FOUNDATIONS AND RETAINING WALLS

SPECIFICATIONS

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FOUNDATIONS & RETAINING WALLS

SPECIFICATIONS

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DEFINITIONS

101. Footing: is the spreading course at the base or bottom of a foundation wall, column, or pier.

102. Retaining wall: is any wall used to resist the lateral displacement of any material.

103. Foundation: that part of a structure that transmits the weight of, and the load on the structure to the bearing materials.

104. Bearing Materials: the materials of the earth on which the structure rests.

I. BEARING MATERIALS

A. Classification

201. Rocks

a. Shale: A laminated, fine-textured, soft rock composed of consolidated clay or silt, which cannot be molded without the addition of water.

b. Slate: A dense, very fine-textured, soft rock which is readily split along cleavage planes into thin sheets and which cannot be reduced to a plastic condition by moderate grinding and mixing with water.

c. Schist: A fine-textured, laminated rock with a more or less wavy cleavage, containing mica or other flaky minerals.

202. Granular Soil

a. Gravel: An uncemented mixture of mineral grains one quarter inch or more in diameter.

b. Sand: A type of soil possessing practically no cohesion when dry, and consisting of mineral grains smaller than one inch quarter in diameter.

c. Coarse Sand: A sand consisting chiefly of grains which will be retained on a sixty-five(65) mesh sieve.

d. Fine Sand: A sand consisting chiefly of grains which will pass a sixty-five mesh sieve.

e. Compact gravel, Compact Sand: Deposits requiring picking for removal and offering height resistance to penetration by excavating tools.

f. Loose Gravel, Loose Sand: Deposits readily removable by

by shoveling only.

203. Cohesive Soil

a. Hardpan: A thoroughly compacted mixture of clay, sand gravel, and boulders, for example boulder clay; or a cemented mixture of sand or of sand and gravel, with or without boulders, and difficult to remove by picking.

b. Clay: A fine-grained, inorganic soil possessing sufficient cohesion when dry to form hard lumps which cannot readily be pulverized by the fingers.

c. Hard Clay: A clay requiring picking for removal, a fresh sample of which cannot be molded in the fingers, or can be molded only with the greatest difficulty.

d. Medium Clay: A clay which can be removed by spading, a fresh sample of which can be molded with substantial pressure of the fingers.

e. Soft Clay: A clay which, when freshly sampled, can be molded under relatively slight pressure of the fingers.

f. Rock Flour (Inorganic Silt): A fine-grained, inorganic soil consisting chiefly of grains which will pass a two hundred (200) mesh sieve, and possessing sufficient cohesion when dry to form lumps which can readily be pulverized with the fingers.

B. Loads on Foundation Bearing Materials.

301. Allowable Loads.

class	Materials	Ton / sq. ft.
1.	Massive bedrock without laminations, such as granite, Diorite, and other granitic rocks; and also Gneiss, trap rock, felsite, and thoroughly cemented conglomerates, all in sound condition.....	20
2.	Laminated rocks such as slate and Schist in sound condition.....	15
3.	Shale in sound condition.....	10
4.	Residual deposits of shattered or broken bedrock of any kind except shale.....	6
5.	Hardpan.....	6
6.	Gravel, sand-gravel mixtures, compact.....	5
7.	Gravel, sand-gravel mixtures, loose; sand, coarse, compact.....	4
8.	Sand, coarse, loose; sand, fine, compact.....	3
9.	Sand, fine, loose.....	1
10.	Hard Clay.....	6
11.	Medium Clay.....	4
12.	Soft Clay.....	1

302. Before issuing a permit for erection or alteration of a permanent structure, and in the absence of satisfactory data, it will be required from the owner to dig pits or make borings at such locations and to such depths as will disclose the character of the materials underlying the site of the proposed structure.

303. When it is proposed to support the structure on bedrock, and loading the rock to more than ten tons per square foot (10 tons/sq. ft.) it shall be required that sufficient number of drill holes or bores be made to prove that bedrock has acctually been reached.

