SUBCHAPTER 11
FOUNDATIONS

TABLE OF CONTENTS

[1112.4]	722	Footings, Foundation Piers, Foundation Walls and Pile Caps
[1112.5]	723	Subgrade for Footings, Foundation Piers, and Foundation Walls
[1112.6]	724	Construction Required for or Affecting the Support of Adjacent Properties or Buildings

***"C26" omitted from section numbers in this column.*
****"27" omitted from section numbers in this column.*

LIST OF TABLES

Table No.

ARTICLE 1 GENERAL

§[C26-1100.1] 27-652 Scope.- The provisions of this subchapter shall establish minimum requirements for the design and construction of the foundations of buildings. In addition, within special flood hazard areas, and below the regulatory flood datum, as described in article ten of subchapter four of this chapter, foundations shall conform with the applicable provisions of reference standard RS 4-5.

§[C26-1100.2] 27-653 Standards.- The provisions of reference standard RS-11 shall be part of this subchapter.

§[C26-1100.3] 27-654 Definitions.- For definitions to be used in the interpretation of this subchapter, see subchapter two of this chapter.

§[C26-1100.4] 27-655 Plans. -For the requirements governing the filing of plans and the work to be shown on the plans, see subchapter one of this chapter**.**

§[C26-1100.5] 27-656 Permits. -For the requirements governing equipment work permits and for equipment use permits, see subchapter one of this chapter.

§[C26-1100.6] 27-657 General requirements. -
Except as otherwise specifically provided herein, the foundations of buildings including retaining walls and other structures shall bear on, or be carried down to, satisfactory bearing materials in such manner that the entire transmitted load will be distributed over the supporting soils at any depth beneath the foundation at unit intensities within the allowable bearing values established in this subchapter. In addition, foundations shall be proportioned to limit settlements to a magnitude that will not cause damage to the proposed construction or to existing adjacent or nearby buildings during or after construction.

§[C26-1100.7] 27-658 Depth of foundations. -
(a) Footings and Pile Caps.- The bottom surface of any footing, pier, pile cap, or other foundation construction, other than grade beams, shall be carried down at least four feet below the lowest level of the adjoining ground or pavement surface that is exposed to frost, except as follows:
(1) In refrigerator, cold storage, or similar areas, the depth shall be increased as required to find [*sic*] the construction below the potential level of freezing in the soil, or loss of heat from the soil shall be prevented by insulation, warm air ducts, circulating systems, or equivalent means.
(2) For foundation elements resting on rock, the footings may rest on the rock surface at shallower depths than those indicated above, provided that visual inspection of the rock surface directly underlying the bearing area shows it to be free of seams, cracks, or disintegrated materials that could serve as reservoirs for water and thus be subject to freezing.
(3) For foundation elements in the interior of closed and heated buildings, or in cases where the soil underlying the foundation is not subject to frost action, there shall be no mandatory minimum requirement for embedment.
(4) Mobile or portable buildings not more than one story high may be supported on foundation elements bearing at grade, subject to the following conditions:
a. The building shall be supported on jacks, wedges, or other devices that will permit readjustment of level in the event of displacement.
b. The bearing capacity of the underlying soil shall be adequate to support the building loads without rupture. Where the building is to be supported on nominally unsatisfactory bearing materials, the provisions of sections 27-677 and 27-679 of article four of this subchapter shall apply except that, where the bearing material is confined under pavement and the bearing pressure on the surface of the soil material does not exceed five hundred psf, special investigation of the foundation will not be required.
c. The bearing area shall be well drained and not subject to inundation.
d. The levels of the foundations shall be checked and adjusted to compensate for displacements at least once every year, and the owner shall maintain a record of such work, available for inspection by the commissioner.
(5) Where piles project above grade and displacement of the pile cap is prevented by interposing a space

between the underside of the cap and the ground, the requirement for embedment of the cap below the level of frost penetration, shall not apply.

(b) Grade beams. -The bottom surface of any grade beam shall be carried down at least eighteen inches below the lowest level of the adjoining ground or pavement surface that is exposed to frost.

§[C26-1100.8] 27-659 Foundations at different levels. -Where footings are supported at different levels, or at different levels from the footings of adjacent structures, the influence of the pressures under the higher footings on the stability of the lower footings shall be considered. Consideration shall be given to the requirements for lateral support of the material supporting the higher footings, the additional load imposed on the lower footings, and assessment of the effects of dragdown on adjacent pile-supported buildings.

