MATERIALS — LOADS AND STRESSES

(CHAPTERS XII THROUGH XXII)

TABLES

CHAPTER XII—MINIMUM DESIGN LOADS

CHAPTER XIII—FOUNDATIONS—EXCAVATIONS, FOOTINGS AND FOUNDATIONS

CHAPTER XIV—MASONRY CONSTRUCTION

CHAPTER XV—STEEL CONSTRUCTION

CHAPTER XVI—CONCRETE CONSTRUCTION

CHAPTER XVII—WOOD CONSTRUCTION

SUPPLEMENT TO CHAPTER XVII—Plywood Diaphragms

CHAPTER XVIII—LATHING AND PLASTERING

CHAPTER XIX—ALUMINUM CONSTRUCTION

CHAPTER XX—GLASS

CHAPTER XXI—PREFABRICATED CONSTRUCTION

CHAPTER XXII—PLASTICS

CHAPTER XII—MINIMUM DESIGN LOADS

SECTION 1201—GENERAL

Every building and structure shall be of sufficient strength to support the imposed live, dead and wind loads and impact loads, if any, without exceeding, in any of its structural elements, the stresses prescribed elsewhere in this code.

SECTION 1202—DEAD LOADS

1202.1—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 I.

1202.2—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.

1202.3—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 pounds per square foot.

SECTION 1203—LIVE LOADS

1203.1—UNIFORMLY DISTRIBUTED LOADS

(a) REQUIRED LIVE LOADS: The live loads to be assumed 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 12A.

(b) LOADS NOT SPECIFIED: For occupancies or uses not listed in 12A, the live load shall be determined in a manner satisfactory to the Building Official.

1203.2—CONCENTRATED LOADS

Floors shall be designed to support safely the uniformly distributed live loads prescribed in Section 1203.1 or the concentrated load in pounds given in Table 12B, whichever produces the greater stresses. Unless otherwise specified, the indicated concentration shall be assumed to occupy an area of 2½ feet square and shall be so located as to produce the maximum stress conditions in the structural members.

TABLE 12A

MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

OCCUPANCY OR USE	LIVE LOAD (Lb. Per Sq. Ft.)
Air Conditioning (Machine Space)	200*
Apartments (See Residential)	
Armories and Drill Rooms	150
Assembly Halls and Other Places of Assembly:	
Fixed Seats	60
Movable Seats	100
Attic:	
Non Storage	20
Storage	80†
Balconies and Galleries:	
Exterior	100
Interior—Fixed	60
Interior—Movable Seats	100
Boiler Room	300*
Bowling Alleys, Pool Rooms, and Similar Recreational Areas	75
Catwalks in Accessible Ceilings	25
Ceiling—Accessible Furred	10
Corridors:	
First Floor and Public	100
(Other Floors, Same As Occupancy Served Except As Indicated)	
Dance Halls	100
Dining Rooms and Restaurants	100
Dormitories:	
Partitioned	40
Nonpartitioned	80
Driveways and Yards (See Sidewalks)	
Dwellings (See Residental)	
Elevator Machine Room	150*
Fan Room	150*
File Room:	
Letter	80†
Card	125†
Addressograph	150†
Fallout Shelters—Group I-1 (dual use)	To be determined by normal occupancy requirements. Concentrated loads due to water storage shall be considered.
Fallout Shelters—Group I-2 (single purpose)	40 (Concentrated loads due to water shall be considered)

TABLE 12A (Continued)

MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

OCCUPANCY OR USE	LIVE LOAD (Lb. Per Sq. Ft.)
Garages And Trucking Spaces:	
Passenger Cars	100
Trucks, With Load, 3 to 10 Tons	150
Trucks, With Load, Above 10 Tons (Floors Shall Be Designed To Carry 150 Percent Of The Maximum Wheel Load Anywhere On The Floor)	200
Grandstands (See Reviewing Stands)	
Hospitals:	
Operating Rooms	60
Private Rooms	40
Wards	40
Laboratories	100*
Hotels (See Residential)	
Kitchens, Other Than Domestic	150*
Laboratories, Scientific	100
Laundries And Bakeries	150*
Libraries:	
Reading Rooms	60
Stack Rooms	150
Manufacturing:	
Light	100*
Heavy	150*
Marquees	75
Morgue	125
Offices, Buildings:	
Offices	80
Lobbies	100
Files (See File Room)	
Business Machine Equipment	100*
Corridors Above First Floor	80
Open Parking Decks For Passenger Cars Only (Decks Shall Be Designed To Carry 150 Percent of the Maximum Wheel Load Anywhere On The Deck)	50
Penal Institutions:	
Cell Blocks	40
Corridors	100

TABLE 12A (Continued)

MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

OCCUPANCY OR USE	LIVE LOAD (Lb. Per Sq. Ft.)
Printing Plants:	
Composing Rooms	100
Linotype Rooms	100
Press Rooms	150*
Public Rooms	100
Ramps, Pedestrian (See Sidewalks)	
Residential:	
Multifamily Houses:	
Private Apartments	40
Public Rooms	100
Corridors	60
Dwellings:	
First Floor	40
Upper Floors And Habitable Attics	30
Uninhabitable Attics	20
Hotels:	
Guest Rooms	40
Public Rooms and Corridors Serving Public Rooms	100
Public Corridors	60
Private Corridors	40
Rest Rooms and Toilet Rooms	60
Reviewing Stands and Bleachers	100
Schools:	
Classrooms	40
Corridors	100
Sidewalks, Vehicular Driveways, and Yards and Ramps Subject To Trucking	250
Skating Rinks	100
Stairs, Fire Escapes, and Exitways	100
Storage Warehouse:	
Light	125†
Heavy	250†
Stores:	
Retail:	
First Floor Rooms	100
Upper Floors	75
Wholesale	125
Telephone Exchange	150*
Theaters:	
Aisles, Corridors, and Lobbies	100
Balconies and Orchestra Floors	60

TABLE 12A (Continued)

MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

OCCUPANCY OR USE	LIVE LOAD (Lb. Per Sq. Ft.)
Dressing Rooms	40
Projection Room	100
Stage Floors	150
Grid-Iron Floor or Fly Gallery Grating Well Beams 250 Lb. Per Lin. Ft. Per Pair, Header Beams, 1,000 Lb. Per Lin. Ft., Pin Rail, 250 Lb. Per Lin. Ft.	60
Transformer Rooms	200*
Vaults, In Offices	250†
Yards and Terraces, Pedestrians Only	100

*Use weight of actual equipment when greater.
†Increase when occupancy exceeds this amount.

