0	24	*3.74	5.70	3.0	8	8	0.00	260	5.70
2000	13.0	5.5	29	*3.44	8.14	3.0	9	8	0.00	285	6.39
2000	15.0	4.5	33	*3.34	10.69	3.0	11	7	0.00	310	6.87

TABLE 3-2-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	21	3.62	3.62	3.0	8	8	0.00	185	4.14
250	7.5	7.5	21	3.40	3.40	3.0	8	8	0.00	162	3.64
250	9.0	6.5	20	*2.90	3.88	3.0	8	7	0.00	163	3.61
250	10.0	5.5	22	*2.92	4.75	3.0	8	7	0.00	175	3.73
250	13.0	4.5	29	*2.84	8.14	3.0	10	7	0.00	232	5.23
250	17.0	3.5	38	*2.87	13.95	3.0	11	6	0.00	303	6.97
500	8.0	8.0	21	*3.62	3.62	3.0	8	8	0.00	185	4.14
500	9.0	7.0	20	*3.12	3.88	3.0	7	7	0.00	176	3.88
500	10.0	6.0	22	*3.12	4.75	3.0	8	7	0.00	189	4.07
500	12.0	5.0	27	*2.98	6.99	3.0	10	7	0.00	224	5.00
500	15.0	4.0	33	*3.02	10.69	3.0	10	6	0.00	276	6.11
750	8.5	8.5	22	*4.03	4.03	3.0	7	7	0.00	219	4.90
750	9.5	7.0	21	*3.32	4.30	3.0	7	8	0.00	197	4.31
750	10.5	6.0	23	*3.31	5.21	3.0	9	8	0.00	210	4.47
750	12.5	5.0	28	*3.14	7.56	3.0	10	7	0.00	244	5.40
750	15.0	4.0	33	*3.15	10.69	3.0	10	6	0.00	282	6.11
1000	8.5	8.5	22	*4.03	4.03	3.0	7	7	0.00	219	4.90
1000	10.0	7.0	22	*3.51	4.75	3.0	8	7	0.00	218	4.75
1000	11.5	6.0	26	*3.36	6.45	3.0	9	8	0.00	246	5.53
1000	13.0	5.0	29	*3.29	8.14	3.0	11	7	0.00	264	5.81
1000	15.5	4.0	34	*3.27	11.38	3.0	10	6	0.00	302	6.50
1250	9.0	9.0	22	*4.27	4.27	3.0	8	8	0.00	247	5.50
1250	10.0	7.5	22	*3.71	4.75	3.0	8	7	0.00	233	5.09
1250	11.0	6.5	24	*3.65	5.70	3.0	9	8	0.00	247	5.29
1250	12.5	5.5	28	*3.45	7.56	3.0	9	8	0.00	269	5.94
1250	14.5	4.5	32	*3.42	10.02	3.0	11	7	0.00	299	6.44
1500	9.5	9.5	22	*4.51	4.51	3.0	8	8	0.00	276	6.12
1500	10.0	8.0	22	*3.91	4.75	3.0	8	7	0.00	247	5.43
1500	11.0	7.0	24	*3.83	5.70	3.0	8	8	0.00	263	5.70
1500	13.0	5.5	29	*3.59	8.14	3.0	9	8	0.00	291	6.39
1500	15.5	4.5	34	*3.53	11.38	3.0	11	7	0.00	335	7.31
2000	9.5	9.5	22	*4.51	4.51	3.0	8	8	0.00	276	6.12
2000	11.0	8.0	24	*4.20	5.70	3.0	8	8	0.00	295	6.51
2000	12.0	7.0	27	*4.08	6.99	3.0	8	8	0.00	314	7.00
2000	14.0	5.5	31	*3.84	9.37	3.0	9	8	0.00	336	7.36
2000	16.5	4.5	36	*3.75	12.83	3.0	11	7	0.00	379	8.25

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	7	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	8	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	9	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	8	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	9	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	8	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	9	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	8	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	9	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	8	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	32	*6.56	10.02	7.5	9	9	0.07	619	13.60
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 3-3-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	8	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	7	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	8	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	7	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	8	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	7	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.08	337	7.50
1000	12.5	6.5	29	*4.41	7.83	7.5	10	8	0.08	340	7.27
1000	14.0	5.0	32	*3.45	9.67	7.5	11	7	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	8	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	31	*4.85	9.03	7.5	9	9	0.11	414	9.04
1500	15.0	5.5	33	*4.90	10.69	7.5	10	8	0.11	423	8.40
2000	12.0	12.0	27	*8.53	*6.99	7.5	9	8	0.11	607	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	30	*5.83	8.74	7.5	9	9	0.11	511	11.25
2000	14.5	7.5	32	*5.18	10.02	7.5	9	9	0.11	485	10.74
2000	15.5	6.0	35	*5.37	11.71	7.5	11	8	0.13	493	10.04

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	7	7	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	7	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	7	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.09	243	5.44
750	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	7	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	27	*4.26	6.99	7.5	10	8	0.11	298	6.00
1000	13.0	5.0	29	*3.13	8.14	7.5	10	7	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*3.97	7.56	7.5	9	8	0.12	316	7.02
1250	13.5	5.0	31	*5.05	9.03	7.5	11	7	0.14	362	6.45
1500	11.0	11.0	24	*6.46	*5.70	7.5	9	8	0.11	434	8.96
1500	11.5	9.5	26	*5.33	6.45	7.5	9	8	0.11	397	8.76
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	30	*4.72	8.42	7.5	10	8	0.13	372	7.82
1500	14.0	5.5	31	*4.61	9.37	7.5	10	8	0.14	371	7.36
2000	11.5	11.5	27	*7.28	*6.70	7.5	8	8	0.13	523	11.02
2000	12.0	10.0	29	*6.26	7.51	7.5	8	9	0.14	488	10.74
2000	13.0	8.5	30	*5.50	8.42	7.5	9	9	0.13	463	10.23
2000	14.0	7.0	31	*5.74	9.37	7.5	10	9	0.14	471	9.37
2000	15.0	5.5	34	*7.08	11.01	7.5	11	8	0.17	537	8.65

TABLE 3-3-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	1.74	2.91	7.5	8	7	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	8.5	3.0	20	*1.59	3.67	7.5	10	5	0.13	74	1.57
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.45
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.30
500	9.0	5.0	22	*2.37	4.27	7.5	9	7	0.13	134	3.05
500	10.0	4.0	22	*2.51	4.75	7.5	9	6	0.14	137	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.0	7.5	22	*3.56	4.27	7.5	8	8	0.13	204	4.58
750	9.5	6.5	23	*3.22	4.71	7.5	9	8	0.13	195	4.38
750	10.0	5.5	24	*3.34	5.18	7.5	9	8	0.15	196	4.07
750	11.0	4.5	24	*3.86	5.70	7.5	11	7	0.15	215	3.66
1000	9.5	9.5	21	*4.38	*4.30	7.5	8	8	0.12	266	5.84
1000	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.12	255	5.67
1000	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.13	243	5.44
1000	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.13	225	5.07
1000	12.0	4.5	27	*4.20	6.99	7.5	11	7	0.17	259	4.50
1250	10.0	10.0	22	*6.54	*5.05	7.5	9	8	0.14	374	6.79
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.88
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.62
1250	11.5	6.0	28	*4.15	6.95	7.5	10	8	0.17	285	5.96
1250	12.5	5.0	28	*5.05	7.56	7.5	11	7	0.18	322	5.40
1500	10.5	10.5	23	*6.74	*5.21	7.5	9	8	0.14	407	7.82
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.94
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.45
1500	12.0	6.5	29	*4.07	7.51	7.5	10	8	0.17	312	6.98
1500	13.0	5.0	31	*5.45	8.70	7.5	11	7	0.20	365	6.21
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.93
2000	12.0	8.5	30	*5.50	7.77	7.5	9	9	0.16	427	9.44
2000	13.0	7.0	31	*4.68	8.70	7.5	9	9	0.17	391	8.70
2000	14.0	5.5	33	*5.50	9.97	7.5	11	8	0.20	422	7.84

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	13	*1.73	*1.56	7.5	6	6	0.17	56	1.21
250	5.5	4.5	15	*1.45	1.78	7.5	7	6	0.22	49	1.14
250	6.0	4.0	15	*1.29	1.94	7.5	7	6	0.18	47	1.11
250	6.5	3.0	15	*1.09	2.10	7.5	8	5	0.21	40	0.90
250	7.0	2.5	16	*0.86	2.41	7.5	8	4	0.19	35	0.86
500	7.0	7.0	17	*2.59	*2.57	7.5	7	7	0.17	114	2.57
500	7.0	6.0	20	*2.59	3.02	7.5	8	7	0.19	113	2.59
500	7.5	5.0	20	*2.16	3.24	7.5	9	7	0.20	101	2.31
500	8.0	4.0	21	*1.81	3.62	7.5	8	6	0.23	89	2.07
500	8.5	3.5	20	*2.14	3.67	7.5	10	6	0.24	95	1.83
750	8.0	8.0	19	*3.70	*3.28	7.5	8	7	0.17	178	3.75
750	8.5	7.0	20	*3.02	3.67	7.5	7	7	0.16	163	3.67
750	8.5	6.0	23	*2.98	4.22	7.5	8	8	0.19	160	3.62
750	9.0	5.0	23	*2.66	4.47	7.5	9	7	0.21	145	3.19
750	10.0	4.0	22	*3.02	4.75	7.5	10	6	0.22	154	2.71
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.0	7.5	23	*3.72	4.47	7.5	8	8	0.18	214	4.79
1000	9.5	6.5	24	*3.36	4.92	7.5	9	8	0.18	203	4.57
1000	10.0	5.5	25	*2.97	5.40	7.5	8	8	0.20	187	4.24
1000	10.5	4.5	26	*3.42	5.89	7.5	11	7	0.24	196	3.79
1250	9.5	9.5	21	*5.53	*4.30	7.5	9	8	0.16	301	5.84
1250	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.17	255	5.67
1250	10.0	7.0	26	*3.93	5.61	7.5	8	8	0.19	251	5.61
1250	11.0	5.5	26	*4.05	6.17	7.5	10	8	0.21	250	4.85
1250	11.5	4.5	28	*4.36	6.95	7.5	11	7	0.25	257	4.47
1500	10.0	10.0	22	*6.86	*5.28	7.5	9	8	0.17	392	6.79
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.66	6.95	7.5	9	8	0.20	267	5.96
1500	12.0	5.0	29	*4.98	7.51	7.5	11	7	0.24	310	5.37
2000	11.0	11.0	24	*5.82	*5.70	7.5	8	8	0.15	411	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	11.5	8.0	30	*5.18	7.45	7.5	9	9	0.20	384	8.51
2000	12.5	6.5	30	*5.00	8.10	7.5	11	8	0.21	369	7.52
2000	13.0	5.5	32	*5.17	8.98	7.5	11	8	0.24	372	7.06

TABLE 3-3-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	4.5	4.5	13	*1.26	*1.26	7.5	7	7	0.25	34	0.81
250	4.5	4.0	13	*1.15	*1.26	7.5	6	6	0.31	30	0.72
250	5.0	3.5	14	*1.05	1.51	7.5	7	6	0.20	31	0.75
250	5.0	3.0	14	*0.93	1.51	7.5	7	5	0.26	27	0.64
250	5.5	2.5	15	*0.82	1.78	7.5	7	4	0.18	26	0.63
500	6.5	6.5	15	*2.10	*2.10	7.5	7	7	0.18	85	1.95
500	6.5	5.5	16	*1.95	2.24	7.5	7	7	0.23	78	1.76
500	7.0	4.5	17	*1.65	2.57	7.5	7	7	0.22	71	1.65
500	7.0	4.0	18	*1.55	2.72	7.5	7	6	0.26	66	1.55
500	7.5	3.0	18	*1.50	2.91	7.5	9	5	0.31	60	1.25
750	7.5	7.5	17	*3.14	*2.75	7.5	7	7	0.20	140	2.95
750	7.5	6.5	19	*2.76	3.07	7.5	8	7	0.24	128	2.85
750	8.0	5.5	20	*2.37	3.45	7.5	7	8	0.23	119	2.71
750	8.5	4.5	20	*2.22	3.67	7.5	9	7	0.25	110	2.36
750	9.0	3.5	21	*2.13	4.08	7.5	10	6	0.30	103	2.04
1000	8.0	8.0	20	*4.92	*3.86	7.5	9	8	0.24	224	3.95
1000	8.5	7.0	22	*3.32	4.03	7.5	8	7	0.21	179	4.04
1000	9.0	6.0	22	*2.85	4.27	7.5	8	8	0.22	162	3.66
1000	9.5	5.0	23	*2.48	4.71	7.5	9	7	0.24	148	3.37
1000	10.0	4.0	23	*2.96	4.96	7.5	10	6	0.29	155	2.83
1250	9.0	9.0	20	*4.81	*3.88	7.5	8	7	0.19	251	5.00
1250	9.0	7.5	24	*3.88	4.66	7.5	8	8	0.23	223	5.00
1250	9.5	6.5	25	*3.51	5.13	7.5	9	8	0.23	212	4.76
1250	10.0	5.5	25	*3.33	5.40	7.5	9	8	0.26	199	4.24
1250	11.0	4.5	24	*3.41	5.70	7.5	11	7	0.26	199	3.66
1500	9.5	9.5	22	*4.83	*4.51	7.5	8	8	0.19	286	6.12
1500	10.0	8.0	24	*4.14	5.18	7.5	8	8	0.20	266	5.92
1500	10.0	7.0	26	*3.94	5.61	7.5	8	8	0.24	251	5.61
1500	11.0	5.5	26	*3.98	6.17	7.5	9	8	0.26	247	4.85
1500	11.5	4.5	28	*3.75	6.95	7.5	11	7	0.29	235	4.47
2000	10.5	10.5	23	*6.86	*5.22	7.5	9	8	0.19	411	7.82
2000	10.5	9.0	27	*5.24	6.12	7.5	8	8	0.22	355	7.87
2000	11.5	7.5	27	*4.51	6.70	7.5	9	8	0.21	328	7.18
2000	11.5	6.5	30	*4.59	7.45	7.5	10	8	0.26	324	6.92
2000	13.0	5.0	29	*4.83	8.14	7.5	11	7	0.27	330	5.81

FOOTING DE[illegible]N TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA (SQ.IN.) X	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	3.0	3.0	10	0.64	0.64	3.0	5	5	0.00	11	0.27
250	4.0	4.0	14	*1.20	1.20	7.5	6	6	0.00	28	0.69
250	4.5	3.5	14	*1.05	1.36	7.5	7	6	0.00	28	0.68
250	4.5	3.0	15	*0.97	1.45	7.5	7	5	0.00	25	0.62
250	5.0	2.5	16	*0.86	1.72	7.5	7	4	0.00	24	0.61
250	5.5	2.5	16	0.86	1.90	3.0	8	4	0.00	27	0.67
500	5.5	5.5	14	*1.93	*1.66	7.5	7	6	0.16	61	1.30
500	5.5	4.5	16	*1.55	1.90	7.5	7	7	0.21	52	1.22
500	6.0	4.0	16	*1.49	2.07	7.5	7	6	0.12	52	1.18
500	6.5	3.0	17	*1.39	2.38	7.5	8	5	0.07	48	1.02
500	7.0	2.5	18	*1.31	2.72	7.5	9	4	0.00	47	0.97
750	6.5	6.5	15	*2.65	*2.20	7.5	8	7	0.24	99	1.95
750	6.5	5.5	17	*2.06	2.38	7.5	7	7	0.30	82	1.87
750	7.0	4.5	18	*1.78	2.72	7.5	8	7	0.27	76	1.75
750	7.5	4.0	18	*1.82	2.91	7.5	8	6	0.21	78	1.66
750	8.0	3.0	19	*1.71	3.28	7.5	9	5	0.23	71	1.40
1000	7.5	7.5	17	*2.91	*2.75	7.5	7	7	0.22	135	2.95
1000	7.5	6.5	19	*2.66	3.07	7.5	8	7	0.26	126	2.85
1000	8.0	5.5	19	*2.31	3.28	7.5	7	7	0.25	114	2.58
1000	8.5	4.5	20	*2.04	3.67	7.5	8	7	0.25	105	2.36
1000	9.0	3.5	20	*2.10	3.88	7.5	10	6	0.29	100	1.94
1250	8.0	8.0	18	*4.37	*3.45	7.5	9	8	0.27	199	3.55
1250	8.0	7.0	21	*3.19	3.62	7.5	7	8	0.31	161	3.62
1250	8.5	6.0	22	*2.85	4.03	7.5	8	7	0.29	153	3.46
1250	9.0	5.0	22	*2.58	4.27	7.5	9	7	0.30	140	3.05
1250	9.5	4.0	22	*2.66	4.51	7.5	9	6	0.35	135	2.58
1500	8.5	8.5	20	*5.01	*3.89	7.5	8	7	0.28	242	4.45
1500	9.0	7.0	23	*3.47	4.47	7.5	8	8	0.27	199	4.47
1500	9.5	6.0	23	*3.09	4.71	7.5	8	8	0.28	182	4.04
1500	10.0	5.0	23	*3.15	4.96	7.5	10	7	0.31	178	3.54
1500	10.5	4.0	23	*3.37	5.21	7.5	11	6	0.37	177	2.98
2000	9.5	9.5	23	*5.50	*4.71	7.5	9	8	0.26	313	6.40
2000	10.0	8.0	25	*4.32	5.40	7.5	9	8	0.27	277	6.17
2000	10.5	7.0	26	*3.93	5.89	7.5	8	8	0.26	264	5.89
2000	11.5	5.5	26	*3.50	6.45	7.5	9	8	0.27	241	5.07
2000	12.0	4.5	27	*3.49	6.99	7.5	11	7	0.32	231	4.50

