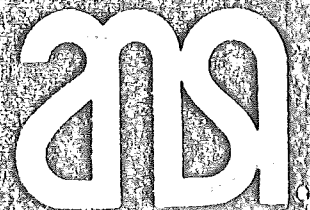


American National Standard

page 32

building code requirements for
minimum design loads in buildings
and other structures

A58.1-1972



american national standards institute, inc.
1430 broadway new york new york 10018

American National Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures

Secretariat
National Bureau of Standards

Approved July 20, 1972
American National Standards Institute, Inc

Abstract

This revision of American Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58.1-1955, gives assumptions for dead, live, wind, snow, and earthquake loads suitable for inclusion in building codes. The basis of the requirements is discussed in an appendix which also gives supplementary information useful to those engaged in preparing and administering local building codes.

While recommended dead loads are essentially those contained in the 1955 publication, new provisions for concentrated live loads and load combinations are contained in this revision. Recommended minimum roof live loads are those contained in the Uniform Building Code, 1970 edition.

The section on wind loads has been completely revised. New distributions of extreme fastest mile winds in the United States for various mean recurrence intervals are based on the latest National Weather Service data. A major innovation is the concept of varying load requirements, both with the dynamic properties of the building and with the nature of the terrain. This edition aids the designer to understand the dynamic nature of wind loads and their application to real structures. This insight is expected to produce designs for buildings and other structures of more uniform safety and thus of greater economy.

Provisions for snow loads have been greatly expanded and are based on ground snow load for various mean recurrence intervals. Use is made of snow load coefficients, based on roof geometry and exposure to wind, to account for local snow accumulation and redistribution due to sliding.

The provisions relating to earthquake loads are largely based on the Recommended Lateral Force Requirements, 1960 (revised 1968), Seismology Committee, Structural Engineers Association of California. A new seismicity zoning map is contained in the appendix to aid designers to anticipate where destructive future earthquakes are likely to occur. Although Zone 0 has been eliminated within the continental United States, shear walls or braced frames may be used in lieu of a ductile moment-resisting space frame under certain conditions.

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Published by

American National Standards Institute
1430 Broadway, New York, New York 10018

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Printed in the United States of America

HS1M576/750

Foreword

(This Foreword is not a part of American National Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58.1-1972.)

American National Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58.1-1972, gives assumptions for dead, live, wind, snow, and earthquake loads suitable for inclusion in building codes. The basis of the requirements is discussed in the appendix, which also gives supplementary information useful to those engaged in preparing and administering local building codes.

In 1924, a report of the Department of Commerce Building Code Committee, entitled "Minimum Live Loads Allowable for Use in Design of Buildings," was published by the National Bureau of Standards. The recommendations contained in that document were widely used in revision of local building codes and were quoted in many textbooks. Those recommendations, based on a study of data obtained from available sources, represented the considered judgment of experienced architects and engineers.

In 1945, the ASA Sectional Committee on Building Code Requirements for Minimum Design Loads in Buildings, A58, issued a report which represented a continuation of work in this field. This committee took into consideration the work of the previous committee and also additional facts that had developed in later investigations. American Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58.1-1945, covered a somewhat wider field than the 1924 report. Loads were construed to include weight of materials and equipment, weight of occupants and movable contents, wind pressures, weight of snow, and earthquake forces.

The 1945 standard was updated by the committee in 1955 and resulted in the issuance of American Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58.1-1955.

In accordance with the procedure of the American National Standards Institute, the committee reviewed the standard issued in 1955 and prepared these revised recommendations which embody results of further research on the subject.

This standard is one of a series of related standards that represent recommended basic building code requirements which are being developed by technical committees under the procedures of the American National Standards Institute.

American National Standards Committee on Building Code Requirements for Minimum Design Loads in Buildings and Other Structures, A58, had the following members at the time it developed and approved this revision of the standard:

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R. D. Marshall, Secretary

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American National Standard Building Code Requirements for Minimum Design Loads in Buildings and Other Structures

1. General

1.1 Scope. These requirements are intended to govern assumptions for dead, live, and other loads in the design of buildings and other structures which are subject to building code requirements. The loads specified herein are the minimum suitable for use with stresses and load factors recommended in current design specifications for concrete, steel, wood, and any other structural materials used in buildings.

1.2 Definitions

building official. The officer or other designated authority charged with the administration and enforcement of the building code or his duly authorized representative.

dead load. The weight of all permanent construction, including walls, floors, roofs, partitions, stairways, and fixed service equipment.

live load. The weight superimposed by the use and occupancy of the building or other structure, not including the wind load, snow load, earthquake load, or dead load.

1.3 Safe Support Required. Buildings or other structures, and all parts thereof, shall be designed and constructed to support safely all loads, including dead loads, without exceeding the allowable stresses (or ultimate strengths when appropriate load factors are applied) for the materials of construction in the structural members and connections. When both wind and earthquake loads are present, only that one which produces the greater stresses need be considered, and both need not be assumed to act simultaneously.

1.3.1 Progressive Collapse. Buildings and structural systems shall provide such structural integrity that the hazards associated with progressive collapse, such as that due to local failure caused by severe overloads or abnormal loads not specifically covered herein, are reduced to a level consistent with good engineering practice.

1.4 Additions to Existing Structures. When an existing

building or other structure is enlarged or otherwise altered, all portions thereof affected by such enlargement or alteration shall be strengthened, if necessary, so that all loads will be supported safely without exceeding the allowable stresses (or ultimate strengths when appropriate load factors are applied) for the materials of construction in the structural members and connections.

1.5 Load Tests. The building official may require a load test of any construction, whenever there is reason to question its safety for the intended occupancy or use.

2. Dead Loads

2.1 Weights of Materials and Constructions. In estimating dead loads for purposes of design, the actual weights of materials and constructions shall be used, provided that in the absence of definite information, values satisfactory to the building official may be assumed.

NOTE: For information on dead loads, see Appendix, Table A1.

2.2 Weight of Fixed Service Equipment. In estimating dead loads for purposes of design, the weight of fixed service equipment, such as plumbing stacks and risers, electrical feeders, heating, ventilating and air-conditioning systems, shall be included, whenever it is carried by structural members.

2.3 Provision for Partitions. In office buildings or other buildings, where partitions might be subject to erection or rearrangement, provision for partition weight shall be made, whether or not partitions are shown on the plans, unless the specified live load exceeds 80 psf (pound-force per square foot).

3. Live Loads

3.1 Uniformly Distributed Loads

3.1.1 Required Live Loads. The live loads to be as-

Table 1
Minimum Uniformly Distributed Live Loads

Occupancy or Use	Live Load (psf)	Occupancy or Use	Live Load (psf)
Apartments (<i>see Residential</i>)		Office buildings:	
Armories and drill rooms	150	Offices	50
Assembly halls and other places of assembly:		Lobbies	100
Fixed seats	60	Corridors, above first floor	80
Movable seats	100	File and computer rooms require heavier loads based upon anticipated occupancy	
Platforms (assembly)	100	Penal institutions:	
Balcony (exterior)	100	Cell blocks	40
On one and two family residences only and not exceeding 100 sq ft	60	Corridors	100
Bowling alleys, poolrooms, and similar recreational areas	75	Residential:	
Corridors:		Multifamily houses:	
First floor	100	Private apartments	40
Other floors, same as occupancy served except as indicated		Public rooms	100
Dance halls and ballrooms	100	Corridors	80
Dining rooms and restaurants	100	Dwellings:	
Dwellings (<i>see Residential</i>)		First floor	40
Fire escapes	100	Second floor and habitable attics	30
On multi- or single-family residential buildings only	40	Uninhabitable attics	20
Garages (passenger cars only)	50	Hotels:	
For trucks and buses use AASHO* lane loads (<i>see Table 2 for concentrated load requirements</i>)		Guest rooms	40
Grandstands (<i>see Reviewing stands</i>)		Public rooms	100
Gymnasiums, main floors and balconies	100	Corridors serving public rooms	100
Hospitals:		Corridors	80
Operating rooms, laboratories	60	Reviewing stands and bleachers†	100
Private rooms	40	Schools:	
Wards	40	Classrooms	40
Corridors, above first floor	80	Corridors	80
Hotels (<i>see Residential</i>)		Sidewalks, vehicular driveways, and yards, subject to trucking	250
Libraries:		Skating rinks	100
Reading rooms	60	Stairs and exitways	100
Stack rooms (books & shelving at 65 pcf) but not less than	150	Storage warehouse:	
Corridors, above first floor	80	Light	125
Manufacturing:		Heavy	250
Light	125	Stores:	
Heavy	250	Retail:	
Marquees	75	First floor, rooms	100
		Upper floors	75
		Wholesale	125
		Theaters:	
		Aisles, corridors, and lobbies	100
		Orchestra floors	60
		Balconies	60
		Stage floors	150
		Yards and terraces, pedestrians	100

*American Association of State Highway Officials.