§[C26-1100.9] 27-660 Slabs on grade. -Slabs on grade within or adjacent to a building shall be so designed to limit settlement of such slabs to a magnitude that will not impair their usability or cause damage to the building or its foundations.

§[C26-1100.10] 27-661 Construction. –

The provisions of subchapter nineteen of this chapter relating to safety and of subchapter ten of this chapter relating to concrete, timber, masonry, and steel construction shall apply. For inspection requirements, see article thirteen of this subchapter.

(a) Cold weather. -No foundation shall be placed on frozen soil. No foundation shall be placed in freezing weather unless provision is made to maintain the underlying soil free of frost.

(b) Seepage. -In an excavation where soil and ground water conditions are such that an inward or upward seepage might be produced in soil material intended to provide vertical or lateral support for foundation elements or for adjacent foundations, excavating methods that will control or prevent the inflow of ground water shall be employed to prevent disturbance of the soil material in the excavation or beneath existing buildings. No foundation shall be laid on soil that has been disturbed by seepage unless remedial measures, as directed by an architect or engineer, are taken.

ARTICLE 2 SOIL INVESTIGATIONS

§[C26-1101.1] 27-662 General. -Borings in earth or rock, recovery of samples, tests of soil samples, load tests, or other investigations or exploratory procedures shall be performed as necessary for the design and construction of a safe foundation subject to inspection in accordance with the requirements of article thirteen of this subchapter.

§[C26-1101.2] 27-663 Borings. -(a) Number. -At least one boring shall be made for every twenty-five hundred square feet of building area or fraction thereof and, for buildings supported on piling of such type or capacity that load tests are required, one boring shall be made for every sixteen hundred square feet of building area or fraction thereof except as indicated in paragraphs one through three of this subdivision.

(1) For one- and two-family dwellings (appurtenant structures such as garages, sheds, and porches shall be considered as part of the dwelling):

a. Buildings supported on footings founded on soil of class 8-65 or better. -For contiguous groups of four or more dwellings at least one boring shall be made for every four buildings. For isolated dwellings and for contiguous groups of two or three dwellings, the overall site shall be explored by at least one boring or auger probing or, alternately, the site of each building shall be explored by one test pit carried to a depth of at least eight feet below the level of the bottom of the proposed footings.

b. Buildings supported on piles or on footings founded in soil strata of class 9-65, or poorer. -The site shall be explored by at least one boring for every four buildings in contiguous groups or one boring for each building in the case of isolated dwellings.

(2) For buildings having a plan area in excess of ten thousand square feet and where subsurface conditions as determined from preliminary borings or from borings on neighboring sites consist of uniform deposits of materials of class 1-65, 2-65, 3-65, 6-65, 7-65, or 8-65, subject to the approval of the commissioner, the required borings may be reduced to one for every five thousand square feet of building area or fraction thereof except where the foundation is to be supported on piles.

(3) Where foundations are to rest on rock of class 1-65, 2-65, or 3-65 and such rock is exposed prior to construction over a part or all of the area of the buildings, borings will not be required in those areas where rock is exposed, and the area (within the limits of the building) of the exposed rock surface shall not be included in the area used to compute the required number of borings, provided the following requirements are met:

a. The presence of defects or the inclination of bedding planes in the rock are of such size and location as to not affect the stability of the foundation.

b. The foundation is designed for bearing pressures not exceeding those permitted in table 11-2 without increase for embedment.

(b) Location. -At least two-thirds of the required number of borings shall be located within the area under the building. Those outside the area shall not be more than twenty-five feet from the limits of the building. Borings shall be uniformly distributed or distributed in accordance with the loading pattern imposed by the building.