TABLE 3-3-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA (SQ.IN.) X	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	11	0.83	0.83	3.0	6	6	0.00	16	0.41
250	4.5	4.5	11	*1.06	1.06	3.0	6	6	0.00	29	0.68
250	4.5	4.0	10	*1.15	*0.97	3.0	6	6	0.00	27	0.55
250	4.5	3.5	10	*1.16	0.97	3.0	7	6	0.00	25	0.48
250	5.0	3.0	11	*1.12	1.18	3.0	7	5	0.00	27	0.50
250	6.0	2.5	14	*0.94	1.81	3.0	8	4	0.00	30	0.64
500	5.0	5.0	16	*1.72	1.72	7.5	7	7	0.00	52	1.23
500	5.5	4.0	17	*1.46	2.01	7.5	7	6	0.00	49	1.15
500	6.0	3.5	17	*1.50	2.20	7.5	8	6	0.00	50	1.10
500	6.5	3.0	18	*1.43	2.52	7.5	8	5	0.00	50	1.08
500	7.5	2.5	17	*1.16	2.75	3.0	9	4	0.00	46	0.98
750	6.0	6.0	16	*2.24	*2.07	7.5	7	7	0.12	80	1.77
750	6.0	5.0	17	*1.98	2.20	7.5	8	7	0.17	70	1.57
750	6.5	4.5	18	*1.85	2.52	7.5	8	7	0.06	72	1.62
750	7.0	3.5	19	*1.77	2.87	7.5	9	6	0.00	68	1.43
750	7.5	3.0	20	*1.68	3.24	7.5	9	5	0.00	67	1.38
1000	6.5	6.5	16	*3.01	*2.39	7.5	8	7	0.30	110	2.08
1000	7.0	5.5	19	*2.25	2.87	7.5	7	7	0.22	98	2.25
1000	7.5	4.5	20	*2.05	3.24	7.5	8	7	0.17	93	2.08
1000	8.0	4.0	20	*2.12	3.45	7.5	9	6	0.11	95	1.97
1000	9.0	3.0	21	*2.11	4.08	7.5	10	5	0.00	95	1.75
1250	7.5	7.5	17	*3.37	*2.75	7.5	8	7	0.24	145	2.95
1250	7.5	6.5	19	*2.73	3.07	7.5	8	7	0.28	128	2.85
1250	8.0	5.5	20	*2.54	3.45	7.5	8	8	0.25	123	2.71
1250	8.5	4.5	21	*2.39	3.85	7.5	9	7	0.23	117	2.47
1250	9.5	3.5	21	*2.51	4.30	7.5	10	6	0.15	121	2.15
1500	8.0	8.0	18	*4.08	*3.21	7.5	8	7	0.28	186	3.55
1500	8.0	7.0	20	*3.42	3.45	7.5	8	8	0.33	163	3.45
1500	8.5	6.0	22	*2.85	4.03	7.5	8	7	0.29	153	3.46
1500	9.0	5.0	22	*2.64	4.27	7.5	9	7	0.29	142	3.05
1500	10.0	4.0	22	*2.74	4.75	7.5	10	6	0.22	145	2.71
2000	9.0	9.0	20	*5.36	*4.14	7.5	9	7	0.29	275	5.00
2000	9.5	7.5	23	*3.72	4.71	7.5	8	8	0.27	226	5.05
2000	10.0	6.5	23	*3.57	4.96	7.5	9	7	0.27	217	4.61
2000	10.5	5.5	24	*3.26	5.44	7.5	9	8	0.27	203	4.27
2000	11.0	4.5	24	*3.34	5.70	7.5	11	7	0.31	197	3.66

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	12	1.03	1.03	3.0	6	6	0.00	24	0.59
250	4.5	4.5	12	*1.16	*1.16	3.0	6	6	0.00	31	0.75
250	5.0	4.0	11	*1.35	1.18	3.0	7	6	0.00	34	0.67
250	5.0	3.5	12	*1.18	1.29	3.0	7	6	0.00	31	0.64
250	6.0	3.0	14	*1.15	1.81	3.0	8	5	0.00	37	0.77
250	6.5	2.5	15	*1.15	2.10	3.0	8	4	0.00	37	0.75
500	5.0	5.0	17	*1.83	1.83	7.5	7	7	0.00	56	1.31
500	6.0	4.0	14	*1.46	1.81	3.0	7	6	0.00	49	1.03
500	6.5	3.5	15	*1.44	2.10	3.0	8	6	0.00	50	1.05
500	7.0	3.0	16	*1.41	2.41	3.0	9	5	0.00	51	1.03
500	8.0	2.5	18	*1.37	3.11	3.0	9	4	0.00	56	1.11
750	6.0	6.0	18	*2.33	2.33	7.5	7	7	0.00	87	2.00
750	6.0	5.0	17	*2.16	2.20	7.5	8	7	0.00	74	1.57
750	6.5	4.5	18	*2.03	2.52	7.5	8	7	0.00	76	1.62
750	7.5	3.5	20	*1.88	3.24	7.5	9	6	0.00	77	1.62
750	8.0	3.0	21	*1.82	3.62	7.5	9	5	0.00	77	1.55
1000	6.5	6.5	18	*2.52	2.52	7.5	8	8	0.04	103	2.34
1000	6.5	5.5	18	*2.48	2.52	7.5	7	8	0.09	93	1.98
1000	7.5	4.5	20	*2.23	3.24	7.5	9	7	0.00	97	2.08
1000	7.5	4.0	21	*2.05	3.40	7.5	8	6	0.00	89	1.94
1000	9.0	3.0	22	*2.13	4.27	7.5	10	5	0.00	98	1.83
1250	7.0	7.0	18	*3.04	*2.72	7.5	7	7	0.17	127	2.72
1250	7.5	6.0	19	*2.85	3.07	7.5	8	7	0.10	125	2.63
1250	8.0	5.0	21	*2.48	3.62	7.5	9	7	0.03	119	2.59
1250	8.5	4.0	22	*2.40	4.03	7.5	9	6	0.00	113	2.30
1250	9.0	3.5	22	*2.47	4.27	7.5	10	6	0.00	115	2.13
1500	7.5	7.5	18	*3.67	*2.91	7.5	8	7	0.24	157	3.12
1500	8.0	6.5	20	*3.08	3.45	7.5	8	8	0.18	149	3.20
1500	8.5	5.5	22	*2.69	4.03	7.5	8	7	0.12	142	3.17
1500	9.0	4.5	22	*2.78	4.27	7.5	10	7	0.10	138	2.75
1500	10.0	3.5	23	*2.77	4.96	7.5	11	6	0.00	140	2.48
2000	8.5	8.5	19	*4.75	*3.69	7.5	8	7	0.29	230	4.23
2000	9.0	7.0	22	*3.51	4.27	7.5	8	8	0.26	196	4.27
2000	9.5	6.0	23	*3.32	4.71	7.5	9	8	0.24	190	4.04
2000	10.0	5.0	24	*3.17	5.18	7.5	10	7	0.23	181	3.70
2000	11.0	4.0	24	*3.30	5.70	7.5	11	6	0.16	185	3.25

TABLE 3-3-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	13	1.26	*1.26	3.0	7	7	0.00	34	0.81
250	5.0	5.0	14	*1.51	1.51	3.0	7	7	0.00	46	1.08
250	5.0	4.0	12	*1.38	1.29	3.0	7	6	0.00	36	0.74
250	6.0	3.5	14	*1.36	1.81	3.0	8	6	0.00	44	0.90
250	6.5	3.0	15	*1.36	2.10	3.0	8	5	0.00	45	0.90
250	7.5	2.5	17	*1.35	2.75	3.0	9	4	0.00	51	0.98
500	5.5	5.5	14	*1.66	1.66	3.0	6	6	0.00	56	1.30
500	6.0	4.5	14	*1.68	1.81	3.0	8	6	0.00	56	1.16
500	6.5	4.0	15	*1.65	2.10	3.0	7	6	0.00	58	1.20
500	7.5	3.0	17	*1.61	2.75	3.0	9	5	0.00	61	1.18
500	8.5	2.5	19	*1.57	3.48	3.0	10	4	0.00	66	1.24
750	6.0	6.0	19	*2.46	2.46	7.5	7	7	0.00	92	2.11
750	6.5	5.0	18	*2.26	2.52	7.5	8	7	0.00	84	1.80
750	6.5	4.5	19	*2.04	2.66	7.5	8	7	0.00	78	1.71
750	8.0	3.5	18	*1.83	3.11	3.0	9	6	0.00	78	1.55
750	8.5	3.0	19	*1.81	3.48	3.0	10	5	0.00	78	1.49
1000	6.5	6.5	19	*2.66	2.66	7.5	8	8	0.00	108	2.47
1000	6.5	5.5	18	*2.66	2.52	7.5	8	8	0.00	97	1.98
1000	7.5	4.5	21	*2.23	3.40	7.5	9	7	0.00	99	2.18
1000	8.0	4.0	21	*2.34	3.62	7.5	9	6	0.00	103	2.07
1000	9.5	3.0	21	*1.96	4.30	3.0	10	5	0.00	96	1.84
1250	7.0	7.0	20	*3.02	3.02	7.5	7	7	0.00	133	3.02
1250	7.0	6.0	19	*2.96	2.87	7.5	8	7	0.00	119	2.46
1250	7.5	5.0	21	*2.56	3.40	7.5	9	7	0.00	113	2.43
1250	8.5	4.0	22	*2.57	4.03	7.5	9	6	0.00	118	2.30
1250	9.5	3.5	23	*2.57	4.71	7.5	10	6	0.00	127	2.36
1500	7.5	7.5	20	*3.24	3.24	7.5	7	7	0.04	154	3.47
1500	7.5	6.5	19	*3.47	3.07	7.5	9	7	0.10	145	2.85
1500	8.0	5.5	22	*2.81	3.80	7.5	8	8	0.00	136	2.98
1500	9.0	4.5	23	*2.77	4.47	7.5	10	7	0.00	141	2.87
1500	10.0	3.5	24	*2.76	5.18	7.5	11	6	0.00	142	2.59
2000	8.0	8.0	19	*4.52	*3.33	7.5	9	8	0.28	200	3.75
2000	8.5	7.0	22	*3.55	4.03	7.5	8	7	0.20	186	4.04
2000	9.0	6.0	23	*3.39	4.47	7.5	9	8	0.15	181	3.83
2000	9.5	5.0	24	*3.26	4.92	7.5	10	7	0.12	175	3.51
2000	10.5	4.0	25	*3.26	5.67	7.5	10	6	0.00	178	3.24

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H * D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	14	1.36	*1.36	3.0	7	7	0.00	37	0.87
250	5.0	5.0	15	*1.62	1.62	3.0	7	7	0.00	49	1.15
250	6.0	4.0	14	*1.57	1.81	3.0	7	6	0.00	51	1.03
250	6.5	3.5	15	*1.58	2.10	3.0	8	6	0.00	53	1.05
250	7.0	3.0	16	*1.57	2.41	3.0	9	5	0.00	55	1.03
250	8.5	2.5	19	*1.57	3.48	3.0	10	4	0.00	66	1.24
500	5.5	5.5	15	*1.78	1.78	3.0	6	6	0.00	60	1.40
500	6.5	4.5	15	*1.86	2.10	3.0	8	7	0.00	66	1.35
500	7.0	4.0	16	*1.85	2.41	3.0	8	6	0.00	69	1.38
500	8.5	3.0	19	*1.80	3.48	3.0	10	5	0.00	78	1.49
500	9.5	2.5	21	*1.77	4.30	3.0	10	4	0.00	83	1.53
750	6.0	6.0	15	*2.00	1.94	3.0	7	7	0.00	73	1.66
750	6.5	5.0	15	*2.16	2.10	3.0	8	7	0.00	76	1.50
750	7.0	4.5	16	*2.12	2.41	3.0	9	6	0.00	79	1.55
750	8.5	3.5	19	*2.02	3.48	3.0	10	6	0.00	90	1.74
750	9.5	3.0	21	*1.98	4.30	3.0	10	5	0.00	97	1.84
1000	6.5	6.5	20	*2.80	2.80	7.5	8	8	0.00	114	2.60
1000	7.0	5.5	19	*2.75	2.87	7.5	8	7	0.00	109	2.25
1000	8.0	4.5	18	*2.29	3.11	3.0	9	7	0.00	101	2.00
1000	8.5	4.0	19	*2.25	3.48	3.0	9	6	0.00	102	1.99
1000	10.0	3.0	22	*2.15	4.75	3.0	11	5	0.00	110	2.03
1250	7.0	7.0	21	*3.17	3.17	7.5	7	7	0.00	140	3.17
1250	7.0	6.0	19	*3.12	2.87	7.5	8	7	0.00	122	2.46
1250	8.0	5.0	22	*2.65	3.80	7.5	9	7	0.00	125	2.71
1250	9.0	4.0	21	*2.29	4.08	3.0	9	6	0.00	114	2.33
1250	10.0	3.5	22	*2.35	4.75	3.0	11	6	0.00	124	2.37
1500	7.0	7.0	20	*3.23	*3.02	7.5	7	7	0.00	138	3.02
1500	7.5	6.0	21	*3.08	3.40	7.5	8	8	0.00	137	2.91
1500	8.5	5.0	23	*2.85	4.22	7.5	10	7	0.00	142	3.01
1500	9.5	4.0	24	*2.88	4.92	7.5	10	6	0.00	146	2.81
1500	10.5	3.5	25	*2.26	5.67	3.0	11	6	0.00	134	2.83
2000	8.0	8.0	21	*3.88	*3.62	7.5	8	8	0.10	191	4.14
2000	8.5	7.0	21	*4.04	3.85	7.5	8	7	0.04	195	3.85
2000	9.0	6.0	23	*3.60	4.47	7.5	9	8	0.00	187	3.83
2000	9.5	5.0	25	*3.24	5.13	7.5	10	7	0.00	177	3.66
2000	11.0	4.0	25	*3.52	5.94	7.5	11	6	0.00	196	3.39

TABLE 3-3-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	17	2.01	2.01	3.0	7	7	0.00	68	1.58
250	5.5	5.5	17	*2.01	2.01	3.0	7	7	0.00	68	1.58
250	6.0	4.5	14	*2.01	*1.81	3.0	8	6	0.00	62	1.16
250	7.0	4.0	16	*2.01	2.41	3.0	8	6	0.00	73	1.38
250	8.5	3.0	19	*2.02	3.48	3.0	10	5	0.00	84	1.49
250	10.0	2.5	22	*2.02	4.75	3.0	11	4	0.00	97	1.69
500	6.0	6.0	17	*2.20	2.20	3.0	7	7	0.00	82	1.88
500	6.5	5.0	15	*2.30	2.10	3.0	8	7	0.00	79	1.50
500	7.0	4.5	16	*2.28	2.41	3.0	9	6	0.00	83	1.55
500	8.5	3.5	19	*2.24	3.48	3.0	10	6	0.00	96	1.74
500	9.5	3.0	21	*2.23	4.30	3.0	10	5	0.00	104	1.84
750	6.5	6.5	17	*2.38	2.38	3.0	7	7	0.00	97	2.21
750	7.0	5.5	16	*2.55	2.41	3.0	8	6	0.00	97	1.90
750	8.0	4.5	18	*2.49	3.11	3.0	9	7	0.00	106	2.00
750	8.5	4.0	19	*2.48	3.48	3.0	9	6	0.00	109	1.99
750	10.5	3.0	23	*2.40	5.21	3.0	11	5	0.00	126	2.23
1000	6.5	6.5	17	*2.43	2.38	3.0	7	7	0.00	98	2.21
1000	7.5	5.5	17	*2.77	2.75	3.0	8	7	0.00	113	2.16
1000	8.5	4.5	19	*2.70	3.48	3.0	10	7	0.00	121	2.24
1000	9.5	4.0	21	*2.64	4.30	3.0	9	6	0.00	132	2.46
1000	11.5	3.0	26	*2.43	6.45	3.0	11	5	0.00	146	2.76
1250	7.0	7.0	18	*2.72	2.72	3.0	7	7	0.00	120	2.72
1250	7.5	6.0	17	*3.03	2.75	3.0	8	7	0.00	123	2.36
1250	8.5	5.0	19	*2.93	3.48	3.0	10	7	0.00	133	2.49
1250	10.0	4.0	22	*2.81	4.75	3.0	10	6	0.00	147	2.71
1250	11.0	3.5	24	*2.74	5.70	3.0	11	6	0.00	156	2.85
1500	7.5	7.5	23	*3.72	3.72	7.5	8	8	0.00	177	3.99
1500	7.5	6.5	21	*3.44	3.40	7.5	9	8	0.00	151	3.15
1500	8.5	5.5	19	*3.15	3.48	3.0	8	7	0.00	145	2.74
1500	9.5	4.5	21	*3.05	4.30	3.0	10	7	0.00	152	2.77
1500	11.5	3.5	26	*2.75	6.45	3.0	11	6	0.00	169	3.22
2000	8.0	8.0	23	*3.97	3.97	7.5	8	8	0.00	202	4.54
2000	8.5	7.0	22	*4.08	4.03	7.5	8	7	0.00	200	4.04
2000	9.0	6.0	24	*3.69	4.66	7.5	9	8	0.00	194	4.00
2000	10.0	5.0	26	*3.51	5.61	7.5	11	7	0.00	199	4.01
2000	11.5	4.0	26	*3.08	6.45	3.0	10	6	0.00	192	3.69