†For detailed recommendations, see American National Standard for Tents, Grandstands, and Air-Supported Structures Used for Places of Assembly, Z20.3-1967 (NFPA No. 102-1967).

sumed in the design of buildings and other structures shall be the greatest loads that probably will be produced by the intended use or occupancy, but in no case less than the minimum uniformly distributed unit loads required by Table 1.

3.1.2 Loads Not Specified. For occupancies or uses not listed in 3.1.1 or 3.2, the live load shall be determined in a manner satisfactory to the building official.

NOTE: For additional information on live loads, see Appendix, Tables A3 and A4.

3.1.3 Thrusts on Handrailings. Stairway and balcony railings, both exterior and interior, shall be designed to resist a vertical and a horizontal thrust of 50 pounds per linear foot applied at the top of the railing.

3.2 Concentrated Loads. Floors shall be designed to

Table 2
Concentrated Loads

Location	Load (lb)
Elevator machine room grating (on area of 4 sq in)	300
Finish light floor plate construction (on area of 1 sq in)	200
Garages	*
Office floors	2000
Scuttles, skylight ribs, and accessible ceilings	200
Sidewalks	8000
Stair treads (on area of 4 sq in at center of tread)	300

*Floors in garages or portions of buildings used for storage of motor vehicles shall be designed for the uniformly distributed live loads of Table 1 or the following concentrated loads: (1) for passenger cars accommodating not more than nine passengers, 2000 pounds acting on an area of 20 sq in; (2) mechanical parking structures without slab or deck, passenger cars only, 1500 pounds per wheel; (3) for trucks or buses, maximum axle load on an area of 20 sq in.

support safely the uniformly distributed live loads prescribed in 3.1 or the concentrated load in pounds given in Table 2, whichever produces the greater stresses. Unless otherwise specified, the indicated concentration shall be assumed to occupy an area of 2-1/2 feet square and shall be so located as to produce the maximum stress conditions in the structural members.

3.2.1 Roof Trusses. Any panel point of the lower chord of roof trusses or any point of other primary structural members supporting roofs over garage, manufacturing, and storage floors shall be capable of carrying safely a suspended concentrated load of not less than 2000 pounds.

3.3 Partial Loading. The full intensity of the appropriately reduced live load applied only to a portion of the length of a structure or member shall be considered if it produces a more unfavorable effect than the same intensity applied over the full length of the structure or member.

3.4 Impact Loads. The live loads specified in 3.1.1 shall be assumed to include adequate allowance for ordinary impact conditions. Provision shall be made in the structural design for uses and loads which involve unusual vibration and impact forces.

3.4.1 Elevators. All moving elevator loads shall be increased 100% for impact, and the structural supports shall be designed within the limits of deflection prescribed by American National Standard Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks, A17.1-1971, and American National Standard

Practice for the Inspection of Elevators (Inspectors' Manual), A17.2-1960.

3.4.2 Machinery. For the purpose of design, the weight of machinery and moving loads shall be increased as follows to allow for impact: (1) elevator machinery, 100%; (2) light machinery, shaft or motor driven, 20%; (3) reciprocating machinery or power-driven units, 50%; (4) hangers for floors or balconies, 33%; all percentages increased if so recommended by the manufacturer.

3.4.3 Craneways. All craneways shall have their design loads increased for impact as follows: (1) a vertical force equal to 25% of the maximum wheel load; (2) a lateral force equal to 20% of the weight of trolley and lifted load only, applied one-half at the top of each rail; and (3) a longitudinal force of 10% of the maximum wheel loads of the crane applied at top of rail.

3.5 Reduction in Live Loads

3.5.1 Live Loads 100 Pound-Force per Square Foot or Less. For live loads of 100 psf or less, the design live load on any member supporting 150 square feet or more may be reduced at the rate of 0.08% per sq ft of area supported by the member, except that no reduction shall be made for areas to be occupied as places of public assembly, for garages, or for roofs. The reduction shall exceed neither R as determined by the following formula, nor 60%:

$$R = 23 \left(1 + \frac{D}{L} \right) \quad (\text{Eq 1})$$

where

R = reduction in percent

D = dead load per square foot of area supported by the member

L = design live load per square foot of area supported by the member

3.5.2 Live Loads Exceeding 100 Pound-Force per Square Foot. For live loads exceeding 100 psf, no reduction shall be made, except that the design live loads on columns may be reduced 20%.

3.6 Posting of Live Loads. In every building or other structure, or part thereof, used for mercantile, business, industrial, or storage purposes, the loads approved by the building official shall be marked on plates of approved design which shall be supplied and securely affixed by the owner of the building, or his duly authorized agent, in a conspicuous place in each space to which they relate. Such plates shall not be removed or defaced and, if lost, removed, or defaced, shall be replaced by the owner or his agent.

Table 3
Minimum Roof Live Loads*

Roof Slope	Tributary Loaded Area in Square Feet for any Structural Member		
	0 to 200	201 to 600	Over 600
Flat or rise less than 4 inches per foot	20	16	12
Arch or dome with rise less than 1/8 of span			
Rise 4 inches per foot to less than 12 inches per foot	16	14	12
Arch or dome with rise 1/8 of span to less than 3/8 of span			
Rise 12 inches per foot and greater	12	12	12
Arch or dome with rise 3/8 of span or greater			

*In pound-force per square foot of horizontal projection.

3.7 Restrictions on Loading. A load greater than that for which a floor or roof is approved by the building official shall not be placed, or caused or permitted to be placed, on any floor or roof of a building or other structure.

3.8 Minimum Roof Loads

3.8.1 Flat, Pitched, or Curved Roofs. Ordinary roofs, either flat, pitched, or curved, shall be designed for the live loads as specified in Table 3 or the snow load as specified in 7.2, whichever produces the greater stresses.

3.8.1.1 Ponding. For roofs, care shall be taken to provide drainage or the load shall be increased to represent all likely accumulations of water. Deflection of roof members will permit ponding of water accompanied by increased deflection and additional ponding.

3.8.2 Special-Purpose Roofs. When used for incidental promenade purposes, roofs shall be designed for a minimum live load of 60 psf; and 100 psf, when designed for roof-garden or assembly uses. Roofs to be used for other special purposes shall be designed for appropriate loads, as directed or approved by the building official.

4. Combination of Loads

4.1 Combining Loads. Except when applicable codes make other provisions, all loads listed herein shall be considered to act in the following combinations, which-

ever produce the most unfavorable effects in the building, foundation, or structural member concerned, reduced when appropriate, according to 3.5. The most unfavorable effect may occur when one or more of the contributing loads are not acting.