TABLE 12B

CONCENTRATED LOADS

LOCATION	LOAD, POUNDS
Elevator machine room grating (on area of 4 sq. in.)	300
Finish light floor plate construction (on area of 1 sq. in.)	200
Office floors	2000
Scuttles, skylight ribs, and accessible ceilings	200
Sidewalks	8000
Stair treads (on center of tread)	300

(a) 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.

1203.3—PARTIAL LOADING

When the construction is such that the structural elements thereof act together in the nature of an elastic frame due to their continuity and the rigidity of the connections, and the live load exceeds 150 lbs. per sq. ft. or twice the dead load, the effect of partial live load such as will produce maximum stress in any member shall be provided for in the design.

1203.4—IMPACT LOADS

The live loads specified in 1203.1(a) shall be assumed to include adequate allowance for ordinary impact conditions. Provisions shall be made in the structural design for uses and loads which involve unusual vibration and impact forces.

(a) ELEVATORS: All moving elevator loads shall be increased 100 percent for impact, and the structural supports shall be designed within the limits of deflection prescribed by the American Standard Safety Code for Elevators, Dumbwaiters, and Escalators, A17, 1-1965, and American Standard Inspection of Elevators (Inspector's Manual), A17.2-1945, or the latest revisions thereof approved by the American Standards Association, Incorporated.

(b) HEAVY MACHINERY: For the purpose of design, the weight of heavy machinery and moving loads shall be increased not less than 25% for impact, unless otherwise specified.

(c) CRANEWAYS: All craneways shall be designed to resist a horizontal transverse force equal to 20% of the crane capacity plus the weight of the trolley applied one-half at the top of each runway rail for impact; and a horizontal longitudinal force equal to 10% of the total of the maximum wheel loads applied at the top of each rail.

1203.5—REDUCTION IN LIVE LOADS

(a) ROOF LIVE LOADS: No reduction shall be applied to the roof live load.

(b) LIVE LOADS 100 LBS. PER SQUARE FOOT OR LESS: For live loads of 100 pounds or less per square foot, the design live load on any member supporting 150 square feet or more may be reduced at the rate of 0.08 percent per square foot of area supported by the member, except that no reduction shall be made for areas to be occupied as places of public assembly. The reduction shall exceed neither R as determined by the following formula, nor 60 percent:

$$R = 100\left(\frac{D+L}{4.33L}\right)$$

in which

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

(c) LIVE LOADS EXCEEDING 100 LBS. PER SQUARE FOOT: For live loads exceeding 100 pounds per square foot, no reduction shall be made, except that the design live loads on columns may be reduced 20 percent.

1203.6—DEFLECTION

The deflection of any structural member shall not exceed the values set forth in Table No. 12C based upon the factor set forth in Table No. 12D.

TABLE 12C

MAXIMUM ALLOWABLE DEFLECTION FOR STRUCTURAL MEMBERS*

Type of Member	Member Loaded With Live Load Only	Member Loaded With Live Load Plus K Times The Dead Load
Roof Member Supporting Plaster or Floor Member	L/360	L/240

*L = Length of member in same units as deflection.
K = Factor as determined in Table 12D.

TABLE 12D—VALUE OF K

WOOD		REINFORCED CONCRETE			STEEL
Unseasoned	Seasoned	A's=0	A's=0.5 As	A's=As	
1.0	0.5	2.0	1.2	0.8	0

1203.7—RESTRICTIONS ON LOADING

It shall be unlawful to place, or cause or permit to be placed, on any floor or roof of a building or other structure a load greater than that for which such floor or roof is approved by the Building Official.

1203.8—MINIMUM ROOF LOADS

(a) FLAT, PITCHED OR CURVED ROOFS: Ordinary roofs, either flat, pitched or curved shall be designed for a live load of not less than the value shown in Table 12E and Figure 12A in addition to the dead, mechanical equipment and wind loads.

(b) UNBALANCED LOADING: Unbalanced loads shall be used where such loading will result in larger members and connections.

(c) SPECIAL CONDITIONS:

(1) Where loads in Table 12E are in excess of 20 pounds per square foot of horizontal projection any excess over this amount may be reduced for each degree of pitch over 20 degrees by (S/40) minus ½, where S is the total snow load in pounds per square foot.

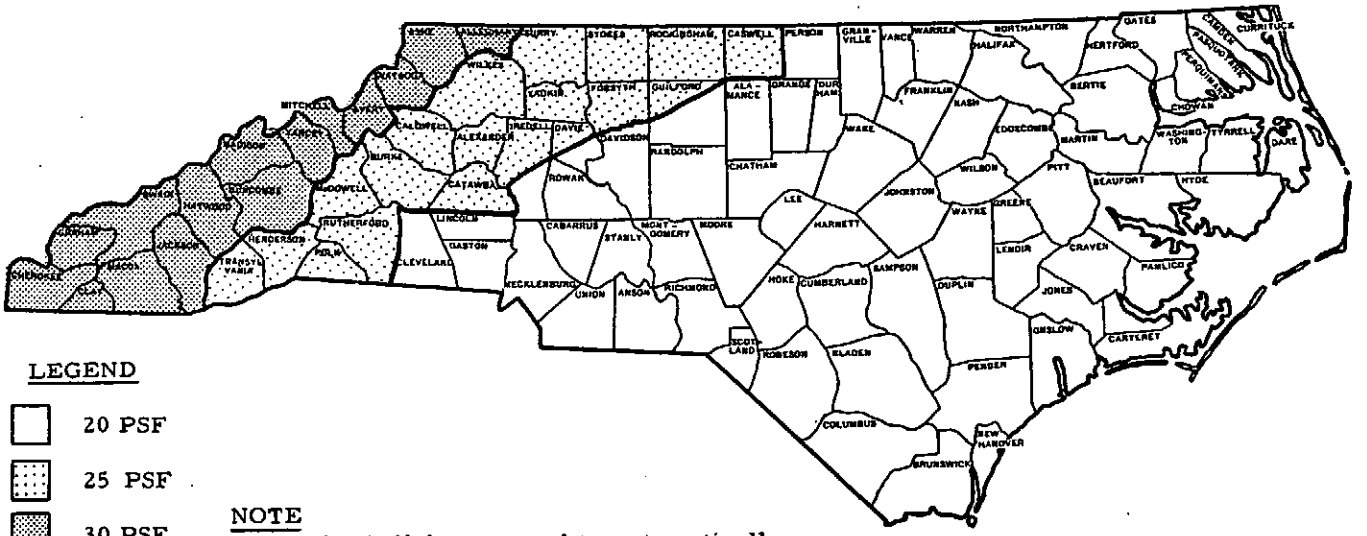
TABLE 12E

MINIMUM ROOF LIVE LOADS

(See Figure 12A for Map of N.C.)