304. The bearing materials under every structure shall be a uniform natural deposit of rock, gravel, sand, clay, silt, or combinations thereof which does not contain and which does not everlie strata containing more than 10% by dry weight of organic matter. (A structure may rest on fill, provided due allowanse is made for the effect of differential settlement.)

305. Due allowance shall be made in deternining the capacity of the bearing materials under a structure for the effect of possible change in moisture content.

306. Where footings are to be placed at varying elevations the effect of adjacent loads shall be included in the foundation analysis.

307. The maximum pressure on soils under foindations shall not exceed the allowable bearing values set forth in this table except when determined in accordance with the provisions in sections..401 to 407.....where modifications can be allowed.

308. The tabulated bearing values for rocks of classes 1 to 3 inclusive shall apply where the loaded area is less than two feet (2'-0") below the point lowest adjacent surface of sound rock. Where the loaded area is more

than two feet below such surface these values may be increased 20% for each foot of additional depth but shall not exceed twice the tabulated values.

309. The allowable bearing values of classes 4 to 9 inclusive may exceed the tabulated values by 2½% for each foot of depth of the loaded area below the lowest ground surface immediately adjacent, but shall not exceed twice the tabulated values. For areas of foundations smaller than three feet (3'-0") in least lateral dimention, the allowable bearing values shall be on third of the allowable bearing values multiplied by the least lateral dimention in feet.

310. The tabulated values of classes 10 to 12 inclusive apply only to pressures directly under individual footing, walls, and piers. When structures are founded on or are underlain by deposits of these classes, the total load over the area of any one bay or other major portion of the structure, minus the weight of the excavated materials, divided by the area, shall not exceed one half (50%) the tabulated bearing values.

311. Where the bearing materials directly under a foundation overlie a stratum having smaller allowable bearing values, these smaller values shall not be exceeded at the level of such stratum.

312. Computation of the vertical pressure in the bearing materials at any depth below a foundation shall be made on the assumption that the load is spread uniformly at an

angle of 60° with the horizontal; but the area considered as supporting the load shall not exceed beyond the intersection of 60° planes of adjacent foundations.

313. Stresses and deformations within the bearing materials shall be determined by the general princeples of soil mechanics.

C. Foundation Load Tests.

401. Whenever the allowable load on a bearing material or on a pile is in doubt, tests should be made, and the load so determined shall be taken as the allowable load.

402. Loads shall be applied by direct weight or by means of hydraulic jack pressure that is automatically maintained constant. Settlement readings should be referred to a bench mark established at a sufficient distance from the test to be unaffected by it and they shall be made by a method which assures accuracy to the degree specified.

403. A test load shall be applied to produce a unit pressure equal to that for which the proposed foundations are designed. This load shall be allowed to remain undisturbed until no measurable settlement occurs during a period of twenty-four hours. The load shall then be doubled in increments not exceeding 25% of the design load. At least four hours shall elapse between the application of successive increments. The total load shall be allowed to remain undisturbed until no measurable settlement occurs during a period of twenty-four hours.

404. Measurments of settlement shall be accurate to one thirty-second inch ($\frac{1}{32}$") and shall be taken and recorded every hour during the first six hours after the application of each increment, and at least once every twelve hours thereafter.

405. For bearing materials of classes 1 to 5 inclussive, the loaded area shall be at least one square foot. In classes

6 to 12 inclussive, the loaded area shall be the full size of the pit and with an area of not less than four square feet.

406. When loading tests are made on bearing materials of classes 10 to 12 inclussive, suitable methods shall be used to prevent evaporation from the materials being tested.

407. When the design load upon bearing materials of classes 1 to 10 inclussive causes settlement of less than three-eighths inch and twice the design load causes settlement of less than one inch, the design load shall be allowed.

II. PILES

A. General Specifications.

501. A detached column or pier supported by piles shall rest upon not less than three piles, but a column or pier connected to permanent construction, which provides adequate lateral support to the top of the piles, may rest upon a single pile or upon two piles.

502. The excavation for pile foundations, whereever practicable, shall be completed to pile cut-off grade, or lower, before piles are driven. In no case shall piles be driven through more than three feet of unexcavated material above pile cut-off grade.