(1) D

(2) $D + L$

(3) $D + (W \text{ or } E)$

(4) $D + T$

(5) $D + L + (W \text{ or } E)$

(6) $D + L + T$

(7) $D + (W \text{ or } E) + T$

(8) $D + L + (W \text{ or } E) + T$

where

D = dead load consisting of:

(a) the weight of the member itself

(b) the weight of all materials of construction incorporated into the building to be permanently supported by the member, including built-in partitions

(c) the weight of permanent equipment

(d) forces due to prestressing

L = loads due to intended use and occupancy (including loads due to movable partitions and to traveling cranes); snow, ice, or rain; earth and hydrostatic pressure; horizontal components of static or inertial forces. For combinations with earthquake, see 8.9.4

W = wind load

E = earthquake load

T = loads, forces, and effects due to contraction or expansion resulting from temperature changes, shrinkage, moisture changes, creep in component materials, movement due to differential settlement or combinations thereof

4.2 Probability Factor. The total of the combined load effects may be multiplied by the following load combination probability factors: An increase in the allowable stresses will not be allowed in conjunction with a decrease due to the above load combinations.

(a) 1.00 for combinations (1) through (4)

(b) 0.75 for combinations (5) through (7)

(c) 0.66 for combination (8)

4.3 Dead Load Counteracting Live Load. When loads other than dead counteract dead loads in a structural member or joint, special care shall be exercised by the designer to ensure adequate safety for possible stress reversals.

5. Soil and Hydrostatic Pressure

5.1 Pressure on Basement Walls. In the design of base-

ment walls, and similar approximately vertical structures below grade, provision shall be made for the lateral pressure of adjacent soil. Due allowance shall be made for possible surcharge from fixed or moving loads. When a portion, or the whole, of the adjacent soil is below a free-water surface, computations shall be based on the weight of the soil diminished by buoyancy, plus full hydrostatic pressure.

5.2 Uplift on Floors. In the design of basement floors and similar approximately horizontal construction below grade, the upward pressure of water, if any, shall be taken as the full hydrostatic pressure applied over the entire area. The hydrostatic head shall be measured from the underside of the construction.

6. Wind Loads

6.1 General. Provisions for calculating wind loads on buildings and other structures are described in the following subsections. These provisions apply to the calculation of wind loads on structures as a whole and on individual structural elements. In all cases, the calculated wind loads act normal to the surfaces to which they apply. Use is made of new distributions of annual, extreme, fastest-mile winds in the United States for various mean recurrence intervals; and the concept of varying load requirements, based on the dynamic properties of the structure and on the nature of the surrounding terrain, is employed. The provisions described herein do not apply to buildings and other structures of unusual shape, exposure, or structural characteristics which would make them susceptible to wind-excited oscillations. In such cases, special investigations are required for safe and economical design.

6.1.1 Symbols and Notations. The following symbols and notations apply only to the provisions of Section 6, Wind Loads:

- A = area in square feet
- a = greater dimension of sign in feet
- b = smaller dimension of sign in feet
- C = distance between windward and leeward edges of roof in feet
- C_D = drag coefficient
- C_f = net pressure coefficient
- C_L = lift coefficient
- C_p = external pressure coefficient
- C_{pi} = internal pressure coefficient
- d = diameter or least horizontal dimension of structure in feet
- d' = depth of protruding elements in feet
- G_F = gust factor for ordinary buildings and structures

- G_P = gust factor for parts and portions of buildings and structures
- g = distance between bottom of sign and ground in feet
- H = height-to-width ratio
- h = vertical dimension of the building or structure in feet
- K = factor which depends upon orientation of sign relative to the wind
- K_z = velocity pressure coefficient at height z which depends upon type of exposure
- n = ratio of open area to solid area of a wall
- p = wind pressure in psf (pound-force per square foot)
- q_A = effective velocity pressure acting over area A ($200 \leq A \leq 1000$) in psf
- q_F = effective velocity pressure for ordinary buildings and structures in psf
- q_I = internal pressure in psf
- q_M = effective velocity pressure in psf for calculating internal pressures
- q_P = effective velocity pressure for parts and portions of buildings and structures in psf
- q_{30} = basic wind pressure in psf
- r = rise-to-span ratio
- V_{30} = basic wind speed in miles per hour
- W = wind load in pounds
- w = least width of building in feet
- X = distance to center of pressure from windward edge of roof in feet
- z = height above ground in feet
- α = angle between wind direction and plane of roof in degrees
- β = angle between wind direction and direction of the chord of the guy in degrees
- θ = roof slope from horizontal in degrees
- λ = ratio of length of the windward edge of the roof to the distance between windward and leeward edges
- ϕ = ratio of solid area to gross area of a sign or tower

6.2 Procedure for Calculating Wind Loads. Wind loads on buildings and other structures shall be determined, using the following procedure:

(1) A mean recurrence interval shall be selected which depends on the intended operational usage, anticipated life of the structure, degree of sensitivity to wind, and risk to human life and property in case of failure. (See 6.3.1.)

(2) A basic wind speed is selected from Table 4 or Figs. 1 and 2. This basic wind speed may require modification, as indicated in 6.3.3.

(3) The basic wind speed is converted to effective velocity pressures q_F or q_P by the formulas of 6.3.4. For convenience, values of q_F for ordinary buildings and structures and q_P for parts and portions have been

Table 4
Hawaii and Puerto Rico, Basic Wind Speeds
in Miles per Hour, V_{30}

Exposures	Mean Recurrence Interval (Years)		
	25	50	100
Hawaii			
Westerly	60	65	75
Easterly	70	80	90
Puerto Rico			
All	80	95	110

tabulated in Tables 5 and 6, respectively. Note that certain restrictions are placed on the application of these tables.

(4) The design pressures or design loads are obtained by multiplying the effective velocity pressures by the appropriate pressure coefficients, as indicated in 6.4. Pressure coefficients are given in 6.5 through 6.9.

6.3 Basic Data

6.3.1 Mean Recurrence Interval. A basic wind speed with a 50-year mean recurrence interval shall be used for all permanent structures except those that, in the judgment of the engineer or authority having jurisdiction, present a high degree of sensitivity to wind and an unusually high degree of hazard to life and property in case of failure. In the latter case, a 100-year mean recurrence interval shall be used. For structures that have no human occupants or where there is negligible risk to human life, a 25-year mean recurrence interval may be used. (See Fig. A1.)

6.3.2 Basic Wind Speeds. The basic wind speeds to be used in the determination of wind loads on buildings and other structures are given in Table 4 and in Figs. 1 and 2 for the United States. These speeds correspond to the fastest-mile speeds for 50- and 100-year mean recurrence intervals and are based on observed air flow in open level country at a height of 30 feet above ground. Tornadoes have not been considered in developing the basic wind-speed distributions.

6.3.3 Special Wind Regions. Although the wind maps apply to winds from all types of storms except tornadoes, special consideration shall be given to regions where unusual channeling or lifting may occur. For ocean promontories, mountains, gorges, and other unusual exposures, where wind records or experience indicate that the wind speeds given in Table 4 and in Figs. 1 and 2 are inadequate, higher basic wind speeds may be prescribed by the building official. All mountainous and hilly exposures must be carefully examined for such unusual conditions.

6.3.4 Effective Velocity Pressures—Variation with Height and Exposure. Wind speeds shown in the wind

maps may be converted to velocity pressures, using the formula:

$$q_{30} = 0.00256 V_{30}^2 \quad (\text{Eq 2})$$

where

q_{30} = basic wind pressure in pound-force per square foot

V_{30} = basic wind speed in miles per hour

The effective velocity pressures of winds for buildings and structures, q_F , and for parts and portions, q_P , at various heights above the ground shall be computed in accordance with the following formulas:

$$q_F = K_z G_F q_{30} \quad (\text{Eq 3})$$

$$q_P = K_z G_P q_{30} \quad (\text{Eq 4})$$

where K_z is a velocity pressure coefficient which depends upon the type of exposure and height z above ground, and G_F and G_P are gust factors which depend upon the type of exposure and dynamic response characteristics of the structure, or parts and portions thereof.