County	Lbs./Sq. Ft.	County	Lbs./Sq. Ft.
Counties not listed	20	Henderson	25
Alexander	25	Iredell	25
Allegheny	30	Jackson	30
Ashe	30	Macon	30
Avery	30	Madison	30
Buncombe	30	McDowell	25
Burke	25	Mitchell	30
Caldwell	25	Polk	25
Caswell	25	Rockingham	25
Cherokee	30	Rutherford	25
Clay	30	Surry	25
Davie (See Map)	25	Swain	30
Forsyth	25	Transylvania	25
Graham	30	Watauga	30
Guilford (See Map)	25	Wilkes	25
Haywood	30	Yancey	30
		Yadkin	25

NOTE: The loads shall be assumed to act vertically upon the area projected upon a horizontal plane. Consult local weather records in regions of high altitude.



NOTE
The loads shall be assumed to act vertically upon the area projected upon a horizontal plane. Consult local weather records in regions of high altitude.

Figure 12A-MINIMUM ROOF LIVE LOADS

(2) When the effect of the shape of roof structure as determined by actual test or experience indicates lesser or greater snow-retention value than specified herein, the roof load shall be modified as directed or approved by the Building Official.

(3) When valleys are formed by a multiple series of roofs, special provision shall be made for the increased load at the intersections.

(d) CAMBER: All roofs shall be designed with sufficient slope or camber to assure adequate drainage after long-time deflection from dead load shall be designed to support the loads listed in 1203.8(a) plus the load from possible ponding of water due to deflection.

(e) SPECIAL PURPOSE ROOFS: When used for incidental promenade purposes, roofs shall be designed for a minimum live load of 60 pounds per square foot; and 100 pounds per square foot 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.

1203.9—LOAD TESTS

The Building Official may require a load test of any construction whenever there is reason to question its safety for the intended use. Such tests are to be made at the expense of the owner or his agent. The construction shall sustain a superimposed load equal to twice the design live load and shall recover at least seventy-five (75) percent of its maximum deflection within twenty-four (24) hours after the load is removed.

SECTION 1204—SPECIAL LOADS

1204.1—SOIL PRESSURES ON BASEMENT WALLS AND FLOORS

In the design of basement walls and similar approximately vertical structures below grade, provisions shall be made for lateral pressure of adjacent soil. Due allowances shall be made for possible surcharge from fixed or moving loads.

In the design of basement floors and similar approximately horizontal constructions 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.

1204.2—RAILINGS

Stairway railings, both exterior and interior shall be designed to resist a horizontal thrust of twenty (20) pounds per linear foot applied at the top of the railing.

Balcony railings, both exterior and interior shall be designed to resist a horizontal thrust of fifty (50) pounds per linear foot applied at the top of the railing.

1204.3—SUPPORTS FOR WALKWAYS

Where walkways are to be installed above ceilings, supports shall be designed to carry a load of two hundred (200) pounds occupying a space of two and one-half (2½) square feet, so placed as to produce maximum stresses in the affected members.

SECTION 1205—WIND LOADS

1205.1—MINIMUM DESIGN PRESSURES

Buildings or other structures shall be designed and constructed to withstand the applicable horizontal pressures shown in Table 12F allowing for wind from any direction. The height is to be measured above the average level of the ground adjacent to the building or structure.

1205.2—EXTERIOR WALLS

Every exterior wall shall be designed and constructed to withstand the pressures specified in Section 1205.1 acting either inward or outward.

1205.3—ROOFS

(a) OUTWARD PRESSURES: The roofs of all buildings or other structures shall be designed and constructed to withstand pressures, acting outward normal to the surface, equal to 1¼ times those specified for the corresponding height zone in which the roof is located. The height is to be taken as the mean height of the roof structure above the average level of the ground adjacent to the building or other structure and the pressure assumed on the entire roof area.

(b) INWARD PRESSURES: Roofs or sections of roofs with slopes greater than 30 degrees shall be designed and constructed to withstand pressures, acting inward normal to the surface, equal to those specified for the height zone in which the roof is located, and applied to the windward slope only.

(c) EAVES AND CORNICES: Overhanging eaves and cornices shall be designed and constructed to withstand outward pressures equal to twice those specified in 1205.1.

(d) ANCHORAGE: Adequate anchorage of the roof to walls and columns and of walls and columns to the foundations to resist overturning, uplift, and sliding, shall be provided in all cases.

1205.4—CHIMNEYS, TANKS, AND TOWERS

(a) CHIMNEYS: Chimneys, tanks and solid towers shall be designed and constructed to withstand the pressures specified in 1205.1, multiplied by the following factors:

HORIZONTAL CROSS SECTION	FACTOR
Square or rectangular	1.00
Hexagonal or octagonal	0.80
Round or elliptical	0.60

(b) TRUSSED TOWERS: Radio Towers and other towers of trussed construction shall be designed and constructed to withstand wind pressures specified in 1205.1 multiplied by suitable shape factors, and in accordance with good engineering practice.

TABLE 12F

WIND PRESSURES FOR VARIOUS HEIGHT ZONES ABOVE GROUND*

HEIGHT ZONE (FT.)	BASIC DESIGN WIND PRESSURE (LB. PER SQ. FT.)						
	20	25	30	35	40	45	50
Less than 30	15	20	25	25	30	35	40
30 to 49	20	25	30	35	40	45	50
50 to 99	25	30	40	45	50	55	60
100 to 499	30	40	45	55	60	70	75
500 to 1199	35	45	55	60	70	80	90
1200 and Over	40	50	60	70	80	90	100

*Reference should be made to Table 12G and that wind-pressure column in the table should be selected which is headed by a value corresponding to the minimum permissible resultant wind pressure indicated for the particular locality in Table 12G. The figures given are recommended as minimum. These requirements do not provide for tornadoes.

TABLE 12G

BASIC DESIGN WIND PRESSURES

(See Figure 12B for Map of N. C.)

