Footings and Foundations

1. Purpose of Footings: To transfer loads to the ground.

2. Types of Loads:

a. Dead Loads - The weight of the building and materials (footing, beams, windows, roof, etc.). Dead loads MUST BE CALCULATED by the designer.
b. Live Loads - Any load that can move (furniture, people, etc.). Minimum live loads are dictated by Building Codes. Residential = 40 psf, commercial office = 50 psf, Library stack room = 125 psf.
c. Other Loads: Determined from Building Codes

   i. Snow Loads (especially northern locations)
   ii. Wind Loads (especially along coastlines)
   iii. Seismic Loads (California, west coast states)
   iv. Other Loads:

   - Earth loads (for foundation wall analysis)
   - Water "hydrostatic" loads (i.e., marine structures)

3. Footing Design Criteria:

a. Footing must be able to carry ALL APPLIED LOADS. Required under ALL columns, piers and masonry walls.

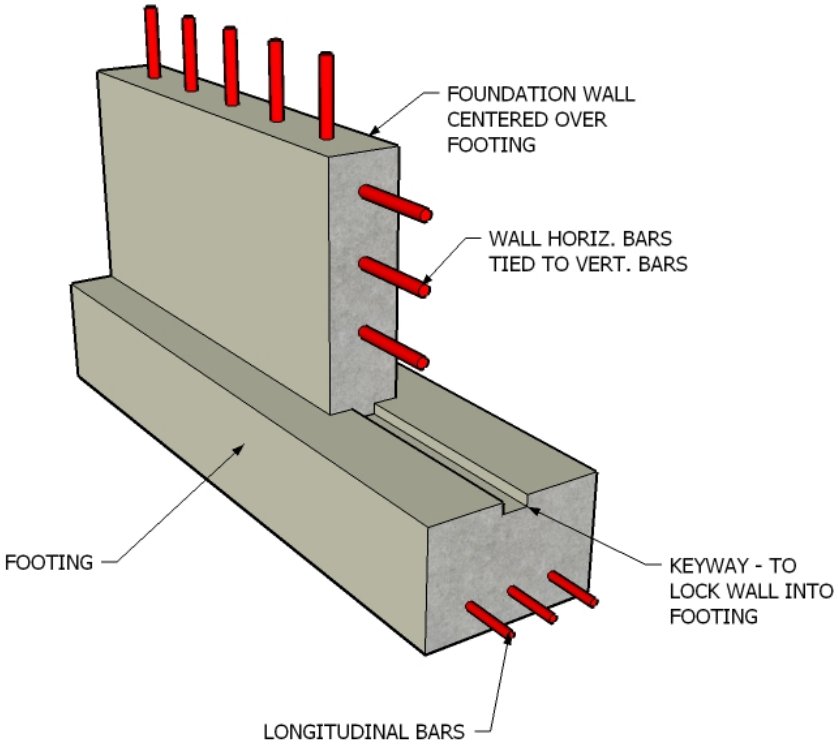
   i. Soil Bearing Capacity - Obtained from local building official, or testing agency. Typical values = 2000 psf to 10,000 psf. Must be placed on UNDISTURBED SOIL!! (**OR** thoroughly compacted engineered fill)
   ii. Bedrock - Capacity up to 100,000 psf (New York City).

b. Bottom of footing must be deeper than frost penetration. Typical frost penetration = 3'-0" (Long Island), 3'-6" (Delhi).