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 3000 PSF
CONC. = 3000 PSI

TABLE 3-3-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.0	6.0	19	2.46	2.46	3.0	7	7	0.00	92	2.11
250	6.0	6.0	19	2.46	2.46	3.0	7	7	0.00	92	2.11
250	6.5	5.0	16	*2.22	2.24	3.0	8	7	0.00	79	1.60
250	7.0	4.5	17	*2.25	2.57	3.0	9	7	0.00	84	1.65
250	9.0	3.5	20	*2.47	3.88	3.0	10	6	0.00	111	1.94
250	11.0	3.0	24	*2.48	5.70	3.0	11	5	0.00	137	2.44
500	6.5	6.5	19	*2.66	2.66	3.0	8	8	0.00	108	2.47
500	7.0	5.5	17	*2.49	2.57	3.0	8	7	0.00	99	2.02
500	8.0	4.5	18	*2.69	3.11	3.0	9	7	0.00	111	2.00
500	9.0	4.0	20	*2.68	3.88	3.0	10	6	0.00	124	2.22
500	11.0	3.0	24	*2.67	5.70	3.0	11	5	0.00	144	2.44
750	6.5	6.5	19	*2.66	2.66	3.0	8	8	0.00	108	2.47
750	7.5	5.5	17	*2.96	2.75	3.0	8	7	0.00	117	2.16
750	9.0	4.5	20	*2.90	3.88	3.0	10	7	0.00	136	2.50
750	9.5	4.0	21	*2.89	4.30	3.0	10	6	0.00	139	2.46
750	12.0	3.0	27	*2.69	6.99	3.0	11	5	0.00	165	3.00
1000	7.0	7.0	19	*2.87	2.87	3.0	7	7	0.00	127	2.87
1000	7.5	6.0	17	*3.22	2.75	3.0	9	7	0.00	128	2.36
1000	8.5	5.0	19	*3.15	3.48	3.0	10	7	0.00	139	2.49
1000	10.0	4.0	22	*3.07	4.75	3.0	10	6	0.00	155	2.71
1000	11.5	3.5	26	*2.87	6.45	3.0	11	6	0.00	173	3.22
1250	7.5	7.5	20	*3.24	3.24	3.0	7	7	0.00	154	3.47
1250	8.0	6.5	18	*3.41	3.11	3.0	9	7	0.00	150	2.88
1250	8.5	5.5	19	*3.37	3.48	3.0	9	7	0.00	151	2.74
1250	10.0	4.5	22	*3.26	4.75	3.0	10	7	0.00	170	3.05
1250	12.0	3.5	27	*3.02	6.99	3.0	11	6	0.00	189	3.50
1500	7.5	7.5	20	*3.24	3.24	3.0	7	7	0.00	154	3.47
1500	8.0	6.5	18	*3.66	3.11	3.0	9	7	0.00	157	2.88
1500	9.0	5.5	20	*3.55	3.88	3.0	9	7	0.00	169	3.05
1500	10.5	4.5	23	*3.42	5.21	3.0	11	7	0.00	187	3.35
1500	12.5	3.5	28	*3.15	7.56	3.0	11	6	0.00	206	3.78
2000	8.0	8.0	25	*4.32	4.32	7.5	9	9	0.00	220	4.93
2000	8.5	7.0	23	*4.22	4.22	7.5	9	8	0.00	208	4.22
2000	9.5	6.0	21	*3.92	4.30	3.0	9	8	0.00	200	3.69
2000	10.5	5.0	23	*3.80	5.21	3.0	11	7	0.00	209	3.72
2000	12.5	4.0	28	*3.46	7.56	3.0	11	6	0.00	231	4.32

TABLE 3-3-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	20	2.80	*2.80	3.0	8	8	0.00	114	2.60
250	6.5	6.5	20	*2.80	*2.80	3.0	8	8	0.00	114	2.60
250	7.0	5.5	18	*2.45	2.72	3.0	7	7	0.00	100	2.13
250	8.5	4.5	19	*2.91	3.48	3.0	10	7	0.00	126	2.24
250	10.0	4.0	22	*2.93	4.75	3.0	10	6	0.00	151	2.71
250	13.0	3.0	29	*2.84	8.14	3.0	11	5	0.00	190	3.49
500	7.0	7.0	21	*3.17	3.17	3.0	7	7	0.00	140	3.17
500	7.0	6.0	19	*2.51	2.87	3.0	8	7	0.00	109	2.46
500	8.5	5.0	19	*3.14	3.48	3.0	10	7	0.00	138	2.49
500	10.0	4.0	22	*3.14	4.75	3.0	10	6	0.00	158	2.71
500	11.0	3.5	24	*3.13	5.70	3.0	11	6	0.00	170	2.85
750	7.0	7.0	21	*3.17	3.17	3.0	7	7	0.00	140	3.17
750	8.0	6.0	18	*3.38	3.11	3.0	9	7	0.00	144	2.66
750	9.0	5.0	20	*3.36	3.88	3.0	10	7	0.00	156	2.77
750	10.5	4.0	23	*3.32	5.21	3.0	11	6	0.00	175	2.98
750	12.0	3.5	27	*3.15	6.99	3.0	11	6	0.00	194	3.50
1000	7.5	7.5	21	*3.40	3.40	3.0	8	8	0.00	162	3.64
1000	8.0	6.5	19	*3.37	3.28	3.0	9	7	0.00	153	3.04
1000	9.0	5.5	20	*3.57	3.88	3.0	9	7	0.00	169	3.05
1000	10.5	4.5	23	*3.50	5.21	3.0	11	7	0.00	190	3.35
1000	12.5	3.5	28	*3.29	7.56	3.0	11	6	0.00	211	3.78
1250	7.5	7.5	21	*3.40	3.40	3.0	8	8	0.00	162	3.64
1250	8.5	6.5	19	*3.82	3.48	3.0	9	7	0.00	175	3.23
1250	9.5	5.5	21	*3.75	4.30	3.0	9	8	0.00	188	3.38
1250	11.0	4.5	24	*3.67	5.70	3.0	11	7	0.00	208	3.66
1250	13.0	3.5	29	*3.44	8.14	3.0	11	6	0.00	229	4.07
1500	8.0	8.0	21	*3.62	3.62	3.0	8	8	0.00	185	4.14
1500	8.5	7.0	19	*4.05	3.48	3.0	8	7	0.00	187	3.48
1500	9.5	6.0	21	*3.96	4.30	3.0	9	8	0.00	201	3.69
1500	10.5	5.0	23	*3.88	5.21	3.0	11	7	0.00	212	3.72
1500	12.5	4.0	28	*3.60	7.56	3.0	11	6	0.00	237	4.32
2000	8.5	8.5	22	*4.03	4.03	3.0	7	7	0.00	219	4.90
2000	9.0	7.0	20	*4.44	3.88	3.0	9	7	0.00	214	3.88
2000	10.0	6.0	22	*4.31	4.75	3.0	10	7	0.00	228	4.07
2000	11.5	5.0	26	*3.96	6.45	3.0	11	7	0.00	247	4.61
2000	13.5	4.0	30	*3.86	8.74	3.0	11	6	0.00	275	5.00

FOOTING D[illegible]N TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	7	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	8	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	9	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	8	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	9	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	8	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	9	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	8	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	9	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	8	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	32	*6.56	10.02	7.5	9	9	0.07	619	13.60
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 3-4-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	8	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	7	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	8	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	7	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	8	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	7	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.08	337	7.50
1000	12.5	6.5	29	*4.41	7.83	7.5	10	8	0.08	340	7.27
1000	14.0	5.0	32	*3.45	9.67	7.5	11	7	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	8	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	31	*4.85	9.03	7.5	9	9	0.11	414	9.04
1500	15.0	5.5	33	*4.90	10.69	7.5	10	8	0.11	423	8.40
2000	12.0	12.0	27	*8.53	*6.99	7.5	9	8	0.11	607	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	30	*5.83	8.74	7.5	9	9	0.11	511	11.25
2000	14.5	7.5	32	*5.18	10.02	7.5	9	9	0.11	485	10.74
2000	15.5	6.0	35	*5.37	11.71	7.5	11	8	0.13	493	10.04

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	7	7	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	7	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	7	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.09	243	5.44
750	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	7	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	27	*4.26	6.99	7.5	10	8	0.11	298	6.00
1000	13.0	5.0	29	*3.13	8.14	7.5	10	7	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*3.97	7.56	7.5	9	8	0.12	316	7.02
1250	13.5	5.0	31	*5.05	9.03	7.5	11	7	0.14	362	6.45
1500	11.0	11.0	24	*6.46	*5.70	7.5	9	8	0.11	434	8.96
1500	11.5	9.5	26	*5.33	6.45	7.5	9	8	0.11	397	8.76
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	30	*4.72	8.42	7.5	10	8	0.13	372	7.82
1500	14.0	5.5	31	*4.61	9.37	7.5	10	8	0.14	371	7.36
2000	11.5	11.5	27	*7.28	*6.70	7.5	8	8	0.13	523	11.02
2000	12.0	10.0	29	*6.26	7.51	7.5	8	9	0.14	488	10.74
2000	13.0	8.5	30	*5.50	8.42	7.5	9	9	0.13	463	10.23
2000	14.0	7.0	31	*5.74	9.37	7.5	10	9	0.14	471	9.37
2000	15.0	5.5	34	*7.08	11.01	7.5	11	8	0.17	537	8.65

TABLE 3-4-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	1.74	2.91	7.5	8	7	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	8.5	3.0	20	*1.59	3.67	7.5	10	5	0.13	74	1.57
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.45
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.30
500	9.0	5.0	22	*2.37	4.27	7.5	9	7	0.13	134	3.05
500	10.0	4.0	22	*2.51	4.75	7.5	9	6	0.14	137	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.0	7.5	22	*3.56	4.27	7.5	8	8	0.13	204	4.58
750	9.5	6.5	23	*3.22	4.71	7.5	9	8	0.13	195	4.38
750	10.0	5.5	24	*3.34	5.18	7.5	9	8	0.15	196	4.07
750	11.0	4.5	24	*3.86	5.70	7.5	11	7	0.15	215	3.66
1000	9.5	9.5	21	*4.38	*4.30	7.5	8	8	0.12	266	5.84
1000	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.12	255	5.67
1000	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.13	243	5.44
1000	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.13	225	5.07
1000	12.0	4.5	27	*4.20	6.99	7.5	11	7	0.17	259	4.50
1250	10.0	10.0	22	*6.54	*5.05	7.5	9	8	0.14	374	6.79
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.88
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.62
1250	11.5	6.0	28	*4.15	6.95	7.5	10	8	0.17	285	5.96
1250	12.5	5.0	28	*5.05	7.56	7.5	11	7	0.18	322	5.40
1500	10.5	10.5	23	*6.74	*5.21	7.5	9	8	0.14	407	7.82
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.94
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.45
1500	12.0	6.5	29	*4.07	7.51	7.5	10	8	0.17	312	6.98
1500	13.0	5.0	31	*5.45	8.70	7.5	11	7	0.20	365	6.21
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.93
2000	12.0	8.5	30	*5.50	7.77	7.5	9	9	0.16	427	9.44
2000	13.0	7.0	31	*4.68	8.70	7.5	9	9	0.17	391	8.70
2000	14.0	5.5	33	*5.50	9.97	7.5	11	8	0.20	422	7.84

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	13	*1.73	*1.56	7.5	6	6	0.17	56	1.21
250	5.5	4.5	15	*1.45	1.78	7.5	7	6	0.22	49	1.14
250	6.0	4.0	15	*1.29	1.94	7.5	7	6	0.18	47	1.11
250	6.0	3.0	17	*1.10	2.20	7.5	8	5	0.28	39	0.94
250	6.5	2.5	16	*1.14	2.24	7.5	8	4	0.28	38	0.80
500	7.0	7.0	17	*2.59	*2.57	7.5	7	7	0.17	114	2.57
500	7.0	6.0	20	*2.59	3.02	7.5	8	7	0.19	113	2.59
500	7.5	5.0	20	*2.16	3.24	7.5	9	7	0.20	101	2.31
500	8.0	4.0	21	*1.81	3.62	7.5	8	6	0.23	89	2.07
500	8.5	3.5	20	*2.14	3.67	7.5	10	6	0.24	95	1.83
750	8.0	8.0	19	*3.70	*3.28	7.5	8	7	0.17	178	3.75
750	8.5	7.0	20	*3.02	3.67	7.5	7	7	0.16	163	3.67
750	8.5	6.0	23	*2.98	4.22	7.5	8	8	0.19	160	3.62
750	9.0	5.0	23	*2.66	4.47	7.5	9	7	0.21	145	3.19
750	9.5	4.0	24	*3.37	4.92	7.5	10	6	0.26	161	2.81
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.0	7.5	23	*3.72	4.47	7.5	8	8	0.18	214	4.79
1000	9.5	6.5	24	*3.36	4.92	7.5	9	8	0.18	203	4.57
1000	10.0	5.5	25	*2.97	5.40	7.5	8	8	0.20	187	4.24
1000	10.5	4.5	26	*3.42	5.89	7.5	11	7	0.24	196	3.79
1250	9.5	9.5	21	*5.53	*4.30	7.5	9	8	0.16	301	5.84
1250	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.17	255	5.67
1250	10.0	7.0	26	*3.93	5.61	7.5	8	8	0.19	251	5.61
1250	11.0	5.5	26	*4.05	6.17	7.5	10	8	0.21	250	4.85
1250	11.5	4.5	28	*4.36	6.95	7.5	11	7	0.25	257	4.47
1500	10.0	10.0	22	*6.86	*5.28	7.5	9	8	0.17	392	6.79
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.66	6.95	7.5	9	8	0.20	267	5.96
1500	12.0	5.0	29	*4.98	7.51	7.5	11	7	0.24	310	5.37
2000	11.0	11.0	24	*5.82	*5.70	7.5	8	8	0.15	411	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.18	409	9.03
2000	11.5	8.0	30	*5.18	7.45	7.5	9	9	0.20	384	8.51
2000	12.5	6.5	30	*5.00	8.10	7.5	11	8	0.21	369	7.52
2000	13.0	5.5	32	*5.17	8.98	7.5	11	8	0.24	372	7.06

