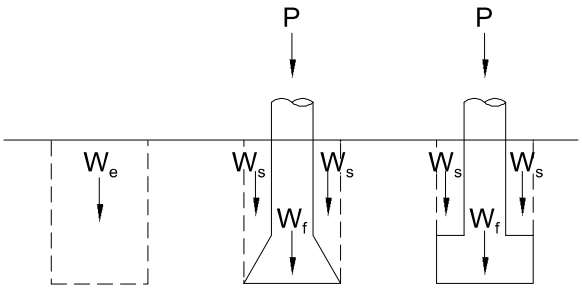
FOUNDATION DESIGN CRITERIA

A properly-sized foundation must satisfy the two following criteria with respect to the supporting soil.

1. For soil strength. The bearing pressure created on the base of the foundation by the maximum design load must be less than that which would cause shear failure in the soil. A factor of safety of 2 or more with respect to the soil shear strength is generally used.
2. For soil compressibility. The bearing pressure created on the base of the foundation by the sustained load must not produce sufficient consolidation in the underlying soil to result in foundation settlement that is detrimental to the safety or utility of the structure.



SYMBOLS

TERMS AND SYMBOLS

P = Column load (subscript can be used to denote character of load: P_s = sustained load, P_n = normal operating load, P_m = maximum design load).

W_e = Weight of soil located above base of foundation excavation and lowest adjacent grade.*

W_s = Weight of soil located above foundation.*

W_f = Weight of foundation.*

A = Area of base of foundation.

p = Average bearing pressure acting on soil (subsript can be used to correspond to column load: P_s, P_n, P_m).

* Position of groundwater level must be considered in determining weights. Effective, or buoyant, unit weights should be used below the highest expected groundwater level.

BEARING PRESSURES

Gross Bearing Pressure, p, for any column load is the total pressure acting on the base of the foundation.

$$p = 1/A\ (P + W_s + W_f)$$

Net Bearing Pressure, p', for any column load is the difference between the gross bearing pressure acting on the base of the foundation and the soil pressure existing at that elevation from the lowest overlying or adjacent soils.

$$p' = 1/A\ (P + W_s + W_f - W_e)$$

For analysis with regard to the first design criterion, soil strength, the column load in the above equations should usually be the maximum design load, P_m. Occasionally, the normal operating load, P_n, may also be used. If footing is loaded eccentrically, the increase in edge bearing pressure due to the eccentricity should be computed in the usual manner.

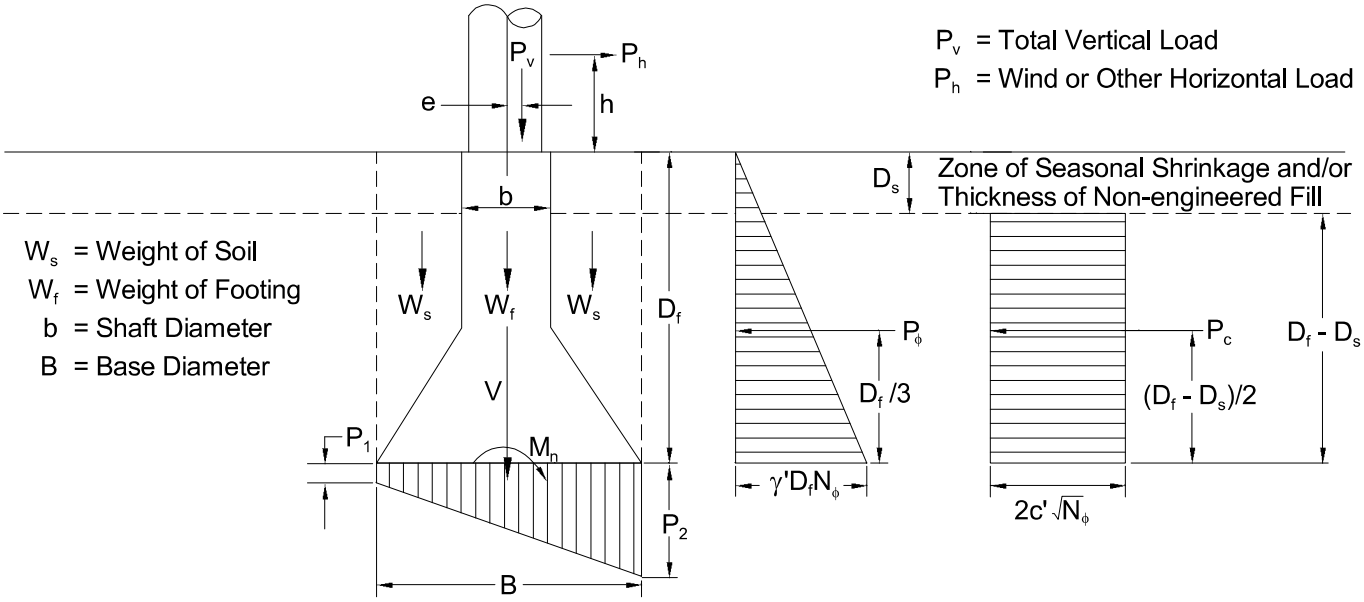
For analysis with regard to the second design criterion, soil compressibility, the column load in the above equations should be the sustained load, P_s. This load is the dead load plus the sustain live load.