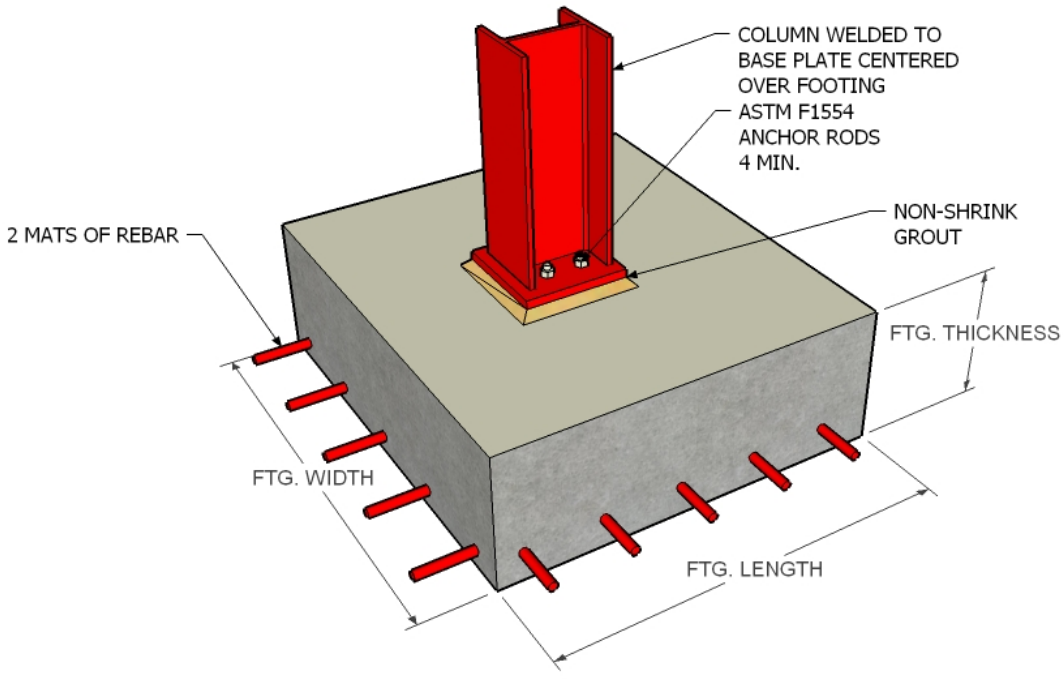
c. Footing must be well-drained to prevent wash-out. Use perimeter footing drains, or provide proper surface drainage.

4. Types of Footings:

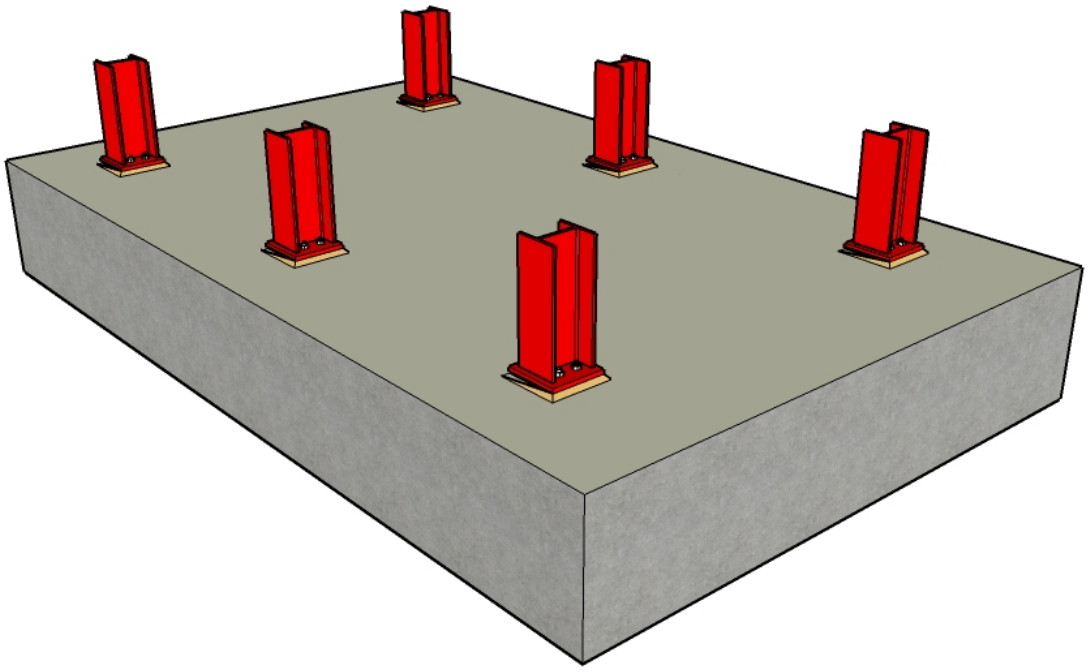
a. **Spread Footing (Strip Footing)** - Used to support walls.