6.3.4.1 Effective Velocity Pressures for Ordinary Buildings and Structures. For convenience, values of q_F for ordinary buildings and structures and q_P for parts and portions have been tabulated for a range of wind speeds in Tables 5 and 6. Effective velocity pressures at heights intermediate to those listed in the tables may be obtained by interpolation. A step function of pressure with height may also be used; in that case, the specified effective pressure at a given height shall be applied over a height zone defined by one-half the difference in adjacent heights for which effective pressures are specified. For example, the pressure at 100 ft would be applied over a height zone that extends from 75 to 125 ft.

The effective velocity pressures given in Table 5 take into account the dynamic response to gusts of ordinary buildings and structures in a direction parallel to the wind and should be considered as a minimum. They do not provide for the effects of vortex shedding or instability due to galloping or flutter. (See Appendix, A6.3.4.) Where a dynamic approach to the action of wind gusts is required, the procedure given in Appendix, A6.3.4.1 should be used to obtain the effective velocity pressures. For buildings whose height exceeds five times the least horizontal dimension, and for buildings whose dynamic properties tend to make them wind-sensitive, a detailed analysis shall be required.

6.3.4.2 Effective Velocity Pressures for Parts and Portions. For parts and portions of structures, such as

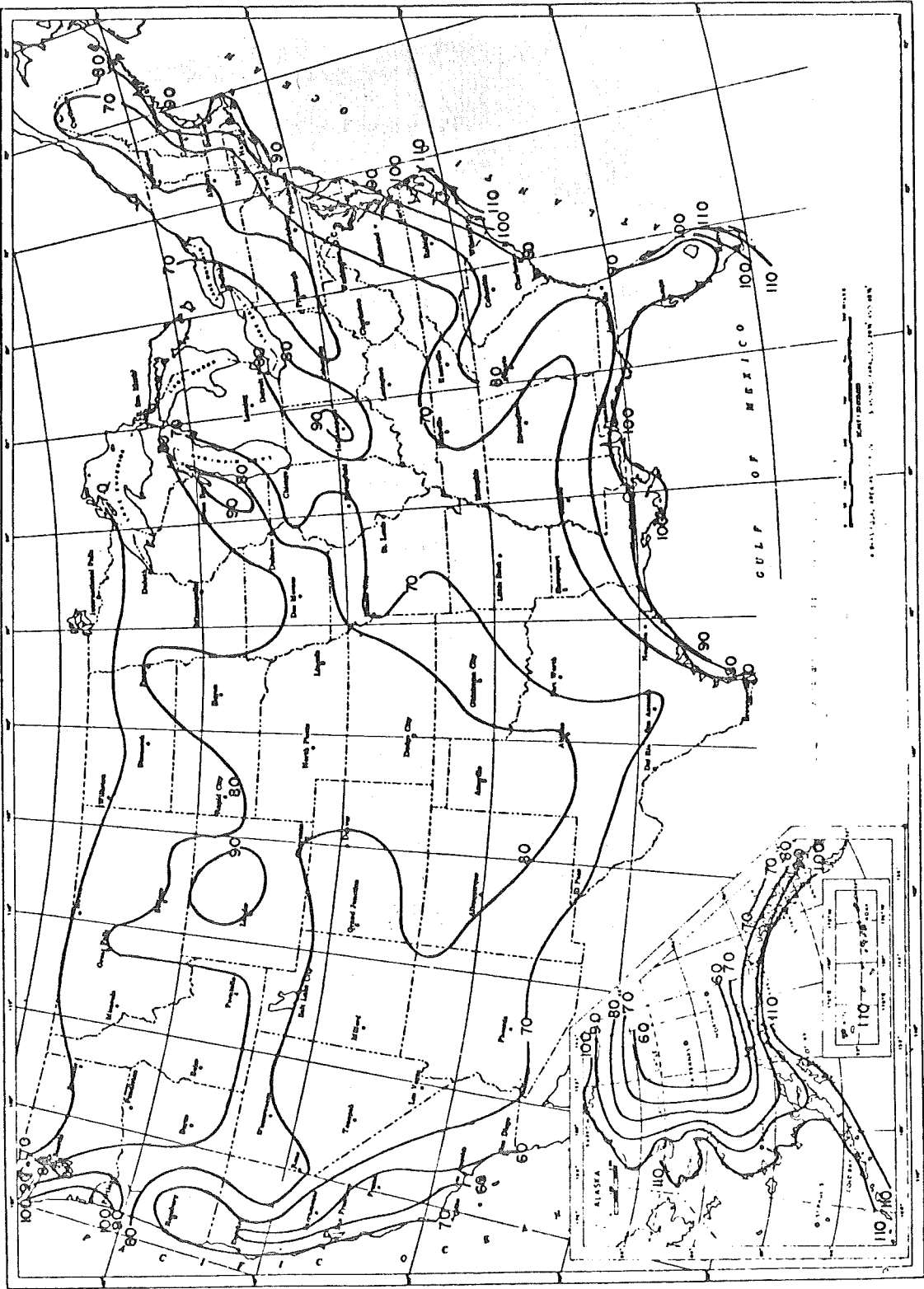


Fig. 1
Basic Wind Speed in Miles per Hour
Annual Extreme Fastest-Mile Speed 30 Feet Above Ground, 50-Year Mean Recurrence Interval