503. Additional piles shall be driven to replace piles injured during driving.

504. A foundation wall of a building not more than twenty (20) feet high, if supported laterally, may be supported by a single row of piles. Other foundation wall shall rest upon at least two rows of piles.

505. Piles shall not be jetted except with specific approval of the commissioner. After jetting, piles shall be driven to the required resistance.

506. The method of driving shall be such as not to impair the strength of the pile and shall meet the approval of the commissioner. A steel or iron follower may be used subject to his approval. It shall be equipped with a

with a suitable socket incasing the pile head sufficiently to prevent damage while driving. Shattered broomed or otherwise damaged pile heads shall be cut back to sound material before driving with the follower.

507. If a wooden driving block is used it shall, at the time it is used for measuring the penetration, be of sound hard wood equal to oak, not more than twelve inches (12") in height, with the gain parallel to the axis of the pile, and shall be enclosed in a steel casing of adequate strength to resist lateral distention.

508. Belled bases for cast-in-place piles shall be at least 4 inches (4") thick at the edge.

509. Structural steel shapes or pipes may be used as piles without a protective covering of concrete.

B. Allowable Loads on Piles.

601. The allowable pile loading shall be limitted by the provision that the vertical pressures in the bearing materials at or below the points of the piles produced by the loads on all piles in a foundation shall not exceed the allowable bearing values of such materials.

602. Piles or pile groups shall be assumed to transfer their loads to the bearing materials by spreading the load uniformely at an angle of sixty degrees (60^{o}) with the horizontal, starting at a polygon circumscribing the piles at the top of the satisfactory bearing stratum in which they are embedded, but the area considered as supporting the load shall not exceed beyond the intersection of the sixty degree planes of adjacent piles or pile groups.

603. The allowable load on each pile shall be limitted by t the requirement that such load shall not cause excessive movement of the pile relative to the soil. Satisfactory proof of this load for all soil conditions and all types of piles can be obtained from load tests.

604. The penetration formulas:-

W - weight of striking part of hammer in pounds (lbs.)

h - height of fall of hammer in feet (ft.).

P - weight of pile as driven (lbs.)

s - average penetration per blow in inches (for the last five blows).

R - allowable pile load (lbs.).

F - actual energy delivered per blow in foot pounds

k - $\frac{3RL}{2AE}$ plus C in inches.

L - length of pile in inches.

A - average sectional area of pile material, as driven, in square inches.

E - modulus of elasticity of pile material, as driven, (p.s.i.)*

C - Constant equals 0.05

(1) R equals $\frac{3Wh}{s\ k}$ times $\frac{W}{W\ P}$ (for drop hammers)

(2) R equals $\frac{3.6Wh}{s\ k}$ times $\frac{W}{W\ P}$ (for single-action steam hammers)

(3) R equals $\frac{4F}{s\ k}$ times $\frac{W}{W\ P}$ (for double-action steam hammers)

Type of Pile	E *
Wooden piles	1,500,000
Precast concrete piles	3,000,000
Simplex piles(steel shell:16" outside diameter, 3/4" thick).	30,000,000
Macarthur concrete piles	30,000,000
Raymond standard concrete piles	30,000,000
Raymond step taper piles	30,000,000
Union metal steel fluted shells(No.11 Ga. St. 1" taper in 4' Fluted shells (No. 11Ga. steel, 1" in 7'-0" taper)	30,000,000

605. In computing the allowable load of a pile driven with a follower, the value of (k) computed for the follower itself shall be added to the value of (k) for the pile; the weight of the follower shall be added to the weight of the pile and included in (P).

606. The value of (k) may be determined from the allowable pile load assumed in the design unless the allowable load computed from the penetration varies more than 20% from such assumed load.

607. Double-acting steam hammers shall be equipped with an approved device for determining the actual energy in foot pounds (ft. lbs.) per blow delivered.