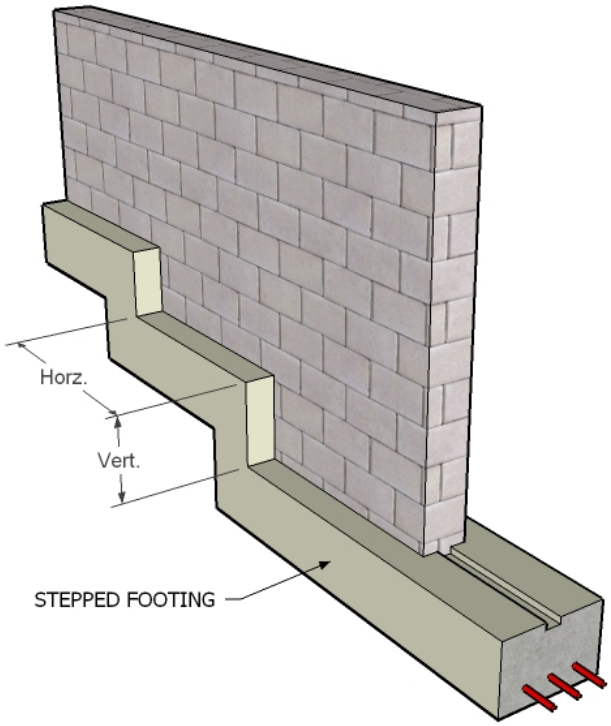
b. **Column Footing** - Usually square or rectangular, used to support columns. Can be placed separately or monolithically with floor slab.



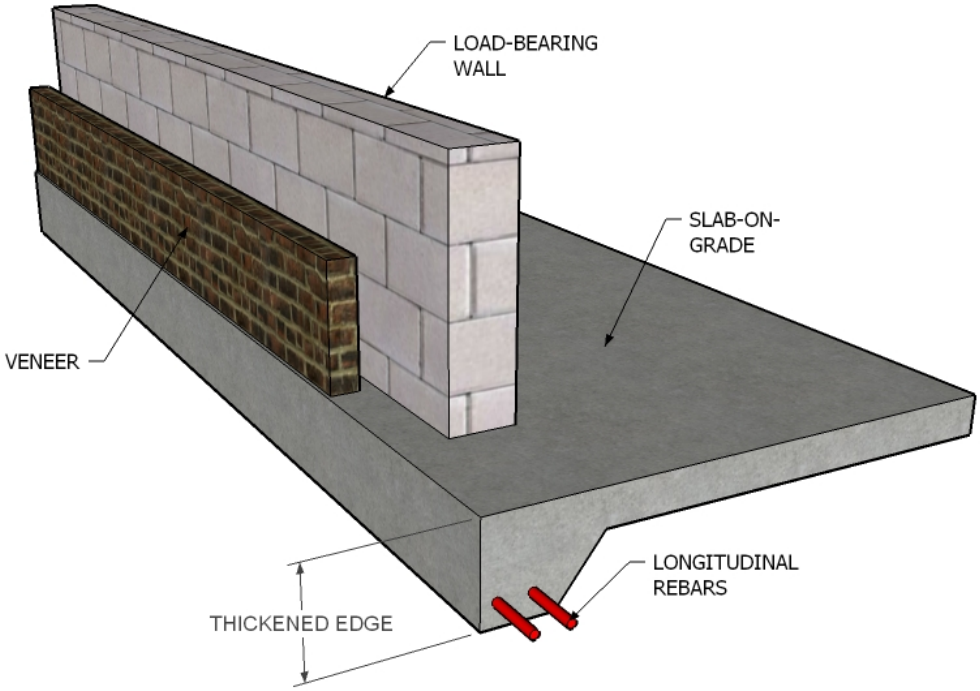
c. **Mat Footing (Raft Footing)** - One large footing that supports multiple columns and walls (Chicago).