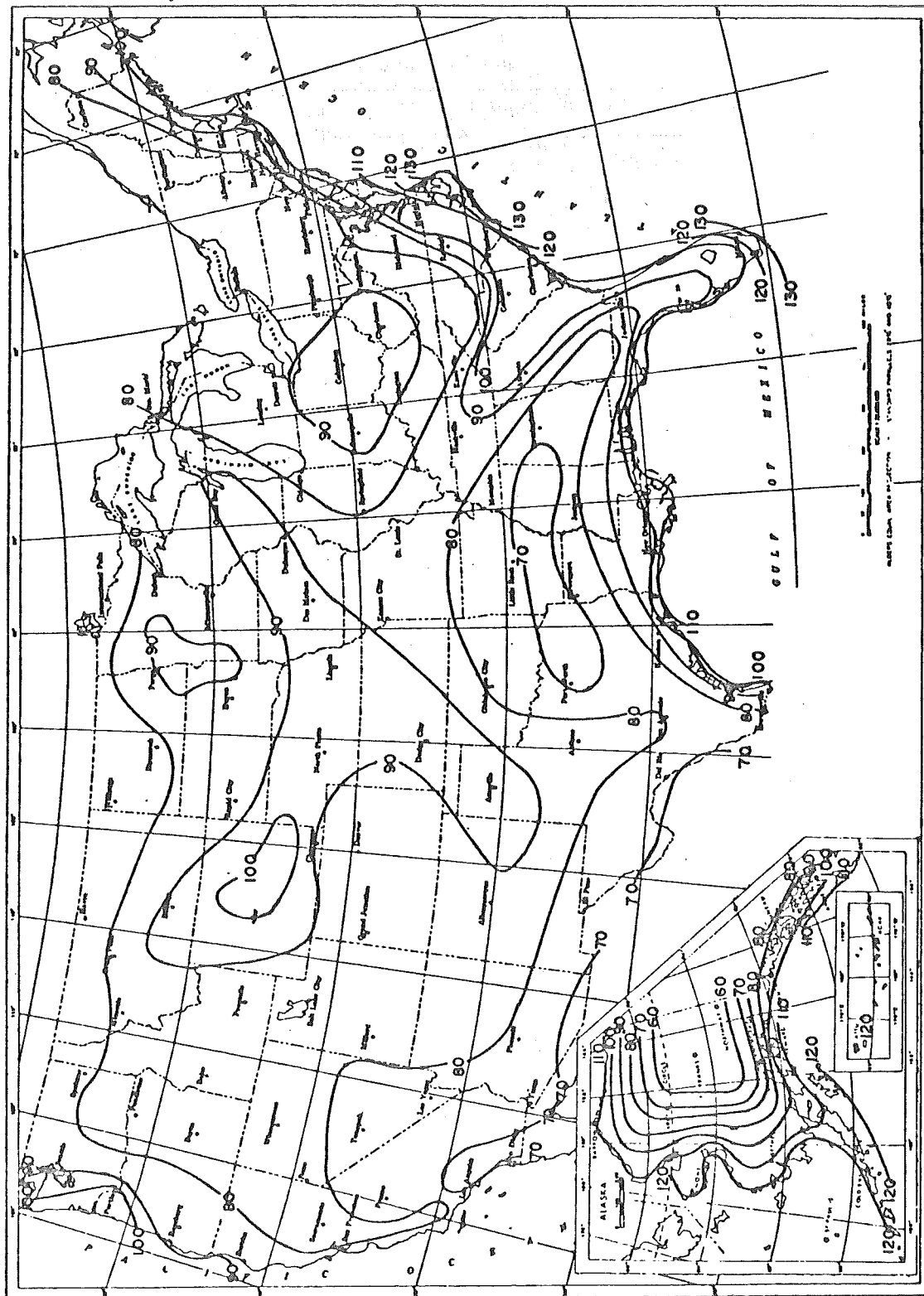


Fig. 2
Basic Wind Speed in Miles per Hour
Annual Extreme Fastest-Mile Speed 30 Feet Above Ground, 100-Year Mean Recurrence Interval

Table 5
Effective Velocity Pressures
for Ordinary Buildings and Structures, q_F
EXPOSURE A*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
Less than 30	3	4	5	6	7	9	10	12	14
30	3	4	5	7	9	11	13	15	18
50	3	5	7	9	11	13	16	19	23
100	5	7	9	12	15	18	22	27	31
150	6	8	11	14	18	22	27	32	38
200	6	9	12	16	21	26	31	37	43
250	7	10	14	18	23	28	34	41	48
300	8	11	15	20	25	31	38	45	53
350	8	12	17	22	27	34	41	49	57
400	9	13	18	23	29	36	44	52	61
450	10	14	19	24	31	38	46	55	64
500	10	15	20	26	33	40	49	58	68
550	11	15	21	27	34	42	51	61	71
600	11	16	22	28	36	44	54	64	75
650	11	17	22	29	37	46	56	66	78
700	12	17	23	31	39	48	58	69	81
750	12	18	24	32	40	50	60	71	84
800	13	18	25	33	42	51	62	74	87

*A: Centers of large cities and very rough, hilly terrain. Interpolations of the values of q_F may be used for intermediate heights.

Table 5
Effective Velocity Pressures
for Ordinary Buildings and Structures, q_F
EXPOSURE B*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
Less than 30	5	6	8	10	13	16	20	23	27
30	5	7	10	13	16	20	25	29	34
50	6	9	12	15	19	24	29	34	40
100	7	11	15	19	24	30	36	43	51
150	9	12	17	22	28	34	41	49	58
200	9	14	18	24	31	38	46	54	64
250	10	15	20	26	33	41	49	59	69
300	11	16	21	28	35	43	52	62	73
350	11	16	22	29	37	45	55	65	77
400	12	17	23	31	39	48	58	69	81
450	12	18	24	32	40	50	60	72	84
500	13	18	25	33	42	51	62	74	87
550	13	19	26	34	43	53	64	76	90
600	14	20	27	35	44	55	66	79	92
650	14	20	28	36	46	57	69	82	96
700	14	21	28	37	47	58	70	83	98
750	15	21	29	38	48	59	72	86	100
800	15	22	30	39	49	61	73	87	102

*B: Suburban areas, towns, city outskirts, wooded areas, and rolling terrain. Interpolations of the values of q_F may be used for intermediate heights.

Table 5
Effective Velocity Pressures
for Ordinary Buildings and Structures, q_F
EXPOSURE C*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
Less than 30	6	7	11	15	20	26	32	39	45
30	8	12	16	21	27	33	40	48	56
50	9	14	18	24	31	38	46	54	64
100	11	16	21	28	35	44	53	63	74
150	12	17	23	31	39	48	58	69	81
200	13	18	25	33	41	51	62	74	86
250	13	19	26	34	43	53	65	77	90
300	14	20	27	36	45	56	68	80	94
350	14	21	28	37	47	58	70	83	97
400	15	21	29	38	48	59	72	86	100
450	15	22	30	39	49	61	74	88	103
500	16	22	30	40	50	62	75	90	105
550	16	23	31	41	52	64	77	92	108
600	16	23	32	42	53	65	79	94	110
650	17	24	33	42	54	66	80	96	112
700	17	24	33	43	55	67	82	97	114
750	17	25	34	44	55	68	83	99	116
800	17	25	34	45	57	70	85	101	118

*C: Flat, open country, open flat coastal belts, and grassland. Interpolations of the values of q_F may be used for intermediate heights.

girts, purlins, windows, spandrels, etc., and tributary areas less than 200 sq ft, the velocity pressures given in Table 6 shall be used. For tributary areas from 200 to 1000 sq ft, q_P may be reduced linearly to the values specified in Table 5. This may be accomplished at height z by the formula:

$$q_A = \left(\frac{1000 - A}{800} \right) (q_P - q_F) + q_F \quad (\text{Eq 5})$$

where

q_A = the effective velocity pressure over area A
(200 $\leq A \leq 1000$)

6.3.5 Shielding and Channeling. No reductions in pressures from those obtained in 6.3.4 are to be made for the effects of direct shielding afforded by other buildings and structures or by terrain features. However, any increases in pressure or suction on buildings and structures as a result of such obstructions are to be allowed for in design.

6.4 Pressure Coefficients – General. In the following sections, external pressure coefficients, C_P , and net pressure coefficients, C_F , are given for various building shapes. Pressure coefficients define the pressure acting at local positions on the surface of a building or structure. Net pressure coefficients apply to the direct calculation of the wind load acting over the projected area

of a structure and are dependent on its external shape and orientation with respect to the wind. The coefficients specified hereinafter have not been increased by a factor of safety.

In the calculation of design wind loads on buildings and structures or elements thereof, the pressure difference between opposite faces shall be taken into account. Where more than one coefficient is specified, each shall be considered in determining the maximum stresses. Therefore, the resultant design wind pressure acting on an element of an enclosed structure is

$$p = qC_P - q_M C_{Pi} \quad (\text{Eq 6})$$

where q equals q_F or q_P , whichever is appropriate, C_P is the external pressure coefficient and q_M and C_{Pi} are as defined in 6.5.4. A negative value for p indicates that the resultant pressure acts outward.

The total design wind load on a building or structure may be obtained by calculating the vector sum of the resultant forces that act on its elements. In certain cases, where net pressure coefficients are available, the total design wind load may be calculated directly by the following formula:

$$W = qC_F A \quad (\text{Eq 7})$$

Here q and C_F are as defined above and A is the projected area of the structure on a vertical plane normal

Table 6
Effective Velocity Pressures for Parts and Portions
of Buildings and Structures, q_p
EXPOSURE A*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
30 or less	3	5	6	8	10	13	15	18	21
50	4	6	8	10	13	16	19	23	27
100	5	8	10	14	17	21	26	31	36
150	6	9	12	16	21	25	31	37	43
200	7	10	14	19	24	29	35	42	49
250	8	12	16	21	26	32	39	46	54
300	9	13	17	23	29	35	43	51	60
350	10	14	19	24	31	38	46	55	64
400	10	15	20	26	33	41	49	58	69
450	11	15	21	27	35	43	52	62	73
500	11	16	22	29	37	45	55	65	76
550	12	17	23	30	38	47	57	68	80
600	12	18	24	31	40	49	59	71	83
650	13	18	25	33	42	51	62	74	87
700	13	19	26	34	43	53	64	77	90
750	14	20	27	35	45	55	67	79	93
800	14	20	28	36	46	57	68	81	96

*A: Centers of large cities and very rough, hilly terrain. Interpolations of the values of q_p may be used for intermediate heights.