For further references, see pp. 506 - 512, "Soil Mechanics in Engineering Practice" by Karl Terzaghi and Ralph B. Peck (2nd edition); and pp. 564 - 565, "Fundamentals of Soil Mechanics" by Donald W. Taylor.

COMPUTATION OF BEARING PRESSURES

USGC OLD OCEAN PIPELINES
SWEENY REFINERY PLANT
OLD OCEAN, TEXAS

DRAFT



1. Applied Vertical Load:
   $V = P_v + W_f + W_s$

2. Applied Overturning Moment:
   $M_o = P_v e + P_h(h + D_f)$

3. Maximum Available Resisting Moment from lateral Earth Pressure:
   $M_r = P_\phi (D_f /3) + P_c[(D_f - D_s)/2]$, where
   M_r cannot be greater than M_o

4. Net Moment Resisted by Base:
   $M_n = M_o - M_r$

5. Bearing Pressures:
   $P_1 = (4V/\pi B^2) - (32 M_n/\pi B^3)$
   $P_2 = (4V/\pi B^2) + (32 M_n/\pi B^3)$

6. Maximum Bearing Pressure, P_2, should not exceed Allowable Gross Bearing Pressure, q_{ga}, where:
   $q_{ga} = q_{na} + \gamma' D_f$
   q_{na} = Allowable Net Bearing Pressure

7. Minimum Bearing Pressure, P_1, should be ≥ 0

$P_\phi = (\gamma'/2)(D_f)^2 b N_\phi$
γ' = Effective Unit Weight of Soil
$N_\phi = \tan^2(45 + \phi'/2)$
$\phi' = \arctan(\tan\phi / F.S.)$
ϕ = Angle of Internal Friction of Soil
F.S. = Factor of Safety (2.0, unless otherwise specified)
$P_c = 2c'(D_f - D_s) b \sqrt{N_\phi}$
$c' = c / F.S.$
c = Cohesion of Soil
F.S. = Factor of Safety (2.0, unless otherwise specified)

NOTES :

1. This simplistic procedure should be used only for those cases where:
   (a) The footing size and depth make it rigid.
   (b) The supported structure is not especially sensitive to lateral deflections.
   If these conditions are not met, a more rigorous analysis or a different foundation type or configuration should be considered.
2. Values for the soil related parameters are given in the text.
3. To be used only for drilled-and-underreamed footings. Not intended for rectangular footings.

ECCENTRICALLY LOADED UNDERREAMED FOOTINGS
USGC OLD OCEAN PIPELINES
SWEENY REFINERY PLANT
OLD OCEAN, TEXAS

PLATE 13