TABLE 3-4-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y (SQ.IN.)		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	4.5	4.5	13	*1.26	*1.26	7.5	7	7	0.25	34	0.81
250	4.5	4.0	13	*1.15	*1.26	7.5	6	6	0.31	30	0.72
250	4.5	3.5	14	*1.05	1.36	7.5	7	6	0.36	28	0.68
250	5.0	3.0	14	*0.93	1.51	7.5	7	5	0.26	27	0.64
250	5.5	2.5	15	*0.82	1.78	7.5	7	4	0.18	26	0.63
500	6.0	6.0	16	*2.79	*2.30	7.5	8	7	0.29	95	1.77
500	6.5	5.0	17	*1.83	2.38	7.5	8	7	0.26	74	1.70
500	6.5	4.5	18	*1.74	2.52	7.5	8	7	0.30	70	1.62
500	7.0	3.5	18	*1.71	2.72	7.5	9	6	0.33	65	1.36
500	7.5	3.0	18	*1.50	2.91	7.5	9	5	0.31	60	1.25
750	7.5	7.5	17	*3.14	*2.75	7.5	7	7	0.20	140	2.95
750	7.5	6.5	19	*2.76	3.07	7.5	8	7	0.24	128	2.85
750	8.0	5.5	20	*2.37	3.45	7.5	7	8	0.23	119	2.71
750	8.0	4.5	22	*2.32	3.80	7.5	9	7	0.31	111	2.44
750	9.0	3.5	21	*2.13	4.08	7.5	10	6	0.30	103	2.04
1000	8.0	8.0	20	*4.92	*3.86	7.5	9	8	0.24	224	3.95
1000	8.5	7.0	22	*3.32	4.03	7.5	8	7	0.21	179	4.04
1000	8.5	6.0	24	*3.11	4.40	7.5	8	8	0.27	167	3.77
1000	9.0	5.0	24	*3.11	4.66	7.5	10	7	0.30	161	3.33
1000	10.0	4.0	23	*2.96	4.96	7.5	10	6	0.29	155	2.83
1250	9.0	9.0	20	*4.81	*3.88	7.5	8	7	0.19	251	5.00
1250	9.0	7.5	24	*3.88	4.66	7.5	8	8	0.23	223	5.00
1250	9.5	6.5	25	*3.51	5.13	7.5	9	8	0.23	212	4.76
1250	10.0	5.5	25	*3.33	5.40	7.5	9	8	0.26	199	4.24
1250	10.5	4.5	26	*3.54	5.89	7.5	11	7	0.30	200	3.79
1500	9.5	9.5	22	*4.83	*4.51	7.5	8	8	0.19	286	6.12
1500	9.5	8.0	26	*4.49	5.33	7.5	9	9	0.23	273	6.09
1500	10.0	7.0	26	*3.94	5.61	7.5	8	8	0.24	251	5.61
1500	11.0	5.5	26	*3.98	6.17	7.5	9	8	0.26	247	4.85
1500	11.5	4.5	28	*3.75	6.95	7.5	11	7	0.29	235	4.47
2000	10.5	10.5	23	*6.86	*5.22	7.5	9	8	0.19	411	7.82
2000	10.5	9.0	27	*5.24	6.12	7.5	8	8	0.22	355	7.87
2000	11.0	7.5	29	*4.71	6.89	7.5	9	9	0.25	332	7.38
2000	11.5	6.5	30	*4.59	7.45	7.5	10	8	0.26	324	6.92
2000	12.5	5.0	31	*5.08	8.37	7.5	11	7	0.30	335	5.97

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	4.0	4.0	14	*1.20	1.20	7.5	6	6	0.00	28	0.69
250	4.0	3.5	14	*1.05	1.20	7.5	6	6	0.00	24	0.60
250	4.0	3.0	15	*0.97	1.29	7.5	6	5	0.00	22	0.55
250	4.5	2.5	16	*0.86	1.55	7.5	7	4	0.00	22	0.55
250	5.0	2.5	16	*0.86	1.72	7.5	7	4	0.00	24	0.61
500	5.0	5.0	15	*1.62	*1.62	7.5	7	7	0.34	49	1.15
500	5.5	4.0	16	*1.44	1.90	7.5	7	6	0.26	47	1.08
500	5.5	3.5	17	*1.28	2.01	7.5	8	6	0.32	42	1.01
500	6.0	3.0	17	*1.33	2.20	7.5	8	5	0.21	43	0.94
500	6.5	2.5	18	*1.25	2.52	7.5	8	4	0.12	42	0.90
750	6.0	6.0	17	*2.44	*2.20	7.5	7	7	0.38	86	1.88
750	6.5	5.0	18	*1.94	2.52	7.5	8	7	0.34	78	1.80
750	6.5	4.5	19	*1.84	2.66	7.5	8	7	0.39	74	1.71
750	7.0	3.5	19	*1.69	2.87	7.5	9	6	0.40	66	1.43
750	7.5	3.0	20	*1.52	3.24	7.5	9	5	0.34	63	1.38
1000	7.0	7.0	18	*3.41	*2.72	7.5	8	7	0.33	135	2.72
1000	7.5	6.0	19	*2.59	3.07	7.5	8	7	0.30	119	2.63
1000	7.5	5.0	21	*2.34	3.40	7.5	9	7	0.38	108	2.43
1000	8.0	4.0	21	*2.27	3.62	7.5	9	6	0.41	101	2.07
1000	8.5	3.5	20	*2.36	3.67	7.5	10	6	0.39	101	1.83
1250	8.0	8.0	18	*4.37	*3.45	7.5	9	8	0.27	199	3.55
1250	8.0	7.0	21	*3.19	3.62	7.5	7	8	0.31	161	3.62
1250	8.5	6.0	22	*2.85	4.03	7.5	8	7	0.29	153	3.46
1250	8.5	5.0	23	*2.89	4.22	7.5	10	7	0.39	143	3.01
1250	9.5	4.0	22	*2.66	4.51	7.5	9	6	0.35	135	2.58
1500	8.5	8.5	20	*5.01	*3.89	7.5	8	7	0.28	242	4.45
1500	9.0	7.0	23	*3.47	4.47	7.5	8	8	0.27	199	4.47
1500	9.0	6.0	25	*3.24	4.86	7.5	9	8	0.34	184	4.16
1500	9.5	5.0	25	*3.13	5.13	7.5	10	7	0.37	174	3.66
1500	10.5	4.0	23	*3.37	5.21	7.5	11	6	0.37	177	2.98
2000	9.5	9.5	23	*5.50	*4.71	7.5	9	8	0.26	313	6.40
2000	10.0	8.0	25	*4.32	5.40	7.5	9	8	0.27	277	6.17
2000	10.0	7.0	27	*4.28	5.83	7.5	9	8	0.32	267	5.83
2000	11.0	5.5	27	*3.90	6.41	7.5	9	8	0.33	248	5.04
2000	11.5	4.5	27	*4.47	6.70	7.5	11	7	0.39	258	4.31

TABLE 3-4-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.0	3.0	10	0.64	0.64	3.0	5	5	0.00	11	0.27
250	4.0	4.0	11	*0.95	0.95	3.0	6	6	0.00	22	0.54
250	4.0	3.5	10	*1.02	0.86	3.0	6	5	0.00	21	0.43
250	4.5	3.0	11	*1.00	1.06	3.0	7	5	0.00	22	0.45
250	5.0	2.5	12	*0.98	1.29	3.0	7	4	0.00	23	0.46
250	5.5	2.5	13	*0.96	1.54	3.0	8	4	0.00	26	0.55
500	4.5	4.5	16	*1.55	1.55	7.5	7	7	0.14	42	1.00
500	5.0	4.0	16	*1.51	1.72	7.5	7	6	0.00	43	0.98
500	5.0	3.5	17	*1.33	1.83	7.5	7	6	0.00	39	0.91
500	5.5	3.0	18	*1.27	2.13	7.5	8	5	0.00	39	0.91
500	6.0	2.5	19	*1.22	2.46	7.5	8	4	0.00	39	0.87
750	5.5	5.5	16	*2.17	*1.90	7.5	7	7	0.31	69	1.49
750	6.0	4.5	18	*1.77	2.33	7.5	8	7	0.20	65	1.50
750	6.0	4.0	19	*1.64	2.46	7.5	7	6	0.24	60	1.40
750	7.0	3.0	20	*1.62	3.02	7.5	9	5	0.02	61	1.29
750	7.5	2.5	22	*1.43	3.56	7.5	9	4	0.00	58	1.27
1000	6.5	6.5	16	*3.01	*2.39	7.5	8	7	0.30	110	2.08
1000	6.5	5.5	19	*2.25	2.66	7.5	7	8	0.35	91	2.09
1000	7.0	4.5	20	*2.00	3.02	7.5	8	7	0.30	85	1.94
1000	7.0	4.0	21	*1.85	3.17	7.5	8	6	0.36	78	1.81
1000	8.0	3.0	22	*1.81	3.80	7.5	9	5	0.21	78	1.62
1250	7.0	7.0	18	*3.46	*2.74	7.5	8	7	0.37	137	2.72
1250	7.5	6.0	20	*2.59	3.24	7.5	8	7	0.31	122	2.77
1250	7.5	5.0	22	*2.37	3.56	7.5	9	7	0.40	111	2.54
1250	8.0	4.0	22	*2.20	3.80	7.5	9	6	0.41	101	2.17
1250	8.5	3.5	22	*2.24	4.03	7.5	10	6	0.36	102	2.02
1500	7.5	7.5	20	*4.02	*3.24	7.5	8	7	0.40	172	3.47
1500	8.0	6.5	21	*3.20	3.62	7.5	9	8	0.36	155	3.37
1500	8.5	5.5	22	*2.76	4.03	7.5	8	7	0.34	143	3.17
1500	9.0	4.5	23	*2.49	4.47	7.5	9	7	0.34	133	2.87
1500	9.5	3.5	24	*2.36	4.92	7.5	10	6	0.38	122	2.46
2000	8.5	8.5	23	*5.02	*4.22	7.5	8	8	0.38	251	5.12
2000	9.0	7.0	25	*3.85	4.86	7.5	8	8	0.38	218	4.86
2000	9.5	6.0	25	*3.68	5.13	7.5	9	8	0.39	208	4.39
2000	10.0	5.0	25	*3.65	5.40	7.5	11	7	0.42	200	3.85
2000	11.0	4.0	24	*3.60	5.70	7.5	11	6	0.39	196	3.25

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	12	0.90	0.90	3.0	6	6	0.00	18	0.45
250	4.0	4.0	12	*1.03	1.03	3.0	6	6	0.00	24	0.59
250	4.5	3.5	11	*1.20	1.06	3.0	7	6	0.00	27	0.53
250	5.0	3.0	12	*1.18	1.29	3.0	7	5	0.00	29	0.55
250	5.5	2.5	14	*1.05	1.66	3.0	8	4	0.00	29	0.59
250	6.0	2.5	14	*1.16	1.81	3.0	8	4	0.00	34	0.64
500	4.5	4.5	17	*1.65	1.65	7.5	7	7	0.00	44	1.06
500	5.0	4.0	17	*1.47	1.83	7.5	7	6	0.00	44	1.04
500	5.5	3.5	18	*1.44	2.13	7.5	8	6	0.00	46	1.06
500	6.0	3.0	14	*1.48	1.81	3.0	8	5	0.00	43	0.77
500	6.5	2.5	16	*1.33	2.24	3.0	8	4	0.00	42	0.80
750	5.5	5.5	18	*2.13	2.13	7.5	7	7	0.00	72	1.68
750	5.5	4.5	18	*1.84	2.13	7.5	8	7	0.00	60	1.37
750	6.0	4.0	19	*1.76	2.46	7.5	8	6	0.00	62	1.40
750	7.0	3.0	21	*1.64	3.17	7.5	9	5	0.00	63	1.36
750	7.5	2.5	23	*1.49	3.72	7.5	9	4	0.00	60	1.33
1000	6.0	6.0	17	*2.66	*2.20	7.5	8	7	0.21	91	1.88
1000	6.5	5.0	19	*2.25	2.66	7.5	8	7	0.10	86	1.90
1000	6.5	4.5	20	*2.05	2.80	7.5	8	7	0.13	80	1.80
1000	7.5	3.5	21	*2.06	3.40	7.5	9	6	0.00	83	1.70
1000	8.0	3.0	22	*1.98	3.80	7.5	9	5	0.00	83	1.62
1250	6.5	6.5	18	*2.99	*2.52	7.5	8	8	0.34	112	2.34
1250	7.0	5.5	20	*2.52	3.02	7.5	8	7	0.25	107	2.37
1250	7.5	4.5	22	*2.21	3.56	7.5	9	7	0.18	101	2.29
1250	7.5	4.0	22	*2.23	3.56	7.5	9	6	0.24	95	2.03
1250	8.5	3.0	24	*2.09	4.40	7.5	10	5	0.05	94	1.88
1500	7.0	7.0	19	*3.39	*2.87	7.5	8	7	0.40	138	2.87
1500	7.5	6.0	21	*2.80	3.40	7.5	8	8	0.33	130	2.91
1500	8.0	5.0	22	*2.64	3.80	7.5	9	7	0.28	125	2.71
1500	8.5	4.0	23	*2.53	4.22	7.5	9	6	0.26	119	2.41
1500	9.0	3.5	24	*2.43	4.66	7.5	10	6	0.19	118	2.33
2000	8.0	8.0	21	*4.53	*3.62	7.5	9	8	0.41	208	4.14
2000	8.5	7.0	23	*3.47	4.22	7.5	8	8	0.35	188	4.22
2000	9.0	6.0	24	*3.11	4.66	7.5	8	8	0.33	177	4.00
2000	9.5	5.0	24	*3.14	4.92	7.5	10	7	0.33	171	3.51
2000	10.0	4.0	25	*3.01	5.40	7.5	10	6	0.35	161	3.08

TABLE 3-4-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD
0	4.0	4.0	13	1.12	1.12	3.0	6	6	0.00	26	0.64
250	4.5	4.5	13	*1.26	*1.26	3.0	7	7	0.00	34	0.81
250	4.5	4.0	12	*1.22	*1.16	3.0	6	6	0.00	30	0.66
250	4.5	3.5	12	*1.22	1.16	3.0	7	6	0.00	28	0.58
250	5.0	3.0	13	*1.24	1.40	3.0	7	5	0.00	30	0.60
250	6.0	2.5	15	*1.26	1.94	3.0	8	4	0.00	36	0.69
500	5.0	5.0	14	*1.51	1.51	3.0	7	7	0.00	46	1.08
500	5.0	4.0	13	*1.56	1.40	3.0	7	6	0.00	40	0.80
500	5.5	3.5	14	*1.55	1.66	3.0	8	6	0.00	43	0.83
500	6.5	3.0	16	*1.52	2.24	3.0	8	5	0.00	50	0.96
500	7.0	2.5	17	*1.51	2.57	3.0	9	4	0.00	51	0.91
750	5.5	5.5	19	*2.25	2.25	7.5	7	7	0.00	76	1.77
750	5.5	4.5	18	*1.97	2.13	7.5	8	7	0.00	62	1.37
750	6.0	4.0	20	*1.75	2.59	7.5	8	6	0.00	63	1.48
750	7.0	3.0	17	*1.77	2.57	3.0	9	5	0.00	61	1.10
750	8.0	2.5	19	*1.72	3.28	3.0	9	4	0.00	66	1.17
1000	6.0	6.0	19	*2.46	2.46	7.5	7	7	0.00	92	2.11
1000	6.0	5.0	19	*2.31	2.46	7.5	8	7	0.00	80	1.75
1000	6.5	4.5	20	*2.21	2.80	7.5	8	7	0.00	83	1.80
1000	7.5	3.5	22	*2.07	3.56	7.5	9	6	0.00	85	1.78
1000	8.0	3.0	23	*2.03	3.97	7.5	9	5	0.00	85	1.70
1250	6.5	6.5	19	*2.80	*2.66	7.5	8	8	0.09	111	2.47
1250	6.5	5.5	20	*2.57	2.80	7.5	8	8	0.14	100	2.20
1250	7.0	4.5	22	*2.29	3.32	7.5	9	7	0.02	96	2.13
1250	7.5	4.0	22	*2.40	3.56	7.5	9	6	0.00	99	2.03
1250	8.5	3.0	25	*2.10	4.59	7.5	10	5	0.00	96	1.96
1500	7.0	7.0	19	*3.35	*2.87	7.5	8	7	0.19	137	2.87
1500	7.0	6.0	20	*3.07	3.02	7.5	8	7	0.26	124	2.59
1500	7.5	5.0	22	*2.70	3.56	7.5	9	7	0.16	119	2.54
1500	8.5	4.0	23	*2.71	4.22	7.5	10	6	0.00	124	2.41
1500	9.0	3.5	24	*2.61	4.66	7.5	10	6	0.00	123	2.33
2000	7.5	7.5	20	*4.26	*3.31	7.5	9	7	0.44	180	3.47
2000	8.0	6.5	23	*3.25	3.97	7.5	9	8	0.35	164	3.69
2000	8.5	5.5	24	*3.11	4.40	7.5	8	8	0.30	159	3.46
2000	9.0	4.5	25	*3.00	4.86	7.5	10	7	0.28	152	3.12
2000	10.0	3.5	27	*2.81	5.83	7.5	11	6	0.13	150	2.91