Table 6
Effective Velocity Pressures for Parts and Portions
of Buildings and Structures, q_p
EXPOSURE B*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
30 or less	6	8	12	15	19	24	28	34	40
50	7	10	13	17	22	27	33	39	46
100	8	12	17	22	27	34	41	49	57
150	10	14	19	25	31	38	46	55	65
200	11	15	21	27	34	42	51	61	72
250	11	16	22	29	37	46	55	66	77
300	12	17	24	31	39	48	59	70	82
350	13	18	25	32	41	51	61	73	86
400	13	19	26	34	43	53	65	77	90
450	14	20	27	35	45	55	67	80	93
500	14	21	28	37	47	57	70	83	97
550	15	21	29	38	48	59	72	85	100
600	15	22	30	39	49	61	74	88	103
650	16	22	30	40	50	62	75	90	105
700	16	23	31	41	52	64	78	92	108
750	16	24	32	42	53	66	80	95	111
800	17	24	33	43	54	67	81	96	113

*B: Suburban areas, towns, city outskirts, wooded areas and rolling terrain. Interpolations of the values of q_p may be used for intermediate heights.

Table 6
Effective Velocity Pressures for Parts and Portions
of Buildings and Structures, q_p
EXPOSURE C*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
30 or less	10	14	19	24	31	38	46	55	64
50	11	15	21	27	34	42	51	61	72
100	12	18	24	31	39	49	59	70	82
150	13	19	26	34	43	53	65	77	90
200	14	20	28	36	46	57	69	82	96
250	15	21	29	38	48	59	72	86	101
300	15	22	30	39	50	61	74	88	104
350	16	23	31	41	52	64	77	92	108
400	16	24	32	42	53	66	80	95	111
450	17	24	33	43	54	67	81	96	113
500	17	25	34	44	56	69	84	99	117
550	18	25	34	45	57	70	85	101	119
600	18	26	35	46	58	72	87	104	122
650	18	26	36	46	59	72	88	104	123
700	19	27	36	48	60	74	90	107	126
750	19	27	37	48	61	76	91	109	128
800	19	28	37	49	62	76	92	110	129

*C: Flat, open country, open flat coastal belts, and grassland. Interpolations of the values of q_p may be used for intermediate heights.

to the wind direction. The net pressure shall, in any case, not be less than 10 psf (total design wind load divided by projected area) for the design of structural frames and shall not be less than 15 psf for the design of parts and portions of structures.

The pressure coefficients applicable at a given height on a building or structure shall be multiplied by the velocity pressure occurring at that height, except that for roofs the coefficients shall be multiplied by the effective velocity pressure that occurs at the mean height of the roof.

6.5 Buildings and Other Enclosed Structures

6.5.1 General. All buildings and other enclosed structures shall be designed to withstand the sliding and overturning effects of wind, allowing for the wind that is normal to any wall. The pressure distributions shall be determined by employing the appropriate pressure coefficients specified below.

6.5.2 Pressure Coefficients. The pressure coefficients given in this section apply to typical rectangular buildings and other enclosed structures that have vertical walls which may have doors, openable windows, etc. The positive and negative pressure coefficients indicate positive pressure and suction pressure, respectively.

6.5.3 External Pressure Coefficients. The average pressure coefficients, listed in Table 7, shall be used for

calculating pressures on external surfaces of buildings.

6.5.3.1 Walls – Local Pressure Coefficients. A pressure coefficient of -2.0 shall be used at the corners of all walls. The pressure shall be assumed to act on vertical strips of width $0.1w$, where w is the least width of the building, and the computed pressure shall be applied outward. These local pressures shall not be included with the net external pressure when computing overall loads.

6.5.3.2 Roofs

6.5.3.2.1 General. For buildings with a ratio of wall height to least width less than 2.5, an external suction pressure coefficient of -0.7 shall be used for the roof and the computed pressure shall be assumed uniform over the entire roof area. For buildings in which the height-width ratio is 2.5 or greater, a value of -0.8 shall be used for the entire roof area. These coefficients allow for wind parallel to the surfaces of flat, arched, and sloped roofs.

6.5.3.2.2 Arched Roofs. For wind perpendicular to the axis of the arch, the coefficients of Table 8 shall be used.

6.5.3.2.3 Gabled Roofs. For wind perpendicular to the ridge of gabled roofs, a pressure coefficient of -0.7 shall be used for the leeward slope, together with a coefficient for the windward slope which depends on the roof slope and the height-width ratio of the building, as given in Table 9. These coefficients

Table 7
External Pressure Coefficients for Walls, C_p

Location of Wall	Pressure Coefficient
Windward wall	0.8
Leeward wall, both height-width and height-length ratios of building ≥ 2.5	-0.6
Other buildings	-0.5
Side walls	-0.7

may also be used for shed and other sloped roofs of buildings.

6.5.3.2.4 Local Pressure Coefficients. The pressure coefficients given in Table 10 shall be used at the ridges, eaves, cornices and 90-degree corners of roofs. The pressure shall be assumed to act on strips of width $0.1w$ and the computed pressure applied outward at these locations along the ridge, eaves, and cornices. w = least width of building normal to ridge.

These local pressures shall not be included with the net external pressure when computing overall loads.

6.5.4 Internal Pressure Coefficients. Pressures acting on the interior surfaces of walls and roofs of buildings

shall be computed in accordance with the following formula:

$$q_I = q_M C_{pi} \quad (\text{Eq 8})$$

where

q_I = internal pressure in psf

q_M = effective velocity pressure in psf at height z

C_{pi} = internal pressure coefficient

The pressure is assumed to be uniform on all internal surfaces at a given building height and shall be calculated using the coefficients given in Table 11.

Both positive and negative coefficients shall be considered in calculating the maximum stresses. Values of q_M for the three terrains are presented in Table 12.

6.6 Roofs Over Nonenclosed Structures

6.6.1 Net Pressure Coefficients. The net pressure coefficients C_f for horizontal or inclined flat roofs over nonenclosed structures, such as open-air parking garages, shelter areas, outdoor arenas, stadiums and theaters, shall be as given in Table 13 in which α is the angle between the wind direction and the plane of the roof and λ is the ratio of the length of the windward edge to the distance between the windward and leeward edges (aspect ratio).

Table 8
External Pressure Coefficients for Arched Roofs, C_p

	Rise-to-Span Ratio, r	Windward Quarter	Center Half	Leeward Quarter
Roof on elevated structure	$0 < r < 0.2$	-0.9		-0.5
	$0.2 \leq r < 0.3$	$(1.5r - 0.3)^*$	$(-0.7 - r)$	-0.5
	$0.3 \leq r \leq 0.6$	$(2.75r - 0.68)$		-0.5
Roof springing from ground level	$0 < r \leq 0.6$	$1.42r$	$(-0.7 - r)$	-0.5

*When the rise-to-span ratio is $(0.2 \leq r \leq 0.3)$, alternate coefficients given by $(6r - 2.1)$ shall also be used for the windward quarter.

Table 9
External Pressure Coefficients for Windward Slope of Gabled Roofs, C_p

h/w	θ								
	$10^\circ-15^\circ$	20°	25°	30°	35°	40°	45°	50°	$\geq 60^\circ$
≤ 0.3	$0.01\theta^*$	0.2	0.25	0.3	0.35	0.4	0.45	0.5	0.01 θ
0.5	-1.0	-0.75	-0.5	-0.2	0.05	0.3	0.45	0.5	0.01 θ
1.0	-1.0	-1.0	-0.8	-0.55	-0.3	-0.05	0.2	0.45	0.01 θ
≥ 1.5	-1.0	-1.0	-1.0	-0.9	-0.6	-0.35	-0.1	0.2	0.01 θ

*Except for roofs rising from ground level ($h/w = 0$), a coefficient of -1.0 shall be used when $10^\circ \leq \theta \leq 15^\circ$. θ = roof slope in degrees from horizontal, h = wall height at eave, w = least width of building normal to ridge.