(c) Depth. -
(1) Unless soil material of class 1-65 through 3-65 is encountered at shallower depth, borings shall extend below the deepest part of the excavation as necessary to satisfy the more restrictive of the following requirements:
a. Borings shall extend deep enough into nominally satisfactory bearing material to establish its character and thickness, but not less than the following:
1. Where the soil material is class 5-65-ten feet.
2. For one- and two-family residences, two stories or less in height-fifteen feet.
3. For other cases-twenty-five feet.
b. Borings shall extend to the depth at which the vertical stress caused by the proposed construction is reduced to ten percent or less of the original vertical stress at this depth due to the weight of the overburden, except that where strata of soil materials of class 9-65 or poorer are encountered within this depth, the borings shall penetrate such strata and be carried to a depth that shows penetration continuous of material of class 8-65 or better as required in paragraph a of this subdivision.
c. In addition to the requirements of paragraphs a and b of this subdivision, at least one boring in every ten thousand square feet of building area, but not less than one boring per building, shall be carried to a depth of one hundred feet below the curb for buildings having an average area load exceeding one thousand psf. The average load shall be computed as the sum of all dead loads and live loads of the building, divided by the area of the building at ground level.
(2) Where rock is encountered in borings within the depths noted in paragraph one the borings shall be cored a minimum of five feet into rock, or farther where necessary or required, to obtain at least a recovery of thirty-five percent core from five feet of penetration but not to exceed the depth in paragraph one of this subdivision. However, for foundations supported on piles or drilled-in caissons bearing on the rock and having a capacity in excess of eighty tons per unit, the capacity of the rock to support the applied load shall be demonstrated by increasing the length of coring to ten feet.
(d) Types. -
(1) SOIL BORINGS. -Soil samples shall be recovered at intervals not to exceed five feet and at every change of soil strata. Such samples shall be recovered using a two inch O.D. split spoon sampler having an inside diameter of one and three-eighths inches and a constant internal cross section. The sampler shall be at least twenty-four inches long and shall be tipped with a heat treated, sharp cutting shoe. It shall be straight and sound, with an undistorted cross section. The rods to which the sampler is attached shall be one inch extra heavy pipe or one and five-eighths O.D. drill rods. The sampling tools shall be driven with a one hundred forty pound hammer having a fall of thirty inches. The blows per foot so recorded shall be designated hereinafter, by the symbol, N. The fall of the hammer shall be a free fall and the energy of impact shall not be mitigated by friction of the hoisting line on the drum, friction of the hammer against its guide, or other similar effects. All samples, except those of rock, shall be preserved in air tight bottles having a capacity of at least eight ounces.
(2) ROCK BORINGS. -Where borings are required to penetrate rock they shall be advanced by core drilling, and core samples shall be recovered using a double tube core barrel and diamond bits that provide cores at least one and three-eighths inches in diameter.
(e) Data to be reported. -Records of all borings required by the provisions of subdivision (a) of this section shall accompany the application for approval of the foundation plans. Such records shall show, as a minimum, the size of casing and the number of blows per foot required to advance the casing (to the depth that casing is used); the weight of hammer and the distance of fall; a description of the sampler; a description of the drill tools and equipment including, where used, the size of diamond bits and type of core barrels; the number of blows required to drive the sampling spoon for each six inches increment of penetration; the elevation of the ground surface referenced to an established datum; the location and depth of the boring and its relation to the proposed construction; the elevations at which samples were taken; the elevations at which core drilling was started and stopped for each "run;" the elevations of the boundaries of soil strata; percent recovery for each "run" of core drilling; description of the soil strata encountered and geological classification of rock drilled (based on visual examination of cores); any particular, unusual, or special conditions such as loss of water in the earth and rock strata, boulders, cavities, and obstructions, use of special type of samplers, traps, etc.; and the level of ground water together with a description of how and when the ground water level was observed. All abandoned or unsuccessful attempts at borings or rock drilling shall be reported.
(f) Disposition of Samples and Cores. -Soil samples and rock cores shall be retained in an accessible location by the owner, or by the party making application for approval of the foundation plans for a period of one year after the date of issuance of a certificate of occupancy, and shall be available upon reasonable notice for inspection by the commissioner.

§[C26-1101.3] 27-664 Test pits. -
(a) Tests pits may be substituted for boring on a one-for-one basis. All applicable requirements as to depth, numbers of samples, data to be reported, and disposition of samples shall be observed, except that the use of sample spoon, recording of driving resistance, and recovery of rock cores is not required in test pit investigations, and except as provided in subdivision (b) of this section.
(b) Test pits for buildings not more than one story in height or for one or two-family residences not more than two stories in height need only extend four feet

below the deepest part of the excavation for the construction of footings, or a minimum of four feet when foundation elements rest on grade pursuant to paragraph four of subdivision (a) of section 27-658 of article one of this subchapter, provided that such structures are supported by footings bearing on nominally satisfactory bearing materials of class 9-65 (except soft clay) soil or better.