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	14	1.20	1.20	3.0	6	6	0.00	28	0.69
250	4.5	4.5	14	*1.36	*1.36	3.0	7	7	0.00	37	0.87
250	4.5	4.0	13	*1.24	*1.26	3.0	6	6	0.00	31	0.72
250	5.0	3.5	13	*1.42	1.40	3.0	7	6	0.00	36	0.70
250	6.0	3.0	15	*1.44	1.94	3.0	8	5	0.00	43	0.83
250	6.5	2.5	17	*1.34	2.38	3.0	8	4	0.00	43	0.85
500	5.0	5.0	15	*1.62	1.62	3.0	7	7	0.00	49	1.15
500	5.5	4.0	14	*1.73	1.66	3.0	8	6	0.00	49	0.95
500	6.0	3.5	15	*1.73	1.94	3.0	8	6	0.00	52	0.97
500	7.0	3.0	17	*1.71	2.57	3.0	9	5	0.00	59	1.10
500	7.5	2.5	19	*1.59	3.07	3.0	9	4	0.00	58	1.09
750	5.5	5.5	20	*2.37	2.37	7.5	7	7	0.00	80	1.86
750	6.0	4.5	15	*2.01	1.94	3.0	8	7	0.00	64	1.25
750	6.5	4.0	16	*1.99	2.24	3.0	8	6	0.00	67	1.28
750	7.5	3.0	18	*1.94	2.91	3.0	9	5	0.00	71	1.25
750	8.5	2.5	21	*1.79	3.85	3.0	10	4	0.00	75	1.37
1000	6.0	6.0	20	*2.59	2.59	7.5	8	8	0.00	97	2.22
1000	6.0	5.0	19	*2.45	2.46	7.5	8	7	0.00	83	1.75
1000	6.5	4.5	21	*2.18	2.94	7.5	8	7	0.00	84	1.89
1000	7.5	3.5	21	*1.78	3.40	3.0	9	6	0.00	77	1.70
1000	8.5	3.0	20	*2.12	3.67	3.0	10	5	0.00	89	1.57
1250	6.0	6.0	20	*2.60	2.59	7.5	8	8	0.01	97	2.22
1250	7.0	5.0	21	*2.62	3.17	7.5	9	7	0.00	106	2.26
1250	7.0	4.5	22	*2.42	3.32	7.5	9	7	0.00	98	2.13
1250	8.0	3.5	24	*2.32	4.14	7.5	9	6	0.00	101	2.07
1250	9.0	3.0	26	*2.24	5.05	7.5	10	5	0.00	107	2.16
1500	6.5	6.5	20	*3.08	*2.80	7.5	8	8	0.15	120	2.60
1500	7.0	5.5	21	*2.98	3.17	7.5	8	7	0.03	120	2.49
1500	8.0	4.5	23	*2.76	3.97	7.5	9	7	0.00	124	2.55
1500	8.5	4.0	24	*2.68	4.40	7.5	10	6	0.00	125	2.51
1500	9.5	3.0	27	*2.41	5.54	7.5	10	5	0.00	121	2.37
2000	7.5	7.5	20	*4.14	*3.24	7.5	8	7	0.26	175	3.47
2000	8.0	6.5	22	*3.61	3.80	7.5	9	8	0.17	169	3.53
2000	8.5	5.5	24	*3.25	4.40	7.5	9	8	0.09	163	3.46
2000	9.0	4.5	25	*3.17	4.86	7.5	10	7	0.03	157	3.12
2000	10.0	3.5	27	*2.98	5.83	7.5	11	6	0.00	155	2.91

TABLE 3-4-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	16	1.55	1.55	3.0	7	7	0.00	42	1.00
250	5.0	5.0	16	*1.72	*1.72	3.0	7	7	0.00	52	1.23
250	5.5	4.0	14	*1.80	1.66	3.0	8	6	0.00	50	0.95
250	6.0	3.5	16	*1.67	2.07	3.0	8	6	0.00	52	1.03
250	7.0	3.0	18	*1.72	2.72	3.0	9	5	0.00	61	1.16
250	8.0	2.5	20	*1.77	3.45	3.0	9	4	0.00	68	1.23
500	5.5	5.5	17	*2.01	2.01	3.0	7	7	0.00	68	1.58
500	6.0	4.5	15	*2.11	1.94	3.0	8	7	0.00	66	1.25
500	6.5	4.0	17	*1.94	2.38	3.0	8	6	0.00	68	1.36
500	8.0	3.0	20	*1.97	3.45	3.0	9	5	0.00	79	1.48
500	9.0	2.5	22	*1.99	4.27	3.0	10	4	0.00	86	1.52
750	5.5	5.5	17	*2.01	2.01	3.0	7	7	0.00	68	1.58
750	6.5	4.5	17	*2.20	2.38	3.0	8	7	0.00	77	1.53
750	7.0	4.0	18	*2.19	2.72	3.0	9	6	0.00	80	1.55
750	8.5	3.0	21	*2.19	3.85	3.0	10	5	0.00	92	1.65
750	10.0	2.5	24	*2.18	5.18	3.0	11	4	0.00	105	1.85
1000	6.0	6.0	17	*2.26	2.20	3.0	7	7	0.00	83	1.88
1000	6.5	5.0	16	*2.65	2.24	3.0	8	7	0.00	88	1.60
1000	7.0	4.5	18	*2.42	2.72	3.0	9	7	0.00	90	1.75
1000	8.5	3.5	20	*2.54	3.67	3.0	10	6	0.00	106	1.83
1000	9.5	3.0	22	*2.50	4.51	3.0	10	5	0.00	115	1.93
1250	6.5	6.5	22	*3.08	3.08	7.5	8	8	0.00	126	2.86
1250	6.5	5.5	21	*2.81	2.94	7.5	8	8	0.00	107	2.31
1250	7.5	4.5	19	*2.63	3.07	3.0	9	7	0.00	104	1.97
1250	8.0	4.0	20	*2.61	3.45	3.0	9	6	0.00	107	1.97
1250	10.0	3.0	24	*2.53	5.18	3.0	11	5	0.00	126	2.22
1500	6.5	6.5	22	*3.08	3.08	7.5	8	8	0.00	126	2.86
1500	7.0	5.5	22	*3.04	3.32	7.5	8	8	0.00	123	2.61
1500	8.0	4.5	25	*2.75	4.32	7.5	9	7	0.00	128	2.77
1500	8.5	4.0	21	*2.79	3.85	3.0	10	6	0.00	121	2.20
1500	10.5	3.0	25	*2.69	5.67	3.0	11	5	0.00	139	2.43
2000	7.5	7.5	23	*3.72	3.72	7.5	8	8	0.00	177	3.99
2000	7.5	6.5	22	*3.82	3.56	7.5	9	8	0.00	163	3.31
2000	8.0	5.5	25	*3.23	4.32	7.5	9	8	0.00	155	3.39
2000	9.0	4.5	26	*3.28	5.05	7.5	10	7	0.00	163	3.25
2000	10.5	3.5	29	*3.12	6.57	7.5	11	6	0.00	173	3.28

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 4000 PSF
CONC. = 3000 PSI

TABLE 3-4-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	18	1.94	1.94	3.0	7	7	0.00	59	1.38
250	5.0	5.0	18	*1.94	1.94	3.0	7	7	0.00	59	1.38
250	6.5	4.0	17	*2.06	2.38	3.0	8	6	0.00	70	1.36
250	7.0	3.5	18	*2.10	2.72	3.0	9	6	0.00	74	1.36
250	8.0	3.0	20	*2.16	3.45	3.0	9	5	0.00	84	1.48
250	10.0	2.5	24	*2.23	5.18	3.0	11	4	0.00	107	1.85
500	5.5	5.5	18	*2.13	*2.13	3.0	7	7	0.00	72	1.68
500	6.5	4.5	17	*2.31	2.38	3.0	8	7	0.00	79	1.53
500	7.0	4.0	18	*2.33	2.72	3.0	9	6	0.00	84	1.55
500	9.0	3.0	22	*2.39	4.27	3.0	10	5	0.00	105	1.83
500	10.0	2.5	25	*2.30	5.40	3.0	11	4	0.00	111	1.92
750	6.0	6.0	19	*2.46	2.46	3.0	7	7	0.00	92	2.11
750	6.5	5.0	17	*2.56	2.38	3.0	8	7	0.00	88	1.70
750	7.0	4.5	18	*2.56	2.72	3.0	9	7	0.00	93	1.75
750	8.5	3.5	21	*2.58	3.85	3.0	10	6	0.00	109	1.92
750	9.5	3.0	24	*2.45	4.92	3.0	10	5	0.00	117	2.11
1000	6.5	6.5	19	*2.66	2.66	3.0	8	8	0.00	108	2.47
1000	6.5	5.5	17	*2.80	2.38	3.0	8	7	0.00	97	1.87
1000	7.5	4.5	20	*2.62	3.24	3.0	9	7	0.00	106	2.08
1000	8.5	4.0	21	*2.78	3.85	3.0	10	6	0.00	121	2.20
1000	10.0	3.0	25	*2.64	5.40	3.0	11	5	0.00	131	2.31
1250	6.5	6.5	19	*2.66	2.66	3.0	8	8	0.00	108	2.47
1250	7.0	5.5	18	*3.03	2.72	3.0	8	7	0.00	113	2.13
1250	8.0	4.5	21	*2.82	3.62	3.0	9	7	0.00	121	2.33
1250	9.0	4.0	21	*3.15	4.08	3.0	10	6	0.00	139	2.33
1250	11.0	3.0	26	*2.92	6.17	3.0	11	5	0.00	157	2.64
1500	7.0	7.0	19	*3.04	2.87	3.0	7	7	0.00	130	2.87
1500	7.0	6.0	17	*3.53	*2.57	3.0	9	7	0.00	126	2.20
1500	8.0	5.0	20	*3.22	3.45	3.0	9	7	0.00	135	2.46
1500	9.5	4.0	22	*3.33	4.51	3.0	10	6	0.00	155	2.58
1500	10.0	3.5	24	*3.13	5.18	3.0	11	6	0.00	154	2.59
2000	7.5	7.5	24	*3.88	3.88	7.5	8	8	0.00	185	4.16
2000	7.5	6.5	23	*3.85	3.72	7.5	9	8	0.00	167	3.46
2000	8.5	5.5	26	*3.49	4.77	7.5	9	8	0.00	176	3.75
2000	9.5	4.5	23	*3.51	4.71	3.0	10	7	0.00	171	3.03
2000	11.0	3.5	26	*3.42	6.17	3.0	11	6	0.00	185	3.08

TABLE 3-4-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.5	5.5	19	2.25	*2.25	3.0	7	7	0.00	76	1.77
250	5.5	5.5	19	*2.25	*2.25	3.0	7	7	0.00	76	1.77
250	6.5	4.5	17	*2.43	2.38	3.0	8	7	0.00	82	1.53
250	7.0	4.0	19	*2.31	2.87	3.0	9	6	0.00	85	1.64
250	10.0	3.0	24	*2.64	5.18	3.0	11	5	0.00	129	2.22
250	12.0	2.5	28	*2.72	7.25	3.0	11	4	0.00	155	2.59
500	6.0	6.0	20	*2.59	2.59	3.0	8	8	0.00	97	2.22
500	6.5	5.0	17	*2.68	*2.38	3.0	8	7	0.00	91	1.70
500	7.0	4.5	19	*2.52	2.87	3.0	9	7	0.00	94	1.84
500	9.0	3.5	22	*2.79	4.27	3.0	10	6	0.00	124	2.13
500	10.0	3.0	25	*2.69	5.40	3.0	11	5	0.00	132	2.31
750	6.5	6.5	20	*2.80	*2.80	3.0	8	8	0.00	114	2.60
750	6.5	5.5	18	*2.71	*2.52	3.0	8	8	0.00	98	1.98
750	8.0	4.5	20	*2.96	3.45	3.0	9	7	0.00	122	2.22
750	8.5	4.0	21	*2.98	3.85	3.0	10	6	0.00	127	2.20
750	10.5	3.0	26	*2.87	5.89	3.0	11	5	0.00	147	2.52
1000	6.5	6.5	20	*2.80	*2.80	3.0	8	8	0.00	114	2.60
1000	7.0	5.5	18	*3.17	2.72	3.0	9	7	0.00	116	2.13
1000	8.5	4.5	21	*3.18	3.85	3.0	10	7	0.00	139	2.47
1000	9.0	4.0	22	*3.19	4.27	3.0	10	6	0.00	143	2.44
1000	11.5	3.0	28	*3.04	6.95	3.0	11	5	0.00	173	2.98
1250	7.0	7.0	21	*3.17	3.17	3.0	7	7	0.00	140	3.17
1250	7.0	6.0	19	*3.18	2.87	3.0	9	7	0.00	124	2.46
1250	8.0	5.0	21	*3.18	3.62	3.0	9	7	0.00	136	2.59
1250	9.5	4.0	23	*3.36	4.71	3.0	10	6	0.00	159	2.69
1250	10.5	3.5	26	*3.19	5.89	3.0	11	6	0.00	168	2.94
1500	7.0	7.0	21	*3.17	3.17	3.0	7	7	0.00	140	3.17
1500	7.5	6.0	19	*3.62	3.07	3.0	9	7	0.00	143	2.63
1500	8.5	5.0	22	*3.38	4.03	3.0	10	7	0.00	154	2.88
1500	10.0	4.0	24	*3.54	5.18	3.0	11	6	0.00	176	2.96
1500	11.0	3.5	27	*3.35	6.41	3.0	11	6	0.00	185	3.20
2000	7.5	7.5	21	*3.57	3.40	3.0	8	8	0.00	166	3.64
2000	8.0	6.5	19	*4.30	3.28	3.0	9	7	0.00	176	3.04
2000	9.0	5.5	23	*3.73	4.47	3.0	9	8	0.00	184	3.51
2000	10.0	4.5	24	*3.89	5.18	3.0	11	7	0.00	196	3.33
2000	12.0	3.5	28	*3.79	7.25	3.0	11	6	0.00	222	3.62

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 3000 PSI

TABLE 3-5-1 AXIAL LOAD: -20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	8.0	8.0	40	6.91	6.91	3.0	9	9	0.00	352	7.90
250	10.5	10.5	23	5.21	5.21	7.5	8	8	0.00	355	7.82
250	11.0	9.0	25	4.86	5.94	7.5	8	8	0.00	345	7.63
250	12.0	7.5	27	4.37	6.99	7.5	9	8	0.00	337	7.50
250	12.5	6.5	30	4.21	8.10	3.0	10	8	0.00	337	7.52
250	14.5	5.0	34	3.67	10.64	3.0	11	7	0.00	337	7.60
500	11.0	11.0	24	5.70	5.70	7.5	8	8	0.00	407	8.96
500	11.5	9.5	26	5.33	6.45	7.5	9	8	0.00	397	8.76
500	12.5	8.0	28	4.83	7.56	7.5	9	9	0.00	390	8.64
500	13.5	6.5	30	4.21	8.74	7.5	10	8	0.00	364	8.12
500	14.5	5.5	32	3.80	10.02	7.5	9	8	0.00	351	7.87
750	11.5	11.5	26	6.45	6.45	7.5	8	8	0.00	483	10.61
750	12.0	10.0	27	5.83	6.99	7.5	8	8	0.00	454	10.00
750	12.5	8.5	28	*5.14	7.56	7.5	8	9	0.02	415	9.18
750	14.0	7.0	31	4.68	9.37	7.5	9	9	0.00	422	9.37
750	15.5	5.5	34	4.03	11.38	7.5	10	8	0.00	399	8.94
1000	11.5	11.5	26	*6.45	6.45	7.5	8	8	0.04	483	10.61
1000	12.5	10.0	28	6.04	7.56	7.5	8	9	0.02	491	10.80
1000	13.0	8.5	30	5.50	8.42	7.5	9	9	0.03	463	10.23
1000	14.5	7.0	32	4.83	10.02	7.5	9	9	0.02	452	10.02
1000	16.0	5.5	35	4.15	12.09	7.5	10	8	0.02	425	9.50
1250	12.0	12.0	27	6.99	6.99	7.5	8	8	0.04	547	12.00
1250	12.5	10.5	29	6.57	7.83	7.5	9	9	0.04	535	11.74
1250	13.5	9.0	30	5.83	8.74	7.5	9	9	0.04	511	11.25
1250	14.5	7.5	32	5.18	10.02	7.5	9	9	0.04	485	10.74
1250	16.0	6.0	35	4.53	12.09	7.5	10	8	0.04	465	10.37
1500	12.5	12.5	28	7.56	7.56	7.5	9	9	0.03	617	13.50
1500	13.0	10.5	30	6.80	8.42	7.5	9	9	0.05	576	12.63
1500	14.0	9.0	31	6.02	9.37	7.5	9	9	0.05	547	12.05
1500	15.0	7.5	33	*5.34	10.69	7.5	9	9	0.06	518	11.45
1500	16.5	6.0	36	*4.66	12.83	7.5	10	8	0.05	494	11.00
2000	13.0	13.0	29	8.14	8.14	7.5	8	8	0.05	692	15.12
2000	13.5	11.0	31	*7.36	9.03	7.5	9	9	0.07	648	14.20
2000	14.5	9.5	32	*6.56	10.02	7.5	9	9	0.07	619	13.60
2000	15.5	8.0	34	*5.87	11.38	7.5	10	9	0.08	590	13.01
2000	17.0	6.5	38	5.33	13.95	7.5	11	8	0.06	584	12.95