COUNTY	LB./SQ. FT.	COUNTY	LB./SQ. FT.
Counties not listed	20	Hyde	45
Beaufort	40	Johnston	25
Bertie	35	Jones	35
Bladen	30	Lenoir	35
Brunswick	35	Martin	35
Camden	40	Nash	25
Carteret	40	New Hanover	35
Chowan	35	Northampton	30
Columbus	35	Onslow	35
Craven	35	Pamlico	40
Cumberland	25	Pasquotank	40
Currituck	40	Pender	35
Dare	45	Perquimans	35
Duplin	30	Pitt	35
Edgecombe	30	Robeson	30
Franklin	25	Sampson	30
Gates	35	Scotland	25
Greene	35	Tyrrell	40
Halifax	30	Warren	25
Harnett	25	Washington	40
Hertford	30	Wayne	30
Hoke	25	Wilson	30

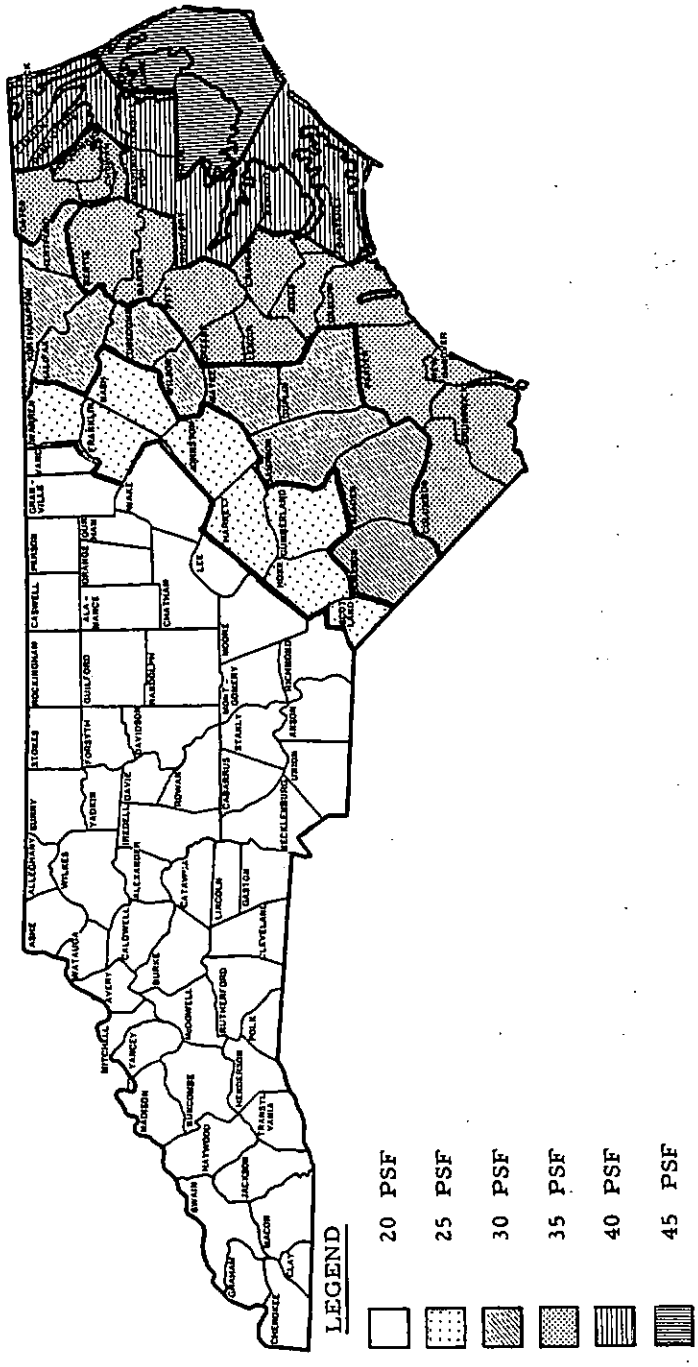


Figure 12B-BASIC DESIGN WIND PRESSURES

1205.5—SIGNS AND OUTDOOR DISPLAY STRUCTURES

(a) WIND PRESSURE:

(1) For the purpose of determining wind pressures, all signs shall be classified as either open or solid. Signs in which the projected area exposed to wind consists of 70 percent or more of the gross area as determined by the over-all dimensions shall be classified as solid signs; those in which the projected exposed area is derived from open letters, figures, strips, and structural framing members, the aggregate total area of which is less than 70 percent of the gross area so determined, shall be classed as open signs.

(2) All signs shall be designed and constructed to withstand wind pressures of not less than the intensities (Table 12H) applied to the projected exposed area.

(b) PROJECTED EXPOSED AREA: The exposed area subjected to wind pressure shall be the total area of all parts of the sign, including structural framing projected on a plane perpendicular to the direction of the wind. Solid signs shall be designed on the basis of their gross area. In determining the stress in any member, the wind shall be assumed to blow from that horizontal direction and from that inclination from the vertical (but not to exceed 20 degrees above or below the horizontal) which produces the maximum stress in that member. No shielding effect of one element by another shall be considered where the distance between them exceeds four times the smaller projected dimension of the windward element.

1205.6—OTHER STRUCTURES

The Building Official may require evidence to support the values for wind pressure used in the design of structures not specifically covered in this section.

1205.7—SHIELDING AND UNUSUAL EXPOSURES

(a) ALLOWANCE: No allowance shall be made for the shielding effect of other buildings or structures.

(b) HIGHER WIND PRESSURES: If the building or other structure is on a mountain, ocean promontory, or in any other location considered by the Building Official to be unusually exposed, higher wind pressures may be prescribed by the Building Official.

1205.8—OVERTURNING AND SLIDING

(a) OVERTURNING: The overturning moment due to the wind load shall not exceed 66⅔ percent of stability 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 bottom of the footings. The weight of earth superimposed over footings may be used in computing the moment of stability due to dead load.

(b) 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.

(c) STRESSES DURING ERECTION: Provision shall be made for wind stress during erection of the building or other structure.

SECTION 1206—SEATING CAPACITY POSTED

Signs stating the maximum seating capacity shall be conspicuously posted by the owner of the building in each assembly room, auditorium or room used for a similar purpose where fixed seats are not installed. It shall be unlawful to remove or deface such notice or to permit more than this legal number of persons within such space.

SECTION 1207—OCCUPANCY PERMITS FOR CHANGED LOADING

Plans for other than residential buildings filed with the Building Official with applications for permits shall show on each drawing the live loads per square foot of area covered, for which the building is designed, and occupancy permits for buildings hereafter erected shall not be issued until the floor load signs, required by Section 105 have been installed. No changes in the occupancy of a building now existing or hereafter erected shall be made until a revised occupancy permit has been issued by the Building Official certifying that the floors are suitable for the loads characteristic of the proposed occupancy.

TABLE 12H

WIND PRESSURES FOR SIGNS AT VARIOUS HEIGHT ZONES ABOVE GROUND*

Height Above Ground (Ft.)	Solid Signs—All Types							Open Signs—All Types						
	Wind-pressure-map areas (lb. per sq. ft.)							Wind-pressure-map areas (lb. per sq. ft.)						
	20	25	30	35	40	45	50	20	25	30	35	40	45	50
Less than 30	17	22	28	28	33	39	44	23	31	39	39	46	54	62
30 to 49	22	28	33	39	44	50	55	31	39	46	54	62	70	77
50 to 99	28	33	44	50	55	61	66	39	46	62	70	77	85	92
100 to 499	33	44	50	61	66	77	83	46	62	70	85	92	104	108

*Reference should be made to Table 12G and that wind-pressure column in Table 12F should be selected which is headed by a value corresponding to the minimum permissible resultant wind pressure indicated for the particular locality in Table 12G. The figures given are recommended as minimum. These requirements do not provide for tornadoes.
Solid ground signs less than 50 feet in height shall be designed for 0.6 of the tabular values given above, but not less than 17 pounds per square foot (psf).
Open ground signs less than 50 feet in height shall be designed for 0.6 of the tabular values given above but not less than 23 psf.
Design pressures on signs located 500 feet or more above ground should be determined by special analysis of conditions.