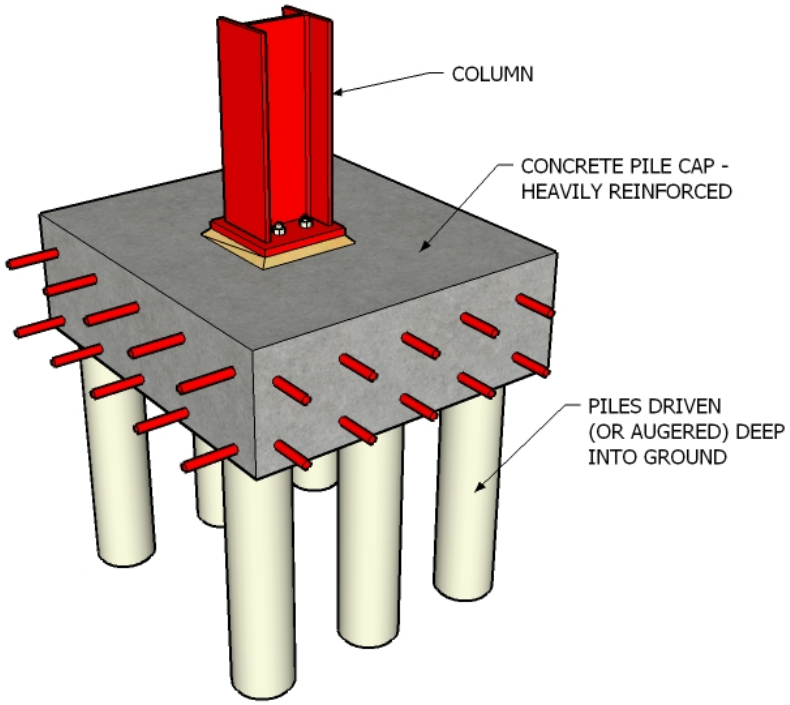
d. **Stepped Footing** - A wall footing that "steps" down hill. Minimum 2H to 1V.



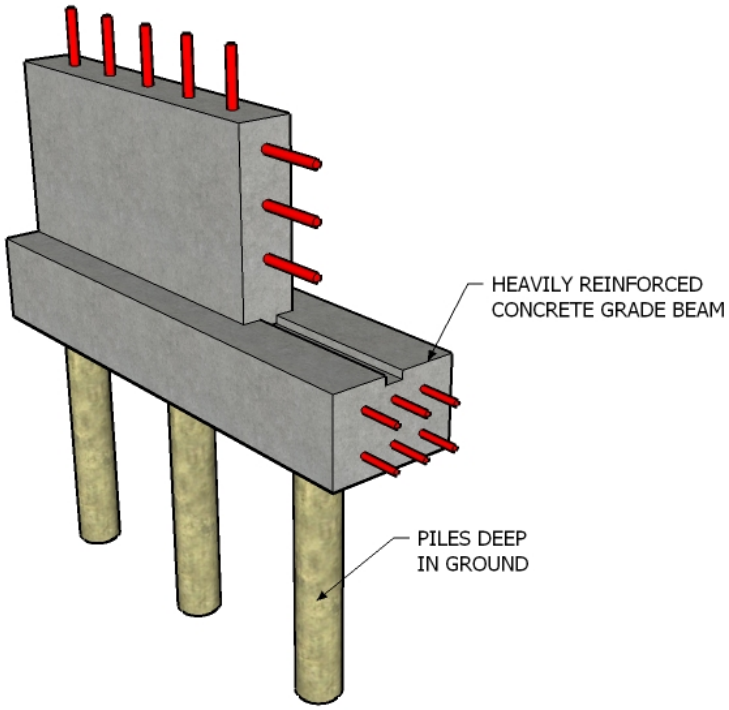
e. **Haunched Slab Footing** - Used in warm climates with no frost.



f. **Piles with Cap** - Used in areas with poor soil or very heavy loads. Piles are driven or augered into ground and supported by bedrock. Cap is used to lock piles together.



g. **Grade Beam** - A concrete "beam" that spans between piles used to support walls or columns.