TABLE 3-5-2 AXIAL LOAD: -10 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD
0	6.5	6.5	32	4.49	4.49	3.0	8	8	0.00	183	4.17
250	9.0	9.0	20	3.88	3.88	7.5	7	7	0.00	224	5.00
250	9.5	7.5	21	3.40	4.30	7.5	8	8	0.00	206	4.61
250	10.0	6.5	22	3.08	4.75	7.5	8	7	0.00	196	4.41
250	11.0	5.5	24	2.85	5.70	7.5	8	8	0.00	198	4.48
250	11.5	4.5	26	2.52	6.45	7.5	9	7	0.00	182	4.15
500	9.5	9.5	21	4.30	4.30	7.5	8	8	0.04	263	5.84
500	10.5	8.0	23	3.97	5.21	7.5	8	8	0.02	268	5.96
500	11.0	7.0	24	3.62	5.70	7.5	8	8	0.02	255	5.70
500	12.0	5.5	27	3.20	6.99	7.5	9	8	0.02	244	5.50
500	13.0	4.5	29	2.81	8.14	7.5	10	7	0.02	230	5.23
750	10.0	10.0	23	4.96	4.96	7.5	7	7	0.06	321	7.09
750	11.0	8.5	24	4.40	5.70	7.5	8	8	0.05	312	6.92
750	11.5	7.5	26	4.21	6.45	7.5	9	8	0.04	311	6.92
750	12.5	6.0	28	3.62	7.56	7.5	9	8	0.05	289	6.48
750	13.5	5.0	30	3.24	8.74	7.5	10	7	0.04	277	6.25
1000	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.07	370	8.16
1000	11.5	9.0	26	5.05	6.45	7.5	8	8	0.05	375	8.30
1000	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.08	337	7.50
1000	12.5	6.5	29	*4.41	7.83	7.5	10	8	0.08	340	7.27
1000	14.0	5.0	32	*3.45	9.67	7.5	11	7	0.08	306	6.91
1250	11.0	11.0	25	*5.94	5.94	7.5	8	8	0.08	424	9.33
1250	11.5	9.5	27	5.54	6.70	7.5	9	8	0.08	412	9.10
1250	12.5	8.0	28	4.83	7.56	7.5	9	9	0.08	390	8.64
1250	13.5	6.5	30	*4.21	8.74	7.5	10	8	0.09	364	8.12
1250	14.5	5.5	32	*3.80	10.02	7.5	9	8	0.08	351	7.87
1500	11.5	11.5	26	6.45	6.45	7.5	8	8	0.07	483	10.61
1500	12.0	10.0	27	*5.83	6.99	7.5	8	8	0.09	454	10.00
1500	12.5	8.5	30	5.50	8.10	7.5	9	9	0.09	445	9.83
1500	13.5	7.0	31	*4.85	9.03	7.5	9	9	0.11	414	9.04
1500	15.0	5.5	33	*4.90	10.69	7.5	10	8	0.11	423	8.40
2000	12.0	12.0	27	*8.53	*6.99	7.5	9	8	0.11	607	12.00
2000	12.5	10.5	30	6.80	8.10	7.5	9	9	0.10	553	12.15
2000	13.5	9.0	30	*5.83	8.74	7.5	9	9	0.11	511	11.25
2000	14.5	7.5	32	*5.18	10.02	7.5	9	9	0.11	485	10.74
2000	15.5	6.0	35	*5.37	11.71	7.5	11	8	0.13	493	10.04

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 3000 PSI

TABLE 3-5-3 AXIAL LOAD: -5 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	25	2.70	2.70	3.0	7	7	0.00	82	1.92
250	8.0	8.0	18	3.11	3.11	7.5	7	7	0.01	158	3.55
250	8.0	7.0	19	2.87	3.28	7.5	7	7	0.03	145	3.28
250	8.5	6.0	20	2.59	3.67	7.5	8	7	0.04	139	3.14
250	9.5	5.0	21	2.26	4.30	7.5	9	7	0.02	135	3.07
250	10.5	4.0	23	1.98	5.21	7.5	8	6	0.02	129	2.98
500	9.0	9.0	20	3.88	3.88	7.5	7	7	0.04	224	5.00
500	9.5	7.5	21	3.40	4.30	7.5	8	8	0.05	206	4.61
500	10.0	6.5	22	3.08	4.75	7.5	8	7	0.05	196	4.41
500	10.5	5.5	23	*2.73	5.21	7.5	8	8	0.07	181	4.09
500	11.5	4.5	26	2.52	6.45	7.5	9	7	0.05	182	4.15
750	9.5	9.5	21	*4.30	4.30	7.5	8	8	0.08	263	5.84
750	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.08	255	5.67
750	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.09	243	5.44
750	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.09	225	5.07
750	12.5	4.5	28	*2.72	7.56	7.5	10	7	0.09	214	4.86
1000	10.0	10.0	23	*4.96	4.96	7.5	7	7	0.09	321	7.09
1000	10.5	8.5	25	4.59	5.67	7.5	8	8	0.09	310	6.88
1000	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.10	297	6.62
1000	12.0	6.0	27	*4.26	6.99	7.5	10	8	0.11	298	6.00
1000	13.0	5.0	29	*3.13	8.14	7.5	10	7	0.10	257	5.81
1250	10.5	10.5	24	*5.44	5.44	7.5	8	8	0.10	370	8.16
1250	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.10	359	7.94
1250	12.0	7.5	27	*4.37	6.99	7.5	9	8	0.10	337	7.50
1250	12.5	6.5	28	*3.97	7.56	7.5	9	8	0.12	316	7.02
1250	13.5	5.0	31	*5.05	9.03	7.5	11	7	0.14	362	6.45
1500	11.0	11.0	24	*6.46	*5.70	7.5	9	8	0.11	434	8.96
1500	11.5	9.5	26	*5.33	6.45	7.5	9	8	0.11	397	8.76
1500	12.0	8.0	29	*5.01	7.51	7.5	9	9	0.12	387	8.59
1500	13.0	6.5	30	*4.72	8.42	7.5	10	8	0.13	372	7.82
1500	14.0	5.5	31	*4.61	9.37	7.5	10	8	0.14	371	7.36
2000	11.5	11.5	27	*7.28	*6.70	7.5	8	8	0.13	523	11.02
2000	12.0	10.0	29	*6.26	7.51	7.5	8	9	0.14	488	10.74
2000	13.0	8.5	30	*5.50	8.42	7.5	9	9	0.13	463	10.23
2000	14.0	7.0	31	*5.74	9.37	7.5	10	9	0.14	471	9.37
2000	15.0	5.5	34	*7.08	11.01	7.5	11	8	0.17	537	8.65

TABLE 3-5-4 AXIAL LOAD: 0 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	6.5	6.5	16	*2.24	*2.24	7.5	7	7	0.10	91	2.08
250	7.0	5.5	17	2.01	2.57	7.5	7	7	0.09	88	2.02
250	7.5	4.5	18	1.74	2.91	7.5	8	7	0.10	81	1.87
250	8.0	4.0	18	*1.55	3.11	7.5	7	6	0.10	76	1.77
250	8.5	3.0	20	*1.59	3.67	7.5	10	5	0.13	74	1.57
500	8.0	8.0	18	*3.11	3.11	7.5	7	7	0.10	158	3.55
500	8.0	7.0	20	*3.02	3.45	7.5	7	8	0.12	153	3.45
500	8.5	6.0	21	*2.72	3.85	7.5	8	7	0.12	146	3.30
500	9.0	5.0	22	*2.37	4.27	7.5	9	7	0.13	134	3.05
500	10.0	4.0	22	*2.51	4.75	7.5	9	6	0.14	137	2.71
750	9.0	9.0	20	3.88	3.88	7.5	7	7	0.09	224	5.00
750	9.0	7.5	22	*3.56	4.27	7.5	8	8	0.13	204	4.58
750	9.5	6.5	23	*3.22	4.71	7.5	9	8	0.13	195	4.38
750	10.0	5.5	24	*3.34	5.18	7.5	9	8	0.15	196	4.07
750	11.0	4.5	24	*3.86	5.70	7.5	11	7	0.15	215	3.66
1000	9.5	9.5	21	*4.38	*4.30	7.5	8	8	0.12	266	5.84
1000	10.0	8.0	23	*3.97	4.96	7.5	8	7	0.12	255	5.67
1000	10.5	7.0	24	*3.62	5.44	7.5	8	8	0.13	243	5.44
1000	11.5	5.5	26	*3.08	6.45	7.5	8	8	0.13	225	5.07
1000	12.0	4.5	27	*4.20	6.99	7.5	11	7	0.17	259	4.50
1250	10.0	10.0	22	*6.54	*5.05	7.5	9	8	0.14	374	6.79
1250	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.13	310	6.88
1250	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.13	297	6.62
1250	11.5	6.0	28	*4.15	6.95	7.5	10	8	0.17	285	5.96
1250	12.5	5.0	28	*5.05	7.56	7.5	11	7	0.18	322	5.40
1500	10.5	10.5	23	*6.74	*5.21	7.5	9	8	0.14	407	7.82
1500	11.0	9.0	26	*5.05	6.17	7.5	8	8	0.13	359	7.94
1500	11.5	7.5	28	*4.53	6.95	7.5	9	8	0.15	335	7.45
1500	12.0	6.5	29	*4.07	7.51	7.5	10	8	0.17	312	6.98
1500	13.0	5.0	31	*5.45	8.70	7.5	11	7	0.20	365	6.21
2000	11.5	11.5	26	6.45	6.45	7.5	8	8	0.11	483	10.61
2000	11.5	10.0	28	*6.04	6.95	7.5	8	8	0.15	451	9.93
2000	12.0	8.5	30	*5.50	7.77	7.5	9	9	0.16	427	9.44
2000	13.0	7.0	31	*4.68	8.70	7.5	9	9	0.17	391	8.70
2000	14.0	5.5	33	*5.50	9.97	7.5	11	8	0.20	422	7.84

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. 3000 PSI

TABLE 3-5-5 AXIAL LOAD: 5 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	5.5	5.5	13	*1.73	*1.56	7.5	6	6	0.17	56	1.21
250	5.5	4.5	15	*1.45	1.78	7.5	7	6	0.22	49	1.14
250	5.5	4.0	17	*1.46	2.01	7.5	7	6	0.24	49	1.15
250	6.0	3.0	17	*1.10	2.20	7.5	8	5	0.28	39	0.94
250	6.5	2.5	16	*1.14	2.24	7.5	8	4	0.28	38	0.80
500	7.0	7.0	17	*2.59	*2.57	7.5	7	7	0.17	114	2.57
500	7.0	6.0	20	*2.59	3.02	7.5	8	7	0.19	113	2.59
500	7.5	5.0	20	*2.16	3.24	7.5	9	7	0.20	101	2.31
500	8.0	4.0	21	*1.81	3.62	7.5	8	6	0.23	89	2.07
500	8.5	3.5	20	*2.14	3.67	7.5	10	6	0.24	95	1.83
750	8.0	8.0	19	*3.70	*3.28	7.5	8	7	0.17	178	3.75
750	8.5	7.0	20	*3.02	3.67	7.5	7	7	0.16	163	3.67
750	8.5	6.0	23	*2.98	4.22	7.5	8	8	0.19	160	3.62
750	9.0	5.0	23	*2.66	4.47	7.5	9	7	0.21	145	3.19
750	9.5	4.0	24	*3.37	4.92	7.5	10	6	0.26	161	2.81
1000	9.0	9.0	20	*3.88	*3.88	7.5	7	7	0.14	224	5.00
1000	9.0	7.5	23	*3.72	4.47	7.5	8	8	0.18	214	4.79
1000	9.5	6.5	24	*3.36	4.92	7.5	9	8	0.18	203	4.57
1000	10.0	5.5	25	*2.97	5.40	7.5	8	8	0.20	187	4.24
1000	10.5	4.5	26	*3.42	5.89	7.5	11	7	0.24	196	3.79
1250	9.5	9.5	21	*5.53	*4.30	7.5	9	8	0.16	301	5.84
1250	10.0	8.0	23	*3.97	4.96	7.5	8	7	.17	255	5.67
1250	10.0	7.0	26	*3.93	5.61	7.5	8	8	0.19	251	5.61
1250	11.0	5.5	26	*4.05	6.17	7.5	10	8	0.21	250	4.85
1250	11.5	4.5	28	*4.36	6.95	7.5	11	7	0.25	257	4.47
1500	10.0	10.0	22	*6.86	*5.28	7.5	9	8	0.17	392	6.79
1500	10.5	8.5	25	*4.59	5.67	7.5	8	8	0.16	310	6.88
1500	11.0	7.5	26	*4.21	6.17	7.5	9	8	0.16	297	6.62
1500	11.5	6.0	28	*3.66	6.95	7.5	9	8	0.20	267	5.96
1500	12.0	5.0	29	*4.98	7.51	7.5	11	7	0.24	310	5.37
2000	11.0	11.0	24	*5.82	*5.70	7.5	8	8	0.15	411	8.96
2000	11.0	9.5	28	*5.74	6.65	7.5	9	9	0.13	409	9.03
2000	11.5	8.0	30	*5.18	7.45	7.5	9	9	0.20	384	8.51
2000	12.5	6.5	30	*5.00	8.10	7.5	11	8	0.21	369	7.52
2000	13.0	5.5	32	*5.17	8.98	7.5	11	8	0.24	372	7.06

TABLE 3-5-6 AXIAL LOAD: 10 KIPS

M+ HxD (IN-K)	DIMENSIONS X (FT)	Y (FT)	T (IN)	STEEL AREA X (SQ.IN.)	Y (SQ.IN.)	X-BAR COVER (IN.)	MAX. BAR SIZE X	Y	OVER-BURDEN (KSF)	QUANTITIES STEEL (LBS)	CONC (CU.Y
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.1
250	4.5	4.5	13	*1.26	*1.26	7.5	7	7	0.25	34	0.8
250	4.5	4.0	13	*1.15	*1.26	7.5	6	6	0.31	30	0.7
250	4.5	3.5	14	*1.05	1.36	7.5	7	6	0.36	28	0.6
250	4.5	3.0	15	*0.97	1.45	7.5	7	5	0.44	25	0.6
250	5.0	2.5	15	*0.81	1.62	7.5	7	4	0.34	23	0.5
500	6.0	6.0	16	*2.79	*2.30	7.5	8	7	0.29	95	1.7
500	6.5	5.0	17	*1.83	2.38	7.5	8	7	0.26	74	1.7
500	6.5	4.5	18	*1.74	2.52	7.5	8	7	0.30	70	1.6
500	7.0	3.5	18	*1.71	2.72	7.5	9	6	0.33	65	1.3
500	7.0	3.0	19	*1.78	2.87	7.5	9	5	0.42	63	1.2
750	7.0	7.0	20	*3.24	*3.02	7.5	7	7	0.27	138	3.0
750	7.5	6.0	21	*2.72	3.40	7.5	8	8	0.25	128	2.91
750	8.0	5.0	21	*2.26	3.62	7.5	9	7	0.26	113	2.5
750	8.5	4.0	21	*2.36	3.85	7.5	9	6	0.30	110	2.2
750	8.5	3.5	22	*2.74	4.03	7.5	10	6	0.37	115	2.0
1000	8.0	8.0	20	*4.92	*3.86	7.5	9	8	0.24	224	3.9
1000	8.5	7.0	22	*3.32	4.03	7.5	8	7	0.21	179	4.0
1000	8.5	6.0	24	*3.11	4.40	7.5	8	8	0.27	167	3.77
1000	9.0	5.0	24	*3.11	4.66	7.5	10	7	0.30	161	3.33
1000	9.5	4.0	25	*3.25	5.13	7.5	10	6	0.34	160	2.93
1250	9.0	9.0	20	*4.81	*3.88	7.5	8	7	0.19	251	5.00
1250	9.0	7.5	24	*3.88	4.66	7.5	8	8	0.23	223	5.00
1250	9.5	6.5	25	*3.51	5.13	7.5	9	8	0.23	212	4.76
1250	10.0	5.5	25	*3.33	5.40	7.5	9	8	0.26	199	4.24
1250	10.5	4.5	26	*3.54	5.89	7.5	11	7	0.30	200	3.79
1500	9.5	9.5	22	*4.83	*4.51	7.5	8	8	0.19	286	6.12
1500	9.5	8.0	26	*4.49	5.33	7.5	9	9	0.23	273	6.09
1500	10.0	7.0	26	*3.94	5.61	7.5	8	8	0.24	251	5.61
1500	11.0	5.5	26	*3.98	6.17	7.5	9	8	0.26	247	4.85
1500	11.5	4.5	28	*3.75	6.95	7.5	11	7	0.29	235	4.47
2000	10.5	10.5	23	*6.86	*5.22	7.5	9	8	0.19	411	7.82
2000	10.5	9.0	27	*5.24	6.12	7.5	8	8	0.22	355	7.87
2000	11.0	7.5	29	*4.71	6.89	7.5	9	9	0.25	332	7.38
2000	11.5	6.5	30	*4.59	7.45	7.5	10	8	0.26	324	6.92
2000	12.5	5.0	31	*5.08	8.37	7.5	11	7	0.30	335	5.97