CHAPTER XIII—FOUNDATIONS—EXCAVATIONS, FOOTINGS AND FOUNDATIONS

SECTION 1301—EXCAVATIONS

1301.1—GENERAL

When excavating for buildings or excavations accessory thereto, such excavations shall be properly assured against any danger to life and property. Permanent excavations shall have retaining walls made of steel, masonry, reinforced masonry or reinforced concrete of sufficient strength to prevent movement or caving of the adjoining soil together with any surcharged loads on that soil. Excavation for any purpose shall not extend within one (1) foot of a surface drawn at 45 degrees to the horizontal through the lower edge of any footing or foundation, unless such footing or foundation is first properly underpinned or protected against movement.

1301.2—SUPPORT OF ADJOINING BUILDINGS AND STRUCTURES

(a) When an excavation extends not more than 10 feet below the established curb grade nearest the point of excavation under consideration, the owner of any adjoining building or structure, the footings or foundations of which are to be underpinned or protected under the requirements of this section, shall be notified in writing by the one causing the excavation to be made. The owner of the adjoining structure or building shall be afforded the necessary license to enter the premises where the excavation is to be made, and at his own expense, shall provide the necessary underpinning or protection.

(b) Notice to the owner of adjoining buildings or structures shall be served at least 30 days before an excavation is commenced, and it shall state the depth and location of the proposed excavation.

(c) When an excavation extends more than 10 feet below the established curb grade nearest the point of excavation under consideration, the one causing the excavation to be made, if given the necessary license to enter the adjoining premises, shall provide at his own expense the underpinning and protection required by that part of the excavation which extends to a depth greater than 10 feet below the established curb grade nearest the point of excavation under consideration, whether or not the existing footings or foundations extend to the depth of 10 feet or more below curb grade; or he may shore and brace the sides of his excavation so as to prevent effectively any soil movement into his excavation. If permanent lateral support is provided, the method used must satisfy requirements of the Building Official. If the necessary license is not afforded the person causing the excavation to be made, it shall be the duty of the owner failing to afford such license to provide the required underpinning or protection, for which purpose he shall be afforded the necessary license to enter the premises where such excavation is to be made.

(d) If there is no established curb grade, the depth of excavation shall be referred to the level of the ground at the point under consideration. If an existing building or structure, the footings or foundations of which are required to be underpinned or protected, is so located that the curb grade level to which it is properly referred is at a higher level than the level to which the excavation is properly referred, then such part of the required underpinning or protection that is necessary due to the difference in these

levels shall be made and maintained at the joint expense of the owner of the building or structure and the person causing the excavation to be made. For the purpose of determining such part of the underpinning, or protection that is necessary due to such difference in levels, the level to which a building more than five feet back of the street line is properly referred shall be considered to be the level of the natural ground surface adjoining the building or structure.

(e) A party wall which is in good condition and otherwise suitable for continued use, shall be underpinned or protected as required at the expense of the person causing the excavation to be made.

(f) Where the necessary license has been given to the person making an excavation to enter any adjoining structure for the purpose of underpinning or protecting it, the person receiving such license shall provide for such adjoining structure adequate protection against injury due to the elements resulting from such entry.

(g) Only approved granular materials shall be used for backfill of walls under this section. It shall be compacted by vibratory compactors to a relative density of at least 70% in order to prevent lateral displacements of the soil of the adjoining property after the removal of the shores or braces.

SECTION 1302—FOOTINGS AND FOUNDATIONS

1302.1—GENERAL

Except in the case of temporary structures or secondary buildings not over 1 story in height and not exceeding 400 square feet in area, footings and foundations, unless specifically provided, shall be constructed of grillages of steel, of masonry or of reinforced concrete (one and two family dwellings may not be required to have reinforced concrete footings or grillage of steel) in no case less than 12 inches below grade. Masonry units used in foundation walls and footings shall be laid up in Type M, S, or N mortar. The base areas of all footings and foundations shall be proportioned as specified in Section 1302.3.

1302.2—BEARING CAPACITY OF SOIL AND ROCK

(a) BEARING CAPACITIES: The terms used in this section shall be interpreted in accordance with generally accepted engineering nomenclature. In addition, the following more specific definitions are used for bearing materials in the Piedmont Region.

(1) Rocks

(a) Weathered Rock—Broken and partially weathered rock of sufficient hardness to resist soil boring tools but not suitable for diamond coring.

(b) Saprolite—Mechanically undisturbed rock that has been chemically weathered to such state or condition that it can be easily excavated but yet retains the texture and structure of the parent material. High values of standard penetration resistance.

(2) Soils

(a) Residual Silt—Extensively weathered residual soil material retaining the general structural pattern of the parent rock. Breaks down to cohesionless, silt sized particles with slight remolding. Low values of standard penetration resistance. Usually micaceous.

Footings, piers or end bearing caissons shall be so designed that the bearing pressure on the foundation material shall not exceed the value specified in this section unless the particular soil on which the building is to be placed shows a greater bearing capacity when tested as provided in Section 1302.2(b).

BEARING CAPACITIES OF VARIOUS SOILS

CLASS	MATERIAL	Allowable Bearing Value in Tons per square foot[1]
1	Massive igneous or metamorphic rocks all in sound condition (minor cracks allowed)	100
2	Massive sedimentary rocks (when interbedded, strength shall be determined by weakest member)	20
3	Weathered rock	40
4	Saprolite (assume similar to dense sand)	10[2]
5	Dense Sand	5[2]
6	Stiff Clay	3[2]
7	Loose Sand	1 to 2[2]
8	Soft Clay	1[2]
9	Compacted controlled fill	1 to 2[2,3]

[1]The allowable bearing value given in this section or when determined in accordance with the provisions of Section 1302.2(b) will assure that the soils will be stressed within limits that lie safely below their strength. However, such allowable bearing pressures for classes 6 through 9 do not assure that the settlements will be within tolerable limits for a given structure.

[2]Alternatively the allowable bearing value may be calculated from a value of the angle of internal friction determined by field or laboratory tests.

[3]Alternatively the allowable bearing value may be calculated from the unconfined compressive strength of undisturbed samples.