5. Concrete:

a. A mixture of cement, sand, gravel water and admixtures.
b. Good in compression, poor in tension.
c. Strength measured after 28 days of curing.
d. Strength of concrete ranges from 3000 psi to 14,000 psi.

6. Concrete Reinforcing Bars:

a. Usually used to carry the TENSION in concrete.
b. Are "Deformed" or ribbed to grip concrete.
c. Sizes range form #3 to #18. Size number = 1/8ths of inch in diameter.
d. Epoxy coated bars used to prevent corrosion.

7. Purposes of Foundation Walls:

a. To carry gravity (vertical) loads from walls down to footing.
b. To carry lateral (horizontal) loads to footing and floor structure.

8. Foundation Wall Design Criteria:

a. Must carry ALL loads.
b. Exterior basement walls must be 8" MINIMUM WIDTH.
c. Wall MUST BE TIED to footing at the bottom and floor at top.
d. Minimum VERTICAL reinforcing bar area = 0.0015 X Wall area.
e. Minimum HORIZONTAL reinforcing bar area = 0.0025 X Wall area.
f. Maximum bar spacing = 3 X Wall Thickness or 18" o.c.
g. Minimum bar cover for UNEXPOSED FACE = 3/4"
h. Minimum bar cover for EXPOSED FACE = 1½" for #5 and 2" bigger bars.
i. Cantilever Foundation Wall - Completely exposed face, not "Pinned" to floor structure.

9. Concrete Slab-on-Grade:

a. Thickness ranges from 4" (light-duty residential) up to 12" (heavy industrial).
b. Slab rests on Polyethylene vapor barrier to prevent concrete curing water from "bleeding" out.
c. The vapor barrier rests on 4" - 6" of crushed stone (or gravel) to evenly support the loads.
d. Sometimes, the vapor barrier rests on rigid insulation to prevent heat loss/condensation.

10. Reinforcing for Slab-on-Grade:

a. Primary Purpose - To prevent cracking of slab, secondarily to increase tensile strength.
b. Types of Reinforcing:

    i. Welded Wire Fabric (W.W.F.) - Grid of wires welded together. Typical designation = "6x6 - W1.4xW1.4". 6x6 = wire spacing, W1.4 = wire size (i.e., 1.4 = Area of wire x 100). The WWF SHOULD BE PLACED IN TOP 1/3 of Slab!!
    ii. Fiber Mesh - Sometimes called "Secondary reinforcement". Tiny hair-like polypropylene fibers placed in concrete to prevent micro-cracking due to freeze-thaw. Also increases abrasion resistance of concrete surface. Can be used alone or together with WWF. Typical mixes call for about 1 - 2 pounds of fibers per cubic yard of concrete at the batch plant.
    iii. Reinforcing Bars - Used only in heavy-duty applications where high strength is required.

11. Joints in Slab-on-Grade:

a. Isolation (Expansion) Joint - Used to allow movement between edge of slab and another object, such as a wall or column. Uses a compressible material.
b. Control Joint - Used to induce cracking at pre-selected locations, such as a grid pattern on the floor. Produced by sawcutting into the slab prior to concrete curing (usually within 24-36 hours after pour). Depth of sawcut = 1/4 slab thickness. Sawcut is packed with sealer to prevent moisture from coming up.
c. Construction Joint - Used for "Cold Joints" when new concrete is poured against cured concrete. It is a structural joint - it can carry vertical load through the joint. Can be pre-formed "Key" or smooth dowel bar.

12. Quality Control for Slab-on-Grade:

a. Smooth, troweled finish for most applications.
b. Must be CONTINUOUSLY MOISTENED using hose and vapor barrier for 72 hours to allow complete curing to take place.
c. Control JOINTS CUT AS SOON AS POSSIBLE to prevent unwanted curing cracks.
d. Use "Air Entrainment" concrete admixture for ALL EXPOSED CONCRETE to prevent freeze-thaw cracking.
e. Slab flatness tolerance ≅ 1/8" per 10'-0" unless otherwise specified as “superflat” slab.