608. The penetration (S) for an allowable pile load (R), must not exceed the following:

(1) s equals $\frac{3Wh}{R}$ times $\frac{W}{W+P}$ - k (drop hammers)

(2) s equals $\frac{3.6Wh}{R}$ times $\frac{W}{W+P}$ - k (single- acting hammers)

(3) s equals $\frac{4\ F}{R}$ times $\frac{W}{W+P}$ - k (double- acting hammers)

A negative value of (s) indicates that a heavier hammer must be used.

609. The data used in determining driving resistance shall be obtained during driving and not upon re-driving when a pile has been allowed to stand more than one hour after having been driven.

610. The allowable load upon any pile shall not exceed 50% of the static load at failure. The load at failure shall be assumed to be the load that will produce an increase in settlement disproportional to the increase in load.

C. Wooden Piles.

701. Every wooden pile shall be in one piece cut from a sound live tree, and free from defects which may materially impair its strength or durability.

702. Piles should have a least diameter of at least ten inches (10"). Square timber of approved quality may be used as piling, in which case the average cross-section shall not be less than ten-by-ten inches (10"times 10").

703. The axis of a pile shall not deviate from a straight line more than one inche (1") for each ten feet (10'-0") of length not more than six inches (6").

704. The load on wooden piles shall not exceed the allowable loads as specified in section 604.

705. Loads on wooden piles having the above specified dimentions:

Spruce & Norway Pine.....	12 tons
Oak & Southern Yellow Pine.....	16 tons

These values may be increased by one ton for every inch by which the diameter exceeds the minima specified.

706. Piles shall be cut to sound wood before capping is placed.

707. The cut-off grade shall be determined so as to insure that piles are below the permanent ground water level.

708. The center to center spacing of wooden piles shall not be less than two feet (2'-0") nor less than twice the butt

diameter.

709. If piles are not below the level of the lowest ground-water they should be pressure-tested.

D. Precast Concrete Piles

710. Precast concrete piles shall be designed, cast and cured to have the strength necessary for handling and for driving. The concrete shall be proportioned to have a compressive strength of at least 3000 p.s.i. No pile shall be handled or driven until it has cured sufficiently to develop the necessary strength as shown by standard test specimens made from the same batches of concrete. Each pile shall be cast in one piece.

711. Precast concrete piles shall be reinforced. The ratio of the longitudinal reinforcement to the cross-sectional area of the pile at mid-length shall not be less than 2%. For a length of four feet (4'-0") at both ends of the pile, lateral ties shall be spaced not over three inches center-to-center (3" c/c) or an equivalent spiral shall be provided. Reinforcing steel shall be embedded at least one and one half inches (1½") from the exposed surface, and in piles exposed to sea water such coverage at least shall be three inches (3").

712. The minimum spacing center-to-center of piles shall be two and one half times the square root of the cross-sectional area of the butt ($2.5\sqrt{Ab}$).

713. The load on a pile shall not exceed the allowable load specified in section...604..., and shall not exceed thirty tons for a pile of 169 sq. in. cross-sectional area.

E. Cast-in-Place

714. Cast-in-place concrete piles shall be so made and placed as to insure the exclusion of all foreign matter and to secure a well formed unit of full cross-sedtion. In forming such piles, the concrete shall not be poured through water.

715. The spacing of piles shall be sufficient to insure the preservation of the full cross-section. The spacing center-to-center shall not be less than twice the average diameter of the embedded portion of the pile, nor less than thirty inches (30"). When the center-to-center spacing is less than two and one quarter ($2\frac{1}{4}$) times the average diameter, or less than thirty-six inches (36"), no pile shall be filled with concrete untill all adjacent piles within a raduis of four and one half ($4\frac{1}{2}$) average pile diameter and not less than five feet (5'-0") have been driven to the required resistance.

716. Any cast-in-place pile may be assumed to develop a frictional resistance equal to one-sixth (1/6) the bearing value of the bearing material or to 300 p.s.f., which ever is less.

F. Concrete-Filled Cylindrical Steel Piles

718. Piles shall have an inside diameter not less than ten (10") inches and a shell thickness of at least three-eighths inch ($\frac{3}{8}$) for piles fourteen inches (14") or more and five sixteenth inch ($\frac{5}{16}$) for 10" and 12" piles.