Table 10
Local Peak External Pressure
Coefficients for Roofs, C_p

Roof Slope θ , Degrees*	Ridges and Eaves	Corners
0 to 30	-2.4	(0.10 - 5.0)
Greater than 30	-1.7	-2.0

*For arched roofs, θ shall be taken as the angle between the horizontal and the tangent to the roof at the springing.

6.6.2 Inward and Outward Loads. The net pressure coefficients given in Table 13 are to be used in computing the resultant load normal to the surface. The resultant load may act either inward or outward.

6.6.3 Angle of Attack. In computing the angle between the wind direction and the plane of the roof, the wind shall be assumed to deviate by plus or minus 10 degrees from the horizontal.

6.6.4 Variation of Pressure. Pressures will be higher at the windward edge than at the leeward edge. To allow for this difference, the resultant load shall be assumed to act at the center of pressure X/C , as given in Table 14, where X is the distance to the center of pressure from the windward edge of the roof and C is the distance between the windward and leeward edges.

6.7 Chimneys, Tanks, and Similar Structures. Net pressure coefficients for chimneys, tanks, and similar structures shall be as given in Table 15. These coefficients apply to the projected area of the structure on a vertical plane normal to the wind direction. For slender structures such as flagpoles, a minimum net pressure coefficient of 1.2 shall be used if $d\sqrt{q} < 2.5$.

6.8 Signs and Outdoor Display Structures

6.8.1 General. For the purpose of determining wind loads, all signs shall be classified as either open or solid. Signs with openings greater than 30% of the gross area shall be classified as "open" signs. Those with openings less than 30% of the gross area shall be classified as "solid" signs. The effective velocity pressures of

Table 6 shall be used in calculating design loads.

6.8.2 Solid Signs

6.8.2.1 Height Above Ground. Solid signs are classified as being at the ground when the ratio g/h is less than 0.25; otherwise, they are classified as being above ground (g = distance between the bottom of the sign and the ground, and h is the vertical dimension of the sign).

6.8.2.2 Net Pressure Coefficients

6.8.2.2.1 Normal Wind Incidence. The net pressure coefficients, C_f , for solid signs at ground level and above ground level, for wind normal to the surface, shall be as given in Table 16 in which H is the height-to-width ratio of the surface, a is the greater dimension, and b is the smaller dimension. The computed load shall be assumed to act uniformly over the entire sign area.

6.8.2.2.2 Oblique Wind Incidence. To allow for winds oblique to the surfaces of solid signs, the net pressure normal to the surface shall be assumed to vary linearly from a maximum at the windward edge to a minimum at the leeward edge, in accordance with the following equations:

$$\text{Max } C_f = 1.6KC_f \quad (\text{Eq 9})$$

$$\text{Min } C_f = 0.4KC_f \quad (\text{Eq 10})$$

where C_f is the net pressure coefficient for normal incidence, and K is a factor depending upon the orientation of the sign relative to the wind. The values of K for signs at, and above, ground level shall be as follows:

$K = 1.0$ for rectangular signs having the shorter edge upwind

$K = 1.15$ for rectangular signs having the longer edge upwind and for square signs

6.8.3 Open Signs. For open signs the net pressure coefficients given in Table 17 shall be applied to the projected area normal to the wind of all exposed members and elements (excluding appurtenances and supports which shall be accounted for separately by using the appropriate net pressure coefficients for these individual elements). Table 17 gives net pressure coef-

Table 11
Internal Pressure Coefficients for Buildings, C_{pi}

n^*	Openings Uniformly Distributed	Openings Mainly in:		
		Windward Wall	Leeward Wall	Side Wall(s)
0 to 0.3	± 0.3	$(0.3 + 1.67n)$	$(-0.3 - n)$	$(-0.3 - n)$
Greater than 0.3	± 0.3	0.8	-0.6	-0.6

* n = ratio of open area to solid area of wall having majority of openings.

Table 12
Effective Velocity Pressures for Calculating Internal Pressures, q_M
EXPOSURE A*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
30 or less	1	2	2	3	4	5	6	7	8
50	2	3	3	5	6	7	9	10	12
100	3	4	5	7	9	11	14	16	19
150	4	5	7	9	12	15	18	21	25
200	4	6	9	11	14	18	21	26	30
250	5	7	10	13	17	21	25	30	35
300	6	8	11	15	19	23	28	33	39
350	6	9	13	17	21	26	31	37	44
400	7	10	14	18	23	28	34	41	48
450	8	11	15	19	25	30	37	44	51
500	8	12	16	21	27	33	40	47	55
550	9	13	17	22	28	35	42	50	59
600	9	13	18	24	30	37	45	53	62
650	10	14	19	25	32	39	47	56	66
700	10	15	20	26	33	41	50	59	69
750	11	15	21	27	35	43	52	62	72
800	11	16	22	29	36	45	54	64	75

*A: Large cities and very rough, hilly terrain. Interpolations of the values of q_M may be used for intermediate heights.

Table 12
Effective Velocity Pressures for Calculating Internal Pressures, q_M
EXPOSURE B*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
30 or less	3	5	6	8	10	13	15	18	22
50	4	6	8	10	13	16	19	23	27
100	5	8	11	14	18	22	26	31	37
150	7	9	13	17	21	26	32	38	44
200	7	11	15	19	24	30	36	43	50
250	8	12	16	21	27	33	40	47	55
300	9	13	17	23	29	36	43	51	60
350	10	14	19	24	31	38	46	55	64
400	10	15	20	26	33	40	49	58	68
450	11	15	21	27	34	42	51	61	72
500	11	16	22	29	36	45	54	64	75
550	12	17	23	30	38	47	56	67	79
600	12	17	24	31	39	48	59	70	82
650	13	18	25	32	41	50	61	72	85
700	13	19	25	33	42	52	63	74	87
750	13	19	26	34	43	54	65	77	90
800	14	20	27	35	45	55	67	79	93

*B: Suburban areas, towns, city outskirts, wooded areas, and rolling terrain. Interpolations of the values of q_M may be used for intermediate heights.

Table 12
Effective Velocity Pressures for Calculating Internal Pressures, q_M
EXPOSURE C*

Height (ft)	Basic Wind Speed (mph)								
	50	60	70	80	90	100	110	120	130
30 or less	6	9	13	16	21	26	31	37	43
50	7	11	15	19	24	30	36	43	50
100	9	13	18	23	29	36	44	52	61
150	10	15	20	26	33	40	49	58	68
200	11	16	22	28	36	44	53	63	74
250	12	17	23	30	38	47	57	67	79
300	12	18	24	32	40	49	60	71	83
350	13	19	25	33	42	51	62	74	87
400	13	19	26	34	43	54	65	77	90
450	14	20	27	35	45	55	67	80	93
500	14	21	28	37	46	57	69	82	96
550	15	21	29	38	47	59	71	84	99
600	15	22	29	38	49	60	73	87	102
650	15	22	30	39	50	61	74	88	104
700	16	23	31	40	51	63	76	91	106
750	16	23	31	41	52	64	77	92	108
800	16	24	32	42	53	65	79	94	110

*C: Flat, open country, open flat coastal belts, and grassland. Interpolations of the values of q_M may be used for intermediate heights.