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 3000 PSI

TABLE 3-5-7 AXIAL LOAD: 20 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	3.5	3.5	14	*1.05	1.05	7.5	6	6	0.13	21	0.52
250	3.5	3.0	15	*0.97	1.13	7.5	6	5	0.17	19	0.48
250	4.0	2.5	16	*0.86	1.38	7.5	6	4	0.00	19	0.49
250	4.5	2.5	16	*0.86	1.55	7.5	7	4	0.00	22	0.55
250	5.0	2.5	16	*0.86	1.72	7.5	7	4	0.00	24	0.61
500	5.0	5.0	15	*1.62	*1.62	7.5	7	7	0.34	49	1.15
500	5.0	4.0	17	*1.46	1.83	7.5	7	6	0.45	44	1.04
500	5.5	3.5	17	*1.28	2.01	7.5	8	6	0.32	42	1.01
500	5.5	3.0	18	*1.16	2.13	7.5	8	5	0.39	38	0.91
500	6.0	2.5	19	*1.07	2.46	7.5	8	4	0.28	36	0.87
750	6.0	6.0	17	*2.44	*2.20	7.5	7	7	0.38	86	1.88
750	6.0	5.0	19	*2.09	2.46	7.5	8	7	0.48	76	1.75
750	6.5	4.5	19	*1.84	2.66	7.5	8	7	0.39	74	1.71
750	7.0	3.5	19	*1.69	2.87	7.5	9	6	0.40	66	1.43
750	7.0	3.0	20	*1.61	3.02	7.5	9	5	0.49	61	1.29
1000	7.0	7.0	18	*3.41	*2.72	7.5	8	7	0.33	135	2.72
1000	7.0	6.0	21	*2.72	3.17	7.5	8	7	0.39	119	2.72
1000	7.5	5.0	21	*2.34	3.40	7.5	9	7	0.38	108	2.43
1000	8.0	4.0	21	*2.27	3.62	7.5	9	6	0.41	101	2.07
1000	8.0	3.5	22	*2.25	3.80	7.5	9	6	0.49	96	1.90
1250	7.5	7.5	21	*4.25	*3.40	7.5	9	8	0.36	182	3.64
1250	8.0	6.5	22	*3.08	3.80	7.5	8	8	0.34	156	3.53
1250	8.5	5.5	22	*2.90	4.03	7.5	8	7	0.34	147	3.17
1250	8.5	4.5	24	*2.96	4.40	7.5	10	7	0.45	140	2.83
1250	9.5	3.5	23	*2.67	4.71	7.5	10	6	0.43	130	2.36
1500	8.5	8.5	20	*5.01	*3.89	7.5	8	7	0.28	242	4.45
1500	8.5	7.0	24	*3.79	4.40	7.5	8	8	0.35	200	4.40
1500	9.0	6.0	25	*3.24	4.86	7.5	9	8	0.34	184	4.16
1500	9.5	5.0	25	*3.13	5.13	7.5	10	7	0.37	174	3.66
1500	10.0	4.0	25	*3.35	5.40	7.5	11	6	0.43	172	3.08
2000	9.5	9.5	23	*5.50	*4.71	7.5	9	8	0.26	313	6.40
2000	9.5	8.0	27	*4.66	5.54	7.5	9	9	0.32	284	6.33
2000	10.0	7.0	27	*4.28	5.83	7.5	9	8	0.32	267	5.83
2000	10.5	5.5	29	*4.12	6.57	7.5	10	8	0.39	252	5.16
2000	11.5	4.5	27	*4.47	6.70	7.5	11	7	0.39	258	4.31

TABLE 3-5-8 AXIAL LOAD: 30 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	2.5	2.5	10	0.54	0.54	3.0	4	4	0.00	7	0.19
250	3.5	3.5	15	*1.13	1.13	7.5	6	6	0.00	23	0.56
250	4.0	3.0	11	*0.88	0.95	3.0	6	5	0.00	18	0.40
250	4.5	2.5	12	*0.87	1.16	3.0	7	4	0.00	19	0.41
250	5.0	2.5	12	*0.98	1.29	3.0	7	4	0.00	23	0.46
250	5.5	2.5	13	*0.96	1.54	3.0	8	4	0.00	26	0.55
500	4.5	4.5	16	*1.55	1.55	7.5	7	7	0.14	42	1.00
500	4.5	4.0	16	*1.39	1.55	7.5	7	6	0.19	37	0.88
500	5.0	3.5	17	*1.33	1.83	7.5	7	6	0.00	39	0.91
500	5.0	3.0	18	*1.20	1.94	7.5	7	5	0.00	35	0.83
500	5.5	2.5	19	*1.15	2.25	7.5	8	4	0.00	35	0.80
750	5.5	5.5	16	*2.17	*1.90	7.5	7	7	0.31	69	1.49
750	5.5	4.5	18	*1.74	2.13	7.5	8	7	0.39	58	1.37
750	5.5	4.0	19	*1.64	2.25	7.5	7	6	0.46	54	1.29
750	6.5	3.0	20	*1.54	2.80	7.5	8	5	0.18	55	1.20
750	7.0	2.5	22	*1.38	3.32	7.5	9	4	0.05	53	1.18
1000	6.0	6.0	18	*2.62	*2.33	7.5	8	7	0.48	92	2.00
1000	6.5	5.0	20	*2.16	2.80	7.5	8	7	0.40	87	2.00
1000	6.5	4.5	21	*2.04	2.94	7.5	8	7	0.46	81	1.89
1000	7.0	3.5	21	*1.86	3.17	7.5	9	6	0.45	73	1.58
1000	7.5	3.0	22	*1.77	3.56	7.5	9	5	0.36	72	1.52
1250	7.0	7.0	18	*3.46	*2.74	7.5	8	7	0.37	137	2.72
1250	7.0	6.0	21	*2.72	3.17	7.5	8	7	0.44	119	2.72
1250	7.5	5.0	22	*2.37	3.56	7.5	9	7	0.40	111	2.54
1250	8.0	4.0	22	*2.20	3.80	7.5	9	6	0.41	101	2.17
1250	8.0	3.5	23	*2.09	3.97	7.5	9	6	0.50	94	1.98
1500	7.5	7.5	20	*4.02	*3.24	7.5	8	7	0.40	172	3.47
1500	7.5	6.5	23	*3.22	3.72	7.5	9	8	0.46	152	3.46
1500	8.0	5.5	23	*2.92	3.97	7.5	8	8	0.45	142	3.12
1500	8.5	4.5	23	*2.81	4.22	7.5	10	7	0.46	134	2.71
1500	9.0	3.5	24	*2.56	4.66	7.5	10	6	0.51	121	2.33
2000	8.5	8.5	23	*5.02	*4.22	7.5	8	8	0.38	251	5.12
2000	9.0	7.0	25	*3.85	4.86	7.5	8	8	0.38	218	4.86
2000	9.5	6.0	25	*3.68	5.13	7.5	9	8	0.39	208	4.39
2000	10.0	5.0	25	*3.65	5.40	7.5	11	7	0.42	200	3.85
2000	10.5	4.0	25	*3.76	5.67	7.5	11	6	0.48	195	3.24

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 3000 PSI

TABLE 3-5-9 AXIAL LOAD: 40 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.0	3.0	11	0.71	0.71	3.0	5	5	0.00	12	0.30
250	3.5	3.5	12	*0.90	0.90	3.0	6	6	0.00	18	0.45
250	4.0	3.0	12	*0.91	1.03	3.0	6	5	0.00	19	0.44
250	4.5	2.5	13	*0.94	1.26	3.0	7	4	0.00	21	0.45
250	5.0	2.5	13	*1.06	1.40	3.0	7	4	0.00	25	0.50
250	5.5	2.5	14	*1.05	1.66	3.0	8	4	0.00	29	0.59
500	4.5	4.5	17	*1.65	1.65	7.5	7	7	0.00	44	1.06
500	4.5	4.0	17	*1.46	1.65	7.5	7	6	0.00	39	0.94
500	4.5	3.5	18	*1.36	1.74	7.5	7	6	0.00	36	0.87
500	5.0	3.0	19	*1.23	2.05	7.5	7	5	0.00	36	0.87
500	5.5	2.5	20	*1.20	2.37	7.5	8	4	0.00	36	0.84
750	5.0	5.0	17	*1.92	*1.83	7.5	7	7	0.18	57	1.31
750	5.5	4.0	19	*1.67	2.25	7.5	8	6	0.01	55	1.29
750	5.5	3.5	20	*1.53	2.37	7.5	8	6	0.03	50	1.18
750	6.0	3.0	21	*1.49	2.72	7.5	8	5	0.00	51	1.16
750	6.5	2.5	22	*1.45	3.08	7.5	8	4	0.00	50	1.10
1000	5.5	5.5	18	*2.30	*2.13	7.5	7	7	0.45	75	1.68
1000	6.0	4.5	20	*1.97	2.59	7.5	8	7	0.32	72	1.66
1000	6.5	4.0	21	*1.89	2.94	7.5	8	6	0.17	73	1.68
1000	7.0	3.0	23	*1.72	3.47	7.5	9	5	0.07	67	1.49
1000	7.5	2.5	24	*1.68	3.88	7.5	9	4	0.00	66	1.38
1250	6.5	6.5	18	*2.99	*2.52	7.5	8	8	0.34	112	2.34
1250	6.5	5.5	20	*2.47	2.80	7.5	7	8	0.42	98	2.20
1250	7.0	4.5	22	*2.15	3.32	7.5	9	7	0.34	93	2.13
1250	7.0	4.0	23	*2.01	3.47	7.5	8	6	0.40	86	1.98
1250	8.0	3.0	24	*2.01	4.14	7.5	9	5	0.20	86	1.77
1500	7.0	7.0	19	*3.39	*2.87	7.5	8	7	0.40	138	2.87
1500	7.0	6.0	21	*2.91	3.17	7.5	8	7	0.48	123	2.72
1500	7.5	5.0	23	*2.48	3.72	7.5	9	7	0.42	116	2.66
1500	8.0	4.0	24	*2.32	4.14	7.5	9	6	0.40	108	2.37
1500	8.5	3.5	24	*2.37	4.40	7.5	10	6	0.33	109	2.20
2000	8.0	8.0	21	*4.53	*3.62	7.5	9	8	0.41	208	4.14
2000	8.0	7.0	24	*3.64	4.14	7.5	8	8	0.47	184	4.14
2000	8.5	6.0	24	*3.41	4.40	7.5	9	8	0.45	175	3.77
2000	9.0	5.0	25	*3.05	4.86	7.5	10	7	0.44	162	3.47
2000	9.5	4.0	26	*2.82	5.33	7.5	10	6	0.46	150	3.04

TABLE 3-5-10 AXIAL LOAD: 50 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	13	0.98	0.98	3.0	6	6	0.00	20	0.49
250	4.0	4.0	13	*1.12	1.12	3.0	6	6	0.00	26	0.64
250	4.0	3.5	12	*1.06	1.03	3.0	6	6	0.00	23	0.51
250	4.5	3.0	13	*1.09	1.26	3.0	7	5	0.00	25	0.54
250	5.0	2.5	14	*1.12	1.51	3.0	7	4	0.00	27	0.54
250	5.5	2.5	15	*1.14	1.78	3.0	8	4	0.00	31	0.63
500	4.5	4.5	18	*1.74	1.74	7.5	7	7	0.00	47	1.12
500	4.5	4.0	17	*1.49	1.65	7.5	7	6	0.00	40	0.94
500	5.0	3.5	14	*1.41	1.51	3.0	7	6	0.00	37	0.75
500	5.5	3.0	15	*1.41	1.78	3.0	8	5	0.00	39	0.76
500	6.0	2.5	17	*1.30	2.20	3.0	8	4	0.00	39	0.78
750	5.0	5.0	18	*1.94	1.94	7.5	7	7	0.00	59	1.38
750	5.5	4.0	19	*1.80	2.25	7.5	8	6	0.00	57	1.29
750	6.0	3.5	20	*1.76	2.59	7.5	8	6	0.00	59	1.29
750	6.5	3.0	22	*1.60	3.08	7.5	8	5	0.00	59	1.32
750	7.0	2.5	19	*1.53	2.87	3.0	9	4	0.00	53	1.02
1000	5.5	5.5	18	*2.40	*2.13	7.5	7	7	0.12	77	1.68
1000	6.0	4.5	20	*2.11	2.59	7.5	8	7	0.00	74	1.66
1000	6.0	4.0	21	*1.95	2.72	7.5	8	6	0.00	68	1.55
1000	7.0	3.0	23	*1.85	3.47	7.5	9	5	0.00	70	1.49
1000	8.0	2.5	25	*1.78	4.32	7.5	9	4	0.00	74	1.54
1250	6.0	6.0	19	*2.70	*2.46	7.5	8	7	0.30	96	2.11
1250	6.5	5.0	21	*2.36	2.94	7.5	8	7	0.17	93	2.10
1250	6.5	4.5	22	*2.18	3.08	7.5	8	7	0.20	86	1.98
1250	7.5	3.5	23	*2.23	3.72	7.5	9	6	0.00	91	1.86
1250	8.0	3.0	25	*2.03	4.32	7.5	9	5	0.00	88	1.85
1500	6.5	6.5	20	*2.97	*2.80	7.5	8	8	0.38	118	2.60
1500	7.0	5.5	22	*2.61	3.32	7.5	8	8	0.28	114	2.61
1500	7.5	4.5	23	*2.51	3.72	7.5	9	7	0.20	110	2.39
1500	7.5	4.0	24	*2.36	3.88	7.5	9	6	0.25	102	2.22
1500	8.5	3.0	26	*2.26	4.77	7.5	10	5	0.02	102	2.04
2000	7.5	7.5	20	*4.26	*3.31	7.5	9	7	0.44	180	3.47
2000	7.5	6.5	23	*3.36	3.72	7.5	9	8	0.51	156	3.46
2000	8.0	5.5	25	*2.97	4.32	7.5	8	8	0.44	149	3.39
2000	8.5	4.5	26	*2.76	4.77	7.5	10	7	0.41	140	3.06
2000	9.5	3.5	27	*2.74	5.54	7.5	10	6	0.26	140	2.77

FOOTING DESIGN TABLES

NOTES:
1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (•) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 3000 PSI

TABLE 3-5-11 AXIAL LOAD: 60 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	3.5	3.5	13	0.98	*0.98	3.0	6	6	0.00	20	0.49
250	4.0	4.0	14	*1.20	1.20	3.0	6	6	0.00	28	0.69
250	4.5	3.5	13	*1.25	1.26	3.0	7	6	0.00	29	0.63
250	5.0	3.0	14	*1.28	1.51	3.0	7	5	0.00	32	0.64
250	5.5	2.5	16	*1.20	1.90	3.0	8	4	0.00	33	0.67
250	6.0	2.5	16	*1.33	2.07	3.0	8	4	0.00	39	0.74
500	4.5	4.5	14	*1.41	*1.36	3.0	7	7	0.00	37	0.87
500	5.0	4.0	14	*1.57	1.51	3.0	7	6	0.00	42	0.86
500	5.5	3.5	15	*1.58	1.78	3.0	8	6	0.00	45	0.89
500	6.0	3.0	16	*1.59	2.07	3.0	8	5	0.00	47	0.88
500	6.5	2.5	18	*1.48	2.52	3.0	8	4	0.00	47	0.90
750	5.0	5.0	19	*2.05	2.05	7.5	7	7	0.00	62	1.46
750	5.5	4.0	20	*1.78	2.37	7.5	8	6	0.00	58	1.35
750	6.0	3.5	17	*1.70	2.20	3.0	8	6	0.00	54	1.10
750	6.5	3.0	18	*1.70	2.52	3.0	8	5	0.00	56	1.08
750	7.5	2.5	20	*1.71	3.24	3.0	9	4	0.00	62	1.15
1000	5.5	5.5	20	*2.37	2.37	7.5	7	7	0.00	80	1.86
1000	6.0	4.5	20	*2.24	2.59	7.5	8	7	0.00	77	1.66
1000	6.0	4.0	22	*1.91	2.85	7.5	8	6	0.00	69	1.62
1000	7.5	3.0	24	*1.55	3.88	3.0	9	5	0.00	70	1.66
1000	8.0	2.5	22	*1.79	3.80	3.0	9	4	0.00	71	1.35
1250	6.0	6.0	20	*2.60	2.59	7.5	8	8	0.01	97	2.22
1250	6.0	5.0	21	*2.39	2.72	7.5	8	7	0.05	86	1.94
1250	6.5	4.5	22	*2.32	3.08	7.5	8	7	0.00	89	1.98
1250	7.5	3.5	24	*2.22	3.88	7.5	9	6	0.00	92	1.94
1250	8.0	3.0	26	*2.05	4.49	7.5	9	5	0.00	90	1.92
1500	6.5	6.5	20	*3.08	*2.80	7.5	8	8	0.15	120	2.60
1500	6.5	5.5	21	*2.84	2.94	7.5	8	8	0.21	108	2.31
1500	7.0	4.5	23	*2.57	3.47	7.5	9	7	0.07	104	2.23
1500	7.5	4.0	24	*2.51	3.88	7.5	9	6	0.00	106	2.22
1500	8.5	3.0	27	*2.24	4.95	7.5	10	5	0.00	103	2.12
2000	7.0	7.0	21	*3.73	*3.17	7.5	8	7	0.45	152	3.17
2000	7.5	6.0	23	*3.28	3.72	7.5	9	8	0.35	147	3.19
2000	8.0	5.0	25	*2.96	4.32	7.5	9	7	0.27	141	3.08
2000	8.5	4.0	26	*2.88	4.77	7.5	10	6	0.21	135	2.72
2000	9.0	3.5	28	*2.67	5.44	7.5	10	6	0.09	132	2.72