719. Splices of shells shall be of such material and design as to insure alignment of shells and transmission of the load. The ends of each section of the shell shall be perpendicular to its axis. The outside diameter of the pile shall be at least one-fortieth ($\frac{1}{40}$) of its length.

720. After driving, the inside of the shell shall be carefully cleaned to the bottom and its direction and cross-sectional area shall not vary more than 1% from its original cross-section. Shells shall be filled with concrete having an ultimate strength of at least two thousand lbs. per square inch (2000 p.s.i.). Concrete shall not be placed in water except with special permission.

721. The center-to-center spacing of piles, when driven open-ended shall not be less than the diameter of the shell plus ten inches (10"), and not less than two feet (2'-0") When driven with closed ends, the spacing shall be as for cast-in-place concrete piles.

722. The load on a pile shall not exceed the safe load on the concrete at 400 p.s.i. plus that on the steel shell at 6000 p.s.i. after deducing on eight ($\frac{1}{8}$") in thickness from outside of the tube; nor shall the load carried by the steel shell exceed one half 50% the load on the pile.

723. For piles longer than forty (40) diameter the allowable load is reduced by a percintage equal to the excess length divided by the diameter.

724. The load on a pile shall not exceed the allowable as determined by section...604..., where it is positively proven that the pile rests upon bed rock of known quality the allowable bearing power of the rock may govern.

725. When a single pile supports a detached column or pier, the load shall not exceed two thirds ($\frac{2}{3}$) the capacity of the pile.

G. Friction Piles

726. Friction piles shall be designated as those made by depositing concrete against soil in drilled holes and which transmit loads through the medium of friction between their surface area and the soil.

727. They may be designed by assuming a frictional value of four hundred and fifty pounds per square foot of contact area (450 lbs./sq. ft.), neglecting the top five feet (5'-0") below the ground surface, but their safe bearing capacity shall be verified by load tests.

728. Friction piles shall have concrete poured in such a manner as to insure the exclusion of foreign matter and the retention of a full sized shaft. They shall not extend below the ground water line. Reinforcement shall be the same as for cast-in-place piles.

H. Composite Piles

729. Composite piles shall consist of a combination of any of the types of piles providid for in this part. The minimum dimentions of each part shall be those specified for piles of its type. The allowable load shall be limeted by the strength of the weaker type. The joint between the two types shall be contructed so as to prevent their separation, maintain alignment and support the load.

730. The center-to-center spacing of composite piles consisting of a wood pile and cast-in-place pile shall be limited by the requirements of cast-in-place concrete pile.

III. FOOTINGS

A. Loads

801. (a) Dead Load: The weight of the structure including the weight of permanent partitions.

(b) Horizontal Force: A horizontal force caused by wind pressure or the effect of earthquakes.

(c) Live Load: Any load other than the "dead load" and the"horizontal force"

802. Only vertical concentric loads shall be assumed to be distributed uniformly over the bearing area in contact with the foundation.

803. Distribution of eccentric loads shall be based upon the assumption of a rigid foundation and an elastic bearing material. Stresses due to eccentricity may be neglected if they do not exceed 10% of the axil stress.

804. The allowable stresses may be increased 25% where caused by the combination of vertical loads and horizontal forces.

805. Foundations for structures more than fifteen feet high shall be designed to resist both earthquake forces and wind pressures.

806. The amount of the earthquake force shall be considered to be applied in any direction and shall be not less than that given by the formula: $F = CW$

Where; -

F = force of earthquake in pounds

C = A coefficient

W = Total dead and live load.

807. Values for the coefficient "C" in the formula:

Safe resistance of foundation soils to vertical loads	
Four (4) tons per square foot or over.....	0.06
Between 2 and four (4) tons per square foot.....	0.08
Less than two (2) tons per square foot.....	0.10

808. For buildings supported on piles the coefficient "C" shall be 0.10.

For buildings on piers exctending to firm soil or rock the coefficient "C" shall be 0.08.