The computed vertical pressure at any level beneath a foundation shall not exceed the allowable bearing values for the material at that level. 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 sixty degrees with the horizontal; but the area considered as supporting the load shall not extend beyond the intersection of sixty degree planes of adjacent foundations.

(b) PROOF OF BEARING CAPACITY: Where the bearing capacity of the soil is not definitely known or is in question or where settlements may be excessive due to the presence of surficial or buried layers of class 6, 7, or 8 soils, the Building Official may require field and/or laboratory tests for shear strength and/or compressibility for adequate proof as to the permissible safe bearing capacity at that particular location. To determine the safe bearing capacity of soil it shall be tested at such locations and levels as conditions warrant by one or more of the following field and laboratory tests performed according to some generally accepted engineering standard.

(1) Shear Strength

(a) Standard Penetration Tests for noncohesive soils.

(b) Plate Bearing Tests, on all soils and rock performed by loading an area of not less than 4 square feet for Class 5 through 9 soils and of not less than 1 square foot for Class 1 through 4 soils and rock to not less than twice the maximum bearing capacity desired for use. Such double load shall be sustained by the soil or rock for a period of not less than 48 hours without additional deflection of the test plate in order that such desired bearing capacity may be used.

(c) Unconfined Compression Test on undisturbed samples of cohesive soils and on sound rock.

(d) Triaxial Compression Tests on all soils, and rock.

(e) Direct Shear Tests on all soils and rock.

(2) Compressibility

(a) One Dimensional Consolidation Tests on undisturbed samples of cohesive soils.

(b) Triaxial Consolidation Tests on undisturbed samples of any soil.

(c) Plate Bearing Tests as described above.

(d) Analysis of Atterberg Limit Tests on Clays geologically similar to those for which consolidation tests results are available.

(e) Analysis of detailed settlement records on existing structures founded on the same soil deposit.

(c) SITE CONDITIONS: Where footings are supported by soils of widely different bearing capacity special provisions shall be made in the design to prevent serious differential settlements.

1302.3—FOOTING DESIGN

(a) The base area of the footings of all buildings shall be designed in the following manner: The area of the footing which has the largest percentage of live load to total load shall be determined by dividing the total load by the allowable soil load. From the area thus obtained, the dead load soil pressure of such footing is determined and the areas of all other footings of the building shall be determined on the basis of their respective dead loads only and such dead load soil pressure. In no case shall the load per square foot under any portion of any footing, due to the combined dead, live, wind and/or any other loads, exceed the safe sustaining power of the soil upon which the footing rests. The total reduced live load occurring in the column immediately above the footing shall be the live load used in the above computation.

(b) Footings shall be proportioned to sustain the applied loads and induced reactions without exceeding the allowable stresses specified in this code.

(c) Concrete in footings shall have an ultimate compressive strength of not less than 2,500 pounds per square inch at 28 days.

1302.4—DOWELS

(a) Dowels of the same number as the vertical bars in the column, but not less than four, shall extend into the column a distance of not less than 20, 24 and 30 bar diameters for specified yield strengths of 50,000

and under, 60,000, and 75,000 psi, respectively, nor not less than 12 inches with concrete having a strength of 3,000 psi or more. When the specified concrete strengths are less than 3,000 psi, the amount of lap shall be one-third greater than the values given above. For plain bars, the minimum amount of lap shall be twice that specified for deformed bars. Dowels shall extend down into the supporting pedestal or footing the distance required to transfer the full working value of the dowel to the concrete without exceeding the bond stress and to support all vertical loads without exceeding the unit stresses permitted in Chapter XVI (ACI 318-63). Hooks shall not be considered effective in adding to the compressive resistance of bars.

(b) The thickness of concrete above the reinforcement shall be not less than 8 inches for footings bearing on soil, nor less than 12 inches for footings on piles. The thickness of concrete protecting the steel reinforcement shall in no case be less than 3 inches.

(c) Design of footings shall be in accordance with Chapter XVI (ACI 318-63).

1302.5—FOUNDATION WALLS

(a) Foundation walls shall be not less in thickness than the walls immediately above them and not less than 12 inches for unit masonry walls, or 8 inches for cast-in-place concrete walls; except that solid masonry walls extending not more than 5 feet, and hollow walls of masonry or walls of hollow units extending not more than 4 feet below the adjacent finished ground level may be 8 inches in thickness. These depths may be increased to a maximum of 7 feet with the approval of the Building Official when he is satisfied that soil conditions warrant such an increase. The total height of 8 inch foundation wall and wall supported shall not exceed that permitted by this Code for 8 inch walls. In all cases, however, foundation walls shall have sufficient strength and thickness to resist all lateral pressures permitted by this code.

(b) Foundation walls of 8 inch thickness (except as provided for in Section 1302.5(c) and conforming to the provisions of Section 1302.5(a) may be used as foundations for dwellings with walls of brick veneer on frame walls or with 10 inch cavity walls, provided that the dwelling is not more than 1½ stories in height and the total height of the wall, including the gable, is not more than 20 feet. Foundation walls of 8 inch thickness supporting brick veneer or cavity walls, shall be corbeled with solid units to provide a bearing the full thickness of the wall above. The total projection shall not exceed 2 inches with individual corbels projecting not more than ⅓ the height of the unit. The top corbel course shall not be higher than the bottom of floor joists and shall be a full header course.

(c) Foundation walls of cast-in-place concrete when supporting one story basementless structures may be 6 inches thick if the total height of the foundation wall and the wall supported is within the allowable height permitted by this Code for 6 inch walls.

(d) Foundation wall vents shall be provided as set forth in Chapter XVII, Wood.

1302.6—TIMBER FOOTINGS

Footings of wood may be used if they are entirely below permanent water level.

SECTION 1303—PILES

1303.1—GENERAL REQUIREMENTS

(a) SPACING: The minimum center-to-center spacing of piles not driven to rock shall be not less than twice the average diameter of a round pile, nor less than 1.75 times the diagonal dimension of a rectangular or rolled structural steel pile, nor less than 2 ft.-6 in.

(1) The minimum center-to-center spacing of piles driven to rock shall be not less than twice the average diameter of a round pile, nor less than 1.75 times the diagonal dimension of a rectangular or rolled structural steel pile, nor less than 2 ft.-0 in.

(2) A column or pier supported by piles, unless connected to permanent construction which provides adequate lateral support shall rest on not less than three piles. When the supporting capacity of a single row of piles is adequate for the wall of a structure, effective measures shall be taken to provide for eccentricity and lateral forces, or the piles shall be driven alternately in lines spaced at least one foot apart and located symmetrically under the center of gravity of the loads carried. A single row of piles without lateral bracing may be used for private dwellings not exceeding two stories in height, provided the centers of the piles are located within the width of the foundation wall.