TABLE 3-5-12 AXIAL LOAD: 80 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X (SQ.IN.)	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.0	4.0	15	1.29	*1.29	3.0	6	6	0.00	30	0.74
250	4.5	4.5	16	*1.55	1.55	3.0	7	7	0.00	42	1.00
250	4.5	4.0	15	*1.29	1.45	3.0	7	6	0.00	35	0.83
250	5.0	3.5	15	*1.46	1.62	3.0	7	6	0.00	38	0.81
250	5.5	3.0	16	*1.51	1.90	3.0	8	5	0.00	41	0.81
250	6.5	2.5	19	*1.48	2.66	3.0	8	4	0.00	48	0.95
500	5.0	5.0	16	*1.72	*1.72	3.0	7	7	0.00	52	1.23
500	5.5	4.0	15	*1.92	1.78	3.0	8	6	0.00	53	1.01
500	6.0	3.5	17	*1.79	2.20	3.0	8	6	0.00	56	1.10
500	6.5	3.0	18	*1.82	2.52	3.0	8	5	0.00	58	1.08
500	7.5	2.5	21	*1.74	3.40	3.0	9	4	0.00	64	1.21
750	5.0	5.0	16	*1.82	*1.72	3.0	7	7	0.00	54	1.23
750	6.0	4.0	17	*2.03	2.20	3.0	8	6	0.00	64	1.25
750	6.5	3.5	18	*2.05	2.52	3.0	8	6	0.00	67	1.26
750	7.5	3.0	20	*2.06	3.24	3.0	9	5	0.00	76	1.38
750	8.5	2.5	23	*1.96	4.22	3.0	10	4	0.00	82	1.50
1000	5.5	5.5	21	*2.49	2.49	7.5	8	8	0.00	84	1.96
1000	6.0	4.5	17	*2.28	2.20	3.0	8	7	0.00	72	1.41
1000	6.5	4.0	18	*2.27	2.52	3.0	8	6	0.00	76	1.44
1000	8.0	3.0	22	*2.13	3.80	3.0	9	5	0.00	86	1.62
1000	9.0	2.5	24	*2.14	4.66	3.0	10	4	0.00	93	1.66
1250	6.0	6.0	22	*2.85	2.85	7.5	8	8	0.00	106	2.44
1250	6.0	5.0	21	*2.64	2.72	7.5	8	7	0.00	91	1.94
1250	6.5	4.5	23	*2.43	3.22	7.5	8	7	0.00	93	2.07
1250	7.5	3.5	21	*2.33	3.40	3.0	9	6	0.00	90	1.70
1250	8.5	3.0	23	*2.32	4.22	3.0	10	5	0.00	99	1.81
1500	6.0	6.0	22	*2.85	2.85	7.5	8	8	0.00	106	2.44
1500	6.5	5.0	23	*2.69	3.22	7.5	8	7	0.00	104	2.30
1500	7.0	4.5	24	*2.65	3.62	7.5	9	7	0.00	108	2.33
1500	8.0	3.5	26	*2.60	4.49	7.5	9	6	0.00	112	2.24
1500	9.0	3.0	24	*2.49	4.66	3.0	10	5	0.00	111	2.00
2000	7.0	7.0	22	*3.68	*3.32	7.5	8	8	0.03	155	3.32
2000	7.0	6.0	23	*3.43	3.47	7.5	9	8	0.07	140	2.98
2000	7.5	5.0	25	*3.14	4.05	7.5	9	7	0.00	136	2.89
2000	8.5	4.0	27	*3.00	4.95	7.5	10	6	0.00	140	2.83
2000	9.0	3.5	29	*2.80	5.63	7.5	10	6	0.00	138	2.81

FOOTING DESIGN TABLES

NOTES:

1. Tables based on Grade 60 bars. Grade 40 bars may be substituted directly except when (*) appears. At these locations Grade 40 bars may be substituted by increasing the steel area shown by 50%.
2. For load combinations which include wind, multiply loads by 0.75, then enter table.
3. Enter tables using total footing moment which must include effects of horizontal forces (M + H • D).
4. Design must include overburden shown to provide adequate overturning resistance.

SOIL = 5000 PSF
CONC. = 3000 PSI

TABLE 3-5-13 AXIAL LOAD: 100 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	4.5	4.5	17	1.65	*1.65	3.0	7	7	0.00	44	1.06
250	5.0	5.0	18	*1.94	1.94	3.0	7	7	0.00	59	1.38
250	5.0	4.0	15	*1.76	*1.62	3.0	7	6	0.00	46	0.92
250	6.0	3.5	17	*1.88	2.20	3.0	8	6	0.00	57	1.10
250	6.5	3.0	19	*1.80	2.66	3.0	8	5	0.00	59	1.14
250	8.0	2.5	22	*1.91	3.80	3.0	9	4	0.00	74	1.35
500	5.0	5.0	18	*1.94	1.94	3.0	7	7	0.00	59	1.38
500	6.0	4.0	17	*2.11	2.20	3.0	8	6	0.00	65	1.25
500	6.5	3.5	19	*2.01	2.66	3.0	8	6	0.00	68	1.33
500	7.5	3.0	21	*2.08	3.40	3.0	9	5	0.00	78	1.45
500	8.5	2.5	24	*2.02	4.40	3.0	10	4	0.00	85	1.57
750	5.5	5.5	18	*2.13	*2.13	3.0	7	7	0.00	72	1.68
750	6.0	4.5	17	*2.36	2.20	3.0	8	7	0.00	74	1.41
750	6.5	4.0	19	*2.22	2.66	3.0	8	6	0.00	77	1.52
750	8.0	3.0	22	*2.30	3.80	3.0	9	5	0.00	91	1.62
750	9.5	2.5	26	*2.23	5.33	3.0	10	4	0.00	104	1.90
1000	6.0	6.0	19	*2.46	2.46	3.0	7	7	0.00	92	2.11
1000	6.0	5.0	17	*2.60	2.20	3.0	8	7	0.00	82	1.57
1000	6.5	4.5	19	*2.43	2.66	3.0	8	7	0.00	86	1.71
1000	8.0	3.5	22	*2.48	3.80	3.0	9	6	0.00	102	1.90
1000	8.5	3.0	24	*2.37	4.40	3.0	10	5	0.00	102	1.88
1250	6.0	6.0	19	*2.46	2.46	3.0	7	7	0.00	92	2.11
1250	6.5	5.0	18	*2.84	2.52	3.0	8	7	0.00	96	1.80
1250	7.0	4.5	20	*2.66	3.02	3.0	9	7	0.00	100	1.94
1250	8.5	3.5	23	*2.67	4.22	3.0	10	6	0.00	116	2.11
1250	9.5	3.0	25	*2.68	5.13	3.0	10	5	0.00	125	2.19
1500	6.5	6.5	24	*3.36	3.36	7.5	8	8	0.00	137	3.12
1500	6.5	5.5	22	*3.20	3.08	7.5	8	8	0.00	117	2.42
1500	7.5	4.5	21	*2.86	3.40	3.0	9	7	0.00	114	2.18
1500	8.0	4.0	22	*2.86	3.80	3.0	9	6	0.00	118	2.17
1500	10.0	3.0	26	*2.84	5.61	3.0	11	5	0.00	139	2.40
2000	7.0	7.0	24	*3.62	3.62	7.5	8	8	0.00	160	3.62
2000	7.0	6.0	23	*3.69	3.47	7.5	9	8	0.00	146	2.98
2000	8.0	5.0	26	*3.34	4.49	7.5	9	7	0.00	154	3.20
2000	9.0	4.0	25	*3.04	4.86	3.0	10	6	0.00	145	2.77
2000	9.5	3.5	26	*3.03	5.33	3.0	10	6	0.00	147	2.66

TABLE 3-5-14 AXIAL LOAD: 120 KIPS

M+ HxD (IN-K)	DIMENSIONS			STEEL AREA (SQ.IN.)		X-BAR COVER (IN.)	MAX. BAR SIZE		OVER-BURDEN (KSF)	QUANTITIES	
	X (FT)	Y (FT)	T (IN)	X	Y		X	Y		STEEL (LBS)	CONC. (CU.YD)
0	5.0	5.0	19	2.05	*2.05	3.0	7	7	0.00	62	1.46
250	5.0	5.0	19	*2.05	*2.05	3.0	7	7	0.00	62	1.46
250	6.0	4.0	18	*2.04	2.33	3.0	8	6	0.00	66	1.33
250	6.5	3.5	19	*2.11	2.66	3.0	8	6	0.00	70	1.33
250	8.0	3.0	22	*2.26	3.80	3.0	9	5	0.00	90	1.62
250	9.0	2.5	25	*2.23	4.86	3.0	10	4	0.00	97	1.73
500	5.5	5.5	19	*2.25	*2.25	3.0	7	7	0.00	76	1.77
500	6.0	4.5	17	*2.45	2.20	3.0	8	7	0.00	75	1.41
500	6.5	4.0	19	*2.33	2.66	3.0	8	6	0.00	79	1.52
500	8.5	3.0	23	*2.49	4.22	3.0	10	5	0.00	103	1.81
500	9.5	2.5	27	*2.31	5.54	3.0	10	4	0.00	108	1.97
750	5.5	5.5	19	*2.25	*2.25	3.0	7	7	0.00	76	1.77
750	6.5	4.5	19	*2.54	2.66	3.0	8	7	0.00	88	1.71
750	7.0	4.0	20	*2.58	3.02	3.0	9	6	0.00	93	1.72
750	9.0	3.0	25	*2.56	4.86	3.0	10	5	0.00	115	2.08
750	10.5	2.5	29	*2.52	6.57	3.0	11	4	0.00	130	2.34
1000	6.0	6.0	20	*2.59	2.59	3.0	8	8	0.00	97	2.22
1000	6.5	5.0	19	*2.75	2.66	3.0	8	7	0.00	97	1.90
1000	7.0	4.5	20	*2.78	3.02	3.0	9	7	0.00	102	1.94
1000	8.5	3.5	23	*2.84	4.22	3.0	10	6	0.00	120	2.11
1000	9.5	3.0	26	*2.74	5.33	3.0	10	5	0.00	129	2.28
1250	6.0	6.0	20	*2.59	2.59	3.0	8	8	0.00	97	2.22
1250	7.0	5.0	20	*2.99	3.02	3.0	9	7	0.00	112	2.16
1250	7.5	4.5	21	*3.01	3.40	3.0	9	7	0.00	118	2.18
1250	9.0	3.5	25	*2.89	4.86	3.0	10	6	0.00	133	2.43
1250	10.0	3.0	27	*2.91	5.83	3.0	11	5	0.00	143	2.50
1500	6.5	6.5	20	*2.97	*2.80	3.0	8	8	0.00	118	2.60
1500	7.0	5.5	19	*3.41	2.87	3.0	9	7	0.00	124	2.25
1500	8.0	4.5	22	*3.20	3.80	3.0	9	7	0.00	133	2.44
1500	8.5	4.0	23	*3.21	4.22	3.0	10	6	0.00	137	2.41
1500	10.5	3.0	28	*3.08	6.35	3.0	11	5	0.00	158	2.72
2000	7.0	7.0	25	*3.78	3.78	7.5	8	8	0.00	167	3.78
2000	7.5	6.0	24	*3.11	3.88	3.0	8	8	0.00	146	3.33
2000	8.0	5.0	23	*3.39	3.97	3.0	9	7	0.00	147	2.83
2000	9.5	4.0	25	*3.55	5.13	3.0	10	6	0.00	169	2.93
2000	10.5	3.5	28	*3.37	6.35	3.0	11	6	0.00	179	3.17

APPENDIX C
REINFORCING BAR AREA TABLES

Designations And Properties

Size (Inches)	Diameter (Inches)	Designation	Cross Sectional Area, (Sq. In.)	Unit Wt. Per Ft. (Lb.)
3/8	0.38	No. 3	0.11	0.376
1/2	0.50	No. 4	0.20	0.668
5/8	0.63	No. 5	0.31	1.043
3/4	0.75	No. 6	0.44	1.502
7/8	0.88	No. 7	0.60	2.044
1	1.00	No. 8	0.79	2.670
1 1/8	1.13	No. 9	1.00	3.400
1 1/4	1.27	No. 10	1.27	4.303
1 3/8	1.41	No. 11	1.56	5.313

Areas of Groups of Bars In Square Inches

Bar Designation	Number of Bars												
	2	3	4	5	6	7	8	9	10	11	12	13	14
No. 3	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	1.21	1.32	1.43	1.54
No. 4	0.39	0.58	0.78	0.98	1.18	1.37	1.57	1.77	1.96	2.16	2.36	2.55	2.75
No. 5	0.61	0.91	1.23	1.53	1.84	2.15	2.45	2.76	3.07	3.37	3.68	3.99	3.30
No. 6	0.88	1.32	1.77	2.21	2.65	3.09	3.53	3.98	4.42	4.86	5.30	5.74	6.19
No. 7	1.20	1.80	2.41	3.01	3.61	4.21	4.81	5.41	6.01	6.61	7.22	7.82	8.42
No. 8	1.57	2.35	3.14	3.93	4.71	5.50	6.28	7.07	7.85	8.64	9.43	10.21	11.00
No. 9	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00
No.10	2.53	3.79	5.06	6.33	7.59	8.86	10.12	11.39	12.66	13.92	15.19	16.45	17.72
No.11	3.12	4.68	6.25	7.81	9.37	10.94	12.50	14.06	15.62	17.19	18.75	20.31	21.87

APPENDIX D

TENSION BAR DEVELOPMENT LENGTH, INCHES

(BOTTOM BARS, f_y=60 ksi, f'_c=3000)

	SPACING	
BAR NO.	$<$ 6"	$\bar{>}$ 6"
3	12.0	12.0
4	12.0	12.0
5	15.0	12.0
6	19.3	15.4
7	26.3	21.0
8	34.6	27.7
9	43.8	35.0
10	55.6	44.5
11	68.3	54.6
14	93.0	75.0
18	121.0	97.0

APPENDIX E
FACTORS OF SAFETY

ITEM		FACTOR OF SAFETY OR LOAD FACTOR
FOOTINGS	UNIFORM SOIL PRESSURE	3.0
	NONUNIFORM SOIL PRESSURE	2.4* (3.0 ÷ 1.25)
	UPLIFT	2.0*
	OVERTURNING	2.0*
	SLIDING	2.0*
LOAD COMBINATIONS FOR STRUCTURAL DESIGN OF FOOTINGS	DEAD LOAD + LIVE LOAD	1.7
	DEAD + LIVE + WIND	1.7*
	DEAD + LIVE + EARTHQUAKE	1.7*
	DEAD + WIND	1.7*
	DEAD + EARTHQUAKE	1.7*
HORIZONTAL FORCE TIES	TENSION RODS	1.65*
	HAIRPIN BARS	1.65*

* 33-1/3 REDUCTION ALLOWED IF WIND OR EARTHQUAKE FORCES ARE INVOLVED. FOR ENTERING THE TABLES IN APPENDIX B USE 3/4 of LOADS WHICH INCLUDE WIND OR EARTHQUAKE.

APPENDIX F
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