Table 13
Net Pressure Coefficients for Flat Plates, C_f

α	λ						
	1/5	1/3	1/2	1	2	3	5
10°	0.2	0.25	0.3	0.45	0.55	0.70	0.75
15°	0.35	0.45	0.5	0.68	0.83	0.88	0.83
20°	0.5	0.6	0.75	0.92	1.0	0.96	0.9
25°	0.7	0.8	0.95	1.14	1.1	1.04	0.95
30°	0.9	1.0	1.2	1.32	1.2	1.1	1.0

Table 14
Location of Center of Pressure, X/C , for Flat Plates

α	λ		
	1/5 to 1/2	1	2 to 5
10°	0.35	0.30	0.30
15°	0.35	0.30	0.30
20°	0.35	0.32	0.32
25°	0.35	0.36	0.40
30°	0.35	0.40	0.45

Table 15
Net Pressure Coefficients for Chimneys and Tanks, C_f

Shape	Type of Surface	^a h/d		
		1	7	25
Square (wind normal to a face)	Smooth or rough	1.3	1.4	2.0
Square (wind along diagonal)	Smooth or rough	1.0	1.1	1.5
Hexagonal or octagonal ($d\sqrt{q} > 2.5$)	Smooth or rough	1.0	1.2	1.4
Round ($d\sqrt{q} > 2.5$)	Moderately smooth*	0.5	0.6	0.7
	Rough ($d'/d \approx 0.02$)	0.7	0.8	0.9
	Very rough ($d'/d \approx 0.08$)	0.8	1.0	1.2

NOTE: h = height of structure in feet; d = diameter or least horizontal dimension in feet; d' = depth in feet of protruding elements such as ribs and spoilers; q = the effective velocity pressure in psf from Table 5.

*Metal, timber, concrete.

Table 16
Net Pressure Coefficients for Signs
At and Above Ground Level, C_f

At Ground Level							
H	≤ 3	5	8	10	20	30	≥ 40
C_f	1.2	1.3	1.42	1.52	1.75	1.84	2.0
Above Ground Level							
a/b	≤ 6	10	16	20	40	60	≥ 80
C_f	1.2	1.3	1.42	1.52	1.75	1.84	2.0

Table 17
Net Pressure Coefficients
for Latticed Frameworks, C_f

ϕ^*	Flat-Sided Members	Rounded Members	
		$d\sqrt{q} < 2.5$	$d\sqrt{q} > 2.5$
Less than 0.1	2.0	1.2	0.8
0.1 to 0.3	1.8	1.3	0.9
0.3 to 0.7	1.6	1.5	1.1

*Within ± 0.05 of the common boundary of the ranges of ϕ , the mean values of the net pressure coefficients for the two ranges may be used.

ficients for lattices that are comprised of flat-sided or rounded elements, where ϕ is the ratio of the solid area to the gross area, d is the diameter in feet of a typical element, and q is the velocity pressure in psf. Weighted average coefficients may be used for signs with both flat-sided and rounded elements.

6.8.4 Appurtenances and Supports. The wind loading on appurtenances and supports shall be accounted for separately by using the appropriate net pressure coefficients. Allowance may be made for the shielding effect of one element on another.

6.9 Square- and Triangular-Section Trussed Towers

6.9.1 Towers with Flat-Sided Members. The net pressure coefficients to be applied to Table 5 for square- and triangular-section towers with similar faces comprised of structural angle or similar flat-sided members, and with the wind normal to a face, shall be as given in Table 18. Here ϕ is the ratio of the solid area to the gross area of the face and the net pressure coefficient applies to the solid area of the face. For square towers, the coefficients do not allow for any unmasked (outstanding) lacing on the side faces; such lacing shall be accounted for separately by using the appropriate net pressure coefficients for these elements and by neglecting the interference effects of the other parts of the tower.

6.9.2 Towers with Rounded Members. For square- and triangular-section towers with rounded members, and with wind normal to a face, the net pressure coefficients shall be determined by multiplying the above coefficients for towers with flat-sided members by the factors in Table 19 for corresponding values of ϕ .

Weighted average coefficients may be used for towers with both flat-sided and rounded members.

6.9.3 Oblique Wind Incidence

6.9.3.1 Square-Section Towers. To allow for the maximum horizontal wind load on square-section trussed towers, which occurs when the wind is oblique to the faces, the wind load for normal wind incidence shall be multiplied by a factor of $(1.0 + 0.75\varphi)$ (for $\varphi < 0.5$) and shall be assumed as acting along a diagonal.

6.9.3.2 Triangular-Section Towers. For oblique incidence, the wind force on triangular-section trussed towers (although lower than for normal wind incidence) shall be assumed to be the same as for normal incidence.

6.9.4 Tower Appurtenances. The wind loading on tower appurtenances, such as ladders, conduits, lights, elevators, etc, shall be calculated by using the appropriate net pressure coefficients for these elements and the effective velocity pressures of Table 6. The contribution of these elements to the tower wind loading shall be based on the effective velocity pressures of Table 5. Allowance may be made for shielding effects.

6.9.5 Tower Guys. The minimum net pressure coefficient for wind normal to the chord of tower guys shall be 1.2. For oblique wind incidence, the net pressure coefficients shall be as given in Table 20 in which β is the angle between the wind direction and the chord of the guy, C_D is the drag coefficient which defines the horizontal component of the wind force in the direction of the wind, and C_L is a lift coefficient

Table 18
Net Pressure Coefficients
for Square- and Triangular-Section Towers, C_f

φ	Square Towers	Triangular Towers
Less than 0.025	4.0	3.6
0.025 to 0.45	$4.13 - 5.18\varphi$	$3.71 - 4.47\varphi$
0.45 to 0.7	1.8	1.7
0.7 to 1.0	$1.33 + 0.67\varphi$	$1.0 + \varphi$

Table 19
Ratio of Drag on Towers with Rounded Members
to Drag on Towers with Flat-Sided Members*

φ	Factor
Less than 0.3	2/3
0.3 to 0.8	$(0.66\varphi + 0.47)$
0.8 to 1.0	1.0

*For $d\sqrt{q} < 2.5$, where d = typical member diameter in feet and q = velocity pressure in psf.

Table 20
Wind-Loading Coefficients for Guys, C_D and C_L

β	10°	20°	30°	40°	50°	60°	70°	80°	90°
C_D	0.05	0.1	0.2	0.35	0.6	0.8	1.03	1.16	1.2
C_L	0.04	0.15	0.27	0.36	0.45	0.43	0.33	0.18	0

which defines that component acting normal to the wind and in the plane containing the angle β . The coefficients apply to the exposed area of the guys, Ld , L being their chord length and d their diameter. The coefficients shall be used in conjunction with the effective velocity pressures of Table 5.

6.9.6 Pattern Wind Loads. For guyed towers, a reduction of 25% of the design pressure, in any span between guys, shall be made for the determination of maximum and minimum moments and shears. The cantilever portion shall be designed for 125% of the design pressure.

6.10 Overturning and Sliding

6.10.1 Overturning. The overturning moment due to the wind load shall not exceed 66-2/3% of the stabilizing moment of the building or other structure due to the dead load only, unless the building or other structure is anchored so as to resist the excess overturning moment without exceeding the allowable stresses for the materials used. The axis of rotation for computing the overturning moment and the moment of stability shall be taken as the intersection of the outside wall line on the leeward side and the plane representing the average elevation of the bottoms of the footings. The weight of earth superimposed over footings may be used in computing the moment of stability due to dead load.

6.10.2 Sliding. When the total resisting force due to friction is insufficient to prevent sliding, the building or other structure shall be anchored to withstand the excess sliding force without exceeding the allowable stresses for the materials used. Anchors provided to resist overturning moment may also be considered as providing resistance to sliding.

6.11 Stresses During Erection. Provision shall be made for wind stress during erection of the building or other structure.

7. Snow Loads

7.1 Basic Snow Loads. The basic snow loads to be assumed in the design of buildings or other structures are given in Figs. 3 and 4 for the portion of the United