(3) In no case shall the spacing of piles be such that the average load on the supporting strata will exceed the safe bearing value of those strata, as determined by test borings or other approved methods.

(b) ALLOWABLE LOADS: All piles used to support any building or part thereof shall be driven in such a manner as not to impair their strength. The allowable load on piles may be determined by the applicable formulas of this section or by load tests as prescribed in Section 1303.6.

(1) Subject to the limitations prescribed in this section for the various types of piles, the allowable load for piles driven into granular or more cohesive soil, up to a maximum of forty (40) tons per pile, shall be determined by the value of R obtained by one of the following formulas or the allowable load may be obtained by tests as provided in Section 1303.6. When the allowable load is determined by one of the following formulas, piles with an average diameter or side of 8 inches or less shall be driven by a hammer which delivers a blow of at least 7,000 foot-pounds; piles with an average diameter or side greater than 8 inches and not more than 18 inches shall be driven by a hammer which delivers a blow of at least 15,000 foot-pounds; and piles with an average diameter or side of more than 18 inches shall be driven by a hammer which delivers a blow of at least 22,000 foot-pounds. Power hammers shall be operated at full rated speed, pressure, and stroke as shown in the manufacturer's catalog. The minimum hammer blow for piles intended to carry 25 tons or more shall be 15,000 foot-pounds.

For drop hammers: $$R = \left(\frac{2W_rH}{s+1}\right)$$

For power hammers: $$R = \left(\frac{2E_n}{s+0.1}\right) \times \left(\frac{W_r + KW_p}{W_r + W_p}\right)$$

In which:

R = allowable load in pounds
W_r = Weight of striking part of hammer in pounds
W_p = Weight of pile (including driving appurtenances) in pounds
H = Effective height of fall in feet
E_n = Manufacturers rated energy in foot-pounds
S = Penetration of the pile in inches/blow averaged over the last six inches driven
K = a constant usually taken as 0.2

(2) Piles shall be designed as short columns except that where piles extend above permanent ground or where piles below ground level receive negligible lateral support from the surrounding soil, they shall be designed as long columns throughout their unsupported length. Any soil other than water or fluid soil shall be deemed to afford sufficient lateral support to permit the design of any pile in accordance with normally accepted engineering practice and the applicable provisions of this code.

(c) PROTECTION OF PILES: To such depths or at such horizons as boring records or site conditions indicate possible deleterious action on pile materials because of soil constituents or water levels, such (pile) materials shall be adequately protected by approved preservatives or impervious encasements which will not be rendered ineffective by driving and which will prevent such deleterious action.

(d) SPLICES: Splices shall be such that the resultant vertical and lateral loads at the splices are adequately transmitted. Splices shall be so constructed as to provide and maintain true alignment and position of the component parts of the pile during installation and subsequent thereto. Except for piles which can be visually inspected after driving, splices shall develop not less than fifty percent of the value of the pile in bending. Proper consideration shall be given to the design of splices at sections of piles which may be subject to tension or to bending.

1303.2—STEEL PILES

(a) DEFINITION: Steel piles may consist of rolled shapes, pipe, or built-up structural shapes.

(b) STEEL PIPE PILES: Steel pipe piles shall consist of steel pipe conforming to the American Society for Testing Materials' Standard specifications for Welded and Seamless Steel Pipe Piles, ASTM Designation A252-63T. They may be driven either open-ended or with ends closed. Steel pipe piles driven open-ended shall have a nominal outside diameter of not less than 10¾ inches and a nominal wall thickness of not less than 0.30 inch or if 14 inches or over in nominal outside diameter the nominal wall thickness shall not be less than 0.375 inch. Pipe of less wall thickness may be driven open-ended if a suitable cutting shoe is provided. If steel pipe piles are to be driven with closed ends, a forged or cast steel or flat plate end of approved design shall be used. Steel pipe piles driven with ends closed may be of smaller sizes and wall thickness than specified above but no such pile of uniform section shall have a nominal outside diameter of less than 8⅝ inches. In no case shall the wall thickness be less than 0.219 inches.

(1) The concrete in concrete-filled steel pipe piles shall conform to the requirements for concrete as given elsewhere in this Code. Concrete shall have a minimum compressive strength at twenty-eight days of 2,500 pounds per square inch. No concrete shall be placed through water except with the written approval of the Building Official, who may specify the proportions of the concrete to be so placed and the method of placing. The pipe shall be cleaned of all dirt or other foreign matter before the concrete is placed.

(2) If reinforcement is to be used in concrete-filled steel pipe piles it shall be assembled and tied together so that it may be placed in the pile as a unit. No reinforcement shall be placed within 1 inch of the steel shell.

(3) The maximum allowable load on concrete-filled steel pipe piles not driven open-ended to bearing on rock shall be as specified in Section 1303.1(b) or Section 1303.6. The maximum allowable unit stress in the steel pipe is 12,000 pounds per square inch and the maximum allowable unit stress in the concrete is 25% of its ultimate 28 day compressive strength.

(4) The maximum load on concrete-filled steel pipe piles driven open-ended to bearing on rock, such that the net penetration for the last five blows totals ¼ inch or less under the hammers specified in Section 1303.1(b), is 80% of the load limited by a unit stress of 12,000 psi in the steel and a unit stress in the concrete of 25% of its ultimate 28 day compressive strength unless a greater load is permitted by the provisions of Section 1303.6.

(c) ROLLED STRUCTURAL STEEL PILES: Rolled structural steel piles shall conform to the requirements of the American Society for Testing Materials' Standard Specifications for Steel for Bridges and Buildings, ASTM Designation A7-61T. Sections of such piles shall be of H form, with flange projection not exceeding fourteen times the minimum thickness of metal in either web or flange and with total flange width at least eighty-five percent of the depth of the section. No section shall have a nominal thickness of metal less than ⅜-inch, nor a nominal depth in the direction of the web less than 8 inches. Other structural sections or combinations of sections having flange widths and depths of not less than 10 inches and thickness of metal not less than ½-inch may also be used.

(1) The allowable load on rolled structural steel piles not driven to bearing on rock shall be as specified in Section 1303.1(b) or Section 1303.6 but in no case shall the unit stress exceed 12,000 pounds per square inch. The allowable load on rolled structural steel piles driven to bearing on rock such that the net penetration for the last five blows totals ¼-inch or less under the hammers specified in Section 1303.1(b) is 70 tons for piles of 12 inch nominal depth and 90 tons for piles of 14 inch and over nominal depth unless a greater load is permitted by the provisions of Section 1303.6, provided the unit stress does not exceed 12,000 pounds per square inch.