§[C26-1101.4] 27-665 Boring methods. -
Borings shall be made by continuous driving and cleaning out of a pipe casing (including telescoping of smaller sizes inside of larger casing) except as permitted in subdivisions (a), (b) and (c) of this section. Where casing is used, it shall be cleaned out to undisturbed soil prior to sampling and the sample spoon driven into soil that has not been affected by chopping, washing, or hydrostatic imbalance.
(a) Uncased borings. -Uncased borings, including borings where the casing is omitted for part of the depth, may be used if the mud slurry method is followed. The requirements for soil sampling and rock coring shall be the same for uncased borings as for borings made using casing, except that prior to each soil sampling operation the boring shall be substantially cleaned of disturbed material and the sample spoon shall be advanced through any settled solids before counting the blows required to drive the spoon. Longer sample spoons, having a sludge chamber, shall be used where settled solids exceed six inches. In determining ground water levels, methods shall be used to reduce and replace the mud slurry so that the hydrostatic head may be measured. The procedures shall be described in detail in the records.
(b) Augur borings. -Borings may be made with augers except that short flight augers shall not be used in granular soils below the water level. Sampling procedures in auger borings for both soil and rock shall be the same as for cased borings. Full hydrostatic head shall be maintained in granular soils below the ground water level during the boring operation.
(c) Maximum diameter. -Where the bore hole, as drilled by any method, is in excess of four inches in diameter, sampling operations shall be performed through a temporary casing having a four inch inside diameter or less.

§[C26-1101.5] 27-666 Probings and geophysical explorations. -
(a) Footings, pier or wall designs.- Where the foundations for a proposed building consist of footings or foundation piers or walls bearing on rock of class 1-65, 2-65 or 3-65, the use of probings, auger borings or geophysical methods, made without the recovery of soil samples or rock cores, may (except as hereafter specified) be substituted for up to one-half of the number of borings required by the provisions of subdivision (a) of section 27-663 of this article, provided that such probings, borings, etc. are carried to adequate depth and are of a nature that will reasonably define the surface contours of the rock. The accuracy of such surface contour definition shall be confirmed by recovering rock cores at the locations of at least one-fifth of the probings or auger borings or, in the case where geophysical methods are used, those borings which are made shall be so distributed as to permit confirmation of the accuracy of the geophysical investigations. The provisions of paragraph two of subdivision (a) of section 27-663 of this article, shall not apply where the provisions of this section are invoked.
(b) Pile support.- Where the foundation for the proposed building consists of piling bearing on rock of class 1-65, 2-65 or 3-65, the provisions of subdivision (a) of this section shall apply, provided that the borings consistently show that the soil overlying the rock consists solely of deposits of class 6-65 through 11-65 and is free of boulders or other obstructions.
(c) Geophysical methods.- Geophysical investigations shall be conducted by experienced and qualified personnel acceptable to the commissioner who may reject the results and require additional exploration by borings if the results of the geophysical explorations cannot be satisfactorily correlated to the logs of the borings.

§[C26-1101.6] 27-667 Existing borings.- Existing boring data may be utilized subject to the following:
(1) Borings, test pits, probings, etc., that have been made in accordance with all requirements of this section, but not necessarily for the investigation of the specific project for which application is being made, may be utilized in fulfillment of these provisions.
(2) The logs of borings, test pits, probings, etc., that have been made in accordance with all requirements of this section, but wherein the soil samples and/or rock cores are not available for examination, may be utilized in fulfillment of these provisions to an extent not to exceed one-half of the required number of borings.
(3) Borings, test pits, probings, etc., or the logs thereof, that do not meet the specific requirements of this subchapter, but which are of suitable type and adequate penetration to provide the data required for the safe design and construction of the proposed foundation, may be utilized in fulfillment of the provisions of this section, subject to the approval of the commissioner.

ARTICLE 3 FOUNDATION LOADS

§[C26-1102.1] 27-668 Soil bearing pressures. -The loads to be used in computing the bearing pressures on materials directly underlying footings shall be the total column, pier, or wall reactions