809. For public buildings "C" shall be 0.10 .

810. Computations for stresses in foundations shall be made in accordance with other parts of this code.

811. Reductions in live loads shall be made in accordance with other parts of this code.

B. Design of Footings

901. Footings and foundations, unless specifically provided shall be constructed of masonry or reinforced concrete and shall in all cases extend to the following minimum depths: -

Building	Distance below the natural surface of the ground.
a. One story building	1'-6"
b. 2 or 3 " "	2'-6"
c. 4 " "	3'-6"
d. 5 or 6 " "	4'-0"
e. 7 or 8 " "	5'-0"

Note: These provisions shall not apply to foundations on bed rock.

902. Footings shall be proportioned as to the area or the number of piles it is resting upon on the bases of the total load plus the weight of the footing itself. For computation of moments and shears, an upward reaction per unit area or per pile shall be based on the total load divided by the area or by the number of piles.

903. Footings may be sloped provided the allowable stresses shall not exceeded at any section.

904. Footings supporting buildings of two or more stories shall rest upon a bearing material of undisturbed natural soil.

905. Footings supporting one-story buildings may rest upon filled ground, subject to the following requirements:

(a) The pressure of the footing upon the bearing material due to live and dead loads, shall not be more than

five hundred pounds per square foot (500lbs./sq.ft.)

(b) The footings section shall be at least two feet (2'-0") in depth and be reinforced with four one-half inch (½") steel bars; two, three inches (3") from the top and two, three inches (3") from the bottom of the footing.

(c) A one-story accessory building may rest upon a concrete slab four inches (4") or more in thickness supported upon filled ground. Such slab shall be reinforced with six by six inches (6" times 6") with #10 - #10 welded wire fabric one inch (1") below the top surface of the slab.

906. All bars in footing slabs, except the longitudinal reinforcement between loads in continuous slab footings, shall be anchored by means of standard hooks. The outer faces of these hooks shall be not less than three inches (3") nor more than six inches (6") from the face of the footing. Hooks will not be required when the projection does not exceed the thickness or depth of the footing slab.

C. Design of Isolated Footings

907. The bending moment on any section of an isolated footing shall be equal to the amount of all the external forces on one side of the section for one-way reinforced footings, and shall be equal to 85% of the external moment for two-way reinforced footings.

908. The greatest bending moment in the design of a footing shall be the moment at sections located as follows: -

(a) At the face of the column, pedestal or wall for footings supporting a concrete column, pedestal or wall.

(b) Half-way between the middle and edge of the wall, for footings under masonry walls.

(c) Half-way between the face of the column or pedestal and the edge of the metal base, for footings under metal bases.

909. The total required tensile reinforcement shall be distributed uniformly along one-way reinforced footings and across the width of two-way reinforced rectangular footings. A portion "R" of the required area of the required transverse reinforcement in two-way rectangular footings shall be distributed uniformly across a band of width "B" centere under the column or pedestal.

"B" = width of footing

$$"R" = \frac{2}{s+1}$$

where: s equals the length of footing divided by its width.

The remainder of the transverse reinforcement shall be uniformly distributed over the outer portions of the footing.

910. The critical section for shear or diagonal tension shall be assumed to be located a distance from the face of the column, pedestal or wal equal to the depth "d" for footings on ground, and one-half the depth "d" for footings on piles.

911. Each face of the critical section for shear shall be considered as resisting an external shear equal to the load on an area bounded by the said face of the critical section for shear, the two diagonals and the portion of the edge of the footing intercepted between the two diagonals.

912. The total tensile reinforcement at any section shall provide bond resistance at least equal to the bond requirements as computed from the following percentages of the external shear at the section:

(a) For one-way reinforced footings, 100%.

(b) For two-way reinforced footings, 85%

913. The total stress in the column shall be considered as being transferred by both bearing on top of the supporting footing and by bond on the embeded longitudinal bars or dowels, or by either. The unit compressive stress on the loaded area shall not exceed .25f'c.

914. In computing the stresses in footings supporting a round or octagonal concrete column or pedestal, it will be assumed that the column is a square having an area equal to the area of the column or pedestal.