1303.3—CONCRETE PILES

(a) Concrete piles shall be of material complying with the requirements for Portland cement, fine aggregate, coarse aggregate and reinforcement as specified in Chapter XVI, and steel as specified in Chapter XV. The maximum allowable working stress on any concrete pile shall not exceed

25 percent of the ultimate 28 day compressive strength of the concrete used in the piles, determined by tests as specified in Chapter XVI.

(b) The maximum allowable load on concrete piles shall be as specified in Section 1303.1(b), provided that in no case shall the pile load exceed the working unit stresses specified herein multiplied by the average cross-sectional area of the pile, and provided that except where the load capacity is determined by tests in accordance with Section 1303.6, the allowable load shall not exceed 40 tons for precast concrete piles and cast-in-place concrete piles with steel shells which are driven in intimate contact with the soil and left permanently in place. The maximum allowable load on cast-in-place concrete piles without permanent steel shells shall be 15 tons. For precast concrete piles the maximum load in tons shall not exceed 4 tons times the square root of the minimum cross-sectional area measured above the pile point.

(c) Concrete piles cast-in-place shall be made in such a manner as to insure the exclusion of any foreign matter and to secure a full-sized shaft. The diameter of tapered or step-tapered piles cast-in-place shall be not less than 8" at the point and shall have an average diameter of not less than 11". The diameter of piles cast-in-place without permanent steel shells shall be not less than 14".

(d) No precast concrete pile shall be driven before the concrete has attained a compressive strength at least 3,000 lbs. per sq. in., but in all cases concrete shall be sufficiently cured to attain the ultimate strength upon which its use is based, before piles are driven. Such piles shall be reinforced to withstand conditions of handling, driving, and loading, and shall be so handled and driven as not to cause injury or overstressing which will affect their durability or strength. Precast concrete piles shall have a diameter of not less than 10 inches.

(e) Pile reinforcement when required shall have a protective covering of not less than 1½" of concrete except that where a pile has a metal casing, reinforcement shall be kept not less than 1 inch clear of such exterior casing. Reinforcing for cast-in-place concrete piles shall be considered necessary only when uplift, unbalanced lateral forces, or unsupported lengths (see Section 1303.1(b)) are to be considered.

1303.4—WOOD PILES

(a) Wood piles used to support permanent structures shall be pressure impregnated with coal tar creosote to a minimum final retention of 12 lbs. per cu. ft. in accordance with Appendix "C", unless it is established that the cut-off on untreated wood piles will be below lowest ground-water level assumed to exist during the life of the structure. The treated pile cut-off shall have at least two (2) successive coats of hot creosote liberally applied and (1) be encased in masonry footings so that no part of the pile will be exposed to the air or (2) the cut-off shall be exposed and accessible for inspection. The cut-off on all wood piles shall be along a horizontal plane.

(b) The minimum acceptable standards for wood piles is Class B, ASTM D25-58, Standard Specification for Round Timber Piles. The minimum size of all wood piles shall be at least equal to Class B pile with the following exceptions: (1) Piles having a length of twenty (20) feet or less may have a minimum diameter of ten (10) inches located three (3) feet from butt. (2) Piles used to support five (5) tons or less shall measure at least

eight (8) inches in smallest diameter at cut-off and six (6) inches in smallest diameter at the tip.

(c) The maximum allowable load on a timber pile shall meet the requirements of Section 1303.1(b) provided that the design load does not cause a stress in the timber beyond the following limits: 1200 lbs. per sq. in. on piles of Southern pine, Douglas Fir, Cypress, Oak, or any wood of comparable strength; 850 lbs. per sq. in. on piles of Cedar, Norway Pine, Spruce or any wood of comparable strength nor shall it exceed twenty-five (25) tons.

1303.5—SPECIAL TYPES OF PILES

The use of types of piles not specifically mentioned herein, and the use of piles under conditions not specifically covered herein, may be permitted, subject to the approval of the Building Official, upon the submission of acceptable test data, calculations and other information relating to the structural properties and/or load-carrying capacity of such piles. Prior to giving such approval, the Building Official may require any information or demonstrations which he deems necessary for the determination of the adequacy of the design or of the suitability of the methods of installation. In no case, however, shall the allowable load exceed the limitations specified in the various subsections of Section 1303.

1303.6—TEST OF PILES

(a) When greater loads per pile than permitted by Section 1303.1(b) are desired, or when the design load for any pile foundation is in doubt, control-test piles shall be tested according to some generally accepted engineering standard. The resulting allowable load shall be not more than one-half of that test load which produces a permanent net settlement per ton of test load of not more that 0.01", but in no case more than one-half inch. In subsequent driving of the balance of foundation piles, all piles shall be deemed to have a supporting capacity equal to the control-pile, when the rate of penetration of such piles is equal to or less than that of the control pile through a comparable driving distance. At least one test pile shall be driven and test loaded in each area of uniform foundation materials and additional piles shall be driven and test loaded if deemed necessary to establish safe pile loading.

(b) When any doubt exists as to the safe load-carrying capacity of any pile the Building Official may order a loading test to be made on the pile. Subject to the limitations prescribed in the various sub-sections of Section 1303, the allowable pile load shall be determined as prescribed in the foregoing paragraph.

SECTION 1304—CAISSONS

1304.1—GENERAL

(a) The footings of any structure may be carried down to a firm foundation by isolated piers of plain or reinforced concrete or by open or pneumatic caissons either with or without enlarged base or bell at the bottom. The safe carrying capacity of such shafts or caissons shall not exceed the allowable unit bearing capacity of the soil multiplied by the area of the base or bell at bottom provided such bell shall have at least 4 inch thickness of concrete at its edge and the sides shall slope at an

angle of not less than 60 degrees with the horizontal unless of approved design properly reinforced. In no case shall the shaft of such piers or caissons be of less than 2 feet minimum horizontal dimension unless a permanent steel shell is left between concrete and soil.

(b) The shafts of piers or caissons shall be designed as concrete columns with continuous lateral support. The unit compressive stress shall not exceed 600 psi for plain nor 900 psi for reinforced concrete.

1304.2—CONSTRUCTION

(a) The manner of construction shall be by nondisplacement methods and shall permit inspection of the bearing material in place.

(b) The excavation for piers or caissons shall be protected against caving or sloughing by temporary steel or wood lines that may be removed as the concrete is placed. The design size of the shaft shall be calculated from the interior dimensions of the smallest lines.

(c) With the approval of the Building Official, concrete may be placed through still water by means of a properly operated trench or bottom dump bucket.

(d) The owner shall engage a competent inspector qualified by experience and training to be present at all times while caissons are being installed to inspect and approve the bearing soil and the placement of the concrete. The inspector shall make a record of the type and condition of the bearing soil on which the caisson rests, the dimensions of the shaft and bell bottom and the class of concrete used in its construction.