915. Dowels having a total cross-sectional area not less than the total cross-sectional area of vertical reinforcement

in the column, and embeded in the footing a distance not less than 40 diameters, shall be provided.

916. Not less than four dowels shall be used and no dowel shall have a diameter more than one-eighth inch ($\frac{1}{8}$") greater than the diameter of the column reinforcing bars.

917. In reinforced concrete footings, the thickness above the reinforcement at the edge of the design bearing area shall be not less than six inches (6") for footings on soil, nor less than twelve inches (12") for footings on piles.

918. In plain concrete footings, the thickness at the edge shall be not less than six inches (6") for footings on soil and not less than fourteen inches (14") above the top of the piles for footings on piles.

919. All structural steel shapes used in footings shall have at least six inches (6") of concrete between the steel and the upper footing surface and shall be protected with at least four inches (4") of concrete at all other points.

920. In determining the depth of unreinforced footings or piers the assumption shall be made that the load is carried through the concrete at an angle of thirty detrees (30°) from the vertical without developing bending stresses in the footing. The projection on any side from the face of the supported member shall not be greater than one half ($\frac{1}{2}$) the depth at the face of such member.

D. Design of Continuous Footings

921. Excavation in sloping ground shall be stepped to provide level bearing for footings. The steps in the footing walls shall overlap the steps in the excavation by a distance not less than the depth of the step in the excavation.

922. If not more than one thousand square feet (1000 sq. ft.) in area, any one-story building not used for residential purposes having wood or steel stud bearing walls, may rest upon a concrete slab. Such slab shall be three inches (3") or more in thickness and resting on undisturbed natural soil.

923. Exterior walls resting upon an unreinforced slab shall be supported by a footing eight inches (8") wide extending eight inches (8") into natural ground.

IV DESIGN of FOUNDATION WALLS

1001. Solid masonry foundations walls and those of concrete block or coursed stone shall not be less in thickness than the wall immediatly above and in no case less than twelve inches (12") except when the space enclosed within the foundation is not excavated where they may be eight inches (8") thick.

1002. When built of concrete cast-in-place, foundation walls shall be at least as thick as the walls supported, but in no case less than eight inches (8").

1003. When built of rubble stone, they shall be at least sixteen inches (16") thick.

1004. Rough or random rubble without bonding shall not be used as foundations for walls more than thirty-five feet (35') heigh, nor shall coursed bonded rubble walls be used as foundations for walls more than seventy-five feet (75') heigh.

V FOUNDATION TIES

1101. Piles or foundation piers shall have a structural ties between their tops at the ground line in longitudinal and transverse directions. Ties may be reinforced concrete beams, structural steel encased in concrete, or a continuous reinforced concrete slab.

1102. Each of the foundation ties shall be designed to transmit in tension and /or compression one tenth (1/10) of the total vertical load carried by the heavier of the footings, piers or caps connected. Ties shall be so proportioned as to hold all columns together.

1103. The minimum section of any foundation tie shall be: -

(a) Reinforced concrete: 12" times 12" in gross cross-section. reinforced with four (4) longitudinal steel bars five-eighth inch (5/8") in diameter, and bound with steel ties one-quarter inch (¼") in diameter spaced not over twelve inches (12") on certers.

(b) Structural steel: - A six inch (6") twenty pound (20#) "H" section encased in concrete with at least two inches (2") of concrete outside of the steel.

1104. If a reinforced concrete slab is used, such slab shall gave a thickness not less than one forty-eight (1/48) of the clear distance between footings, piers or piles and not less than six inches (6"). It shall be reinforced with not less than eleven one-hundredth (0.11) square inches of steel per linear foot in both directions.

1105. The longitudinal bars of foundation ties and the reinforce-

ment of slabs shall be embedded not less than forty (40) diameters in piles, piers or footings and provided with standard hooks.

VI RETAINING WALLS

1201. When a wall is retaining earth and/or water, the total pressure, both vertical and horizontal, shall be calculated with the best accepted engineering practice, and such design shall take into account any possible surcharge due to moving or fixed loads.

1202. Drainage of the retained materials shall be provided to such an extent as to keep the forces on the wall within the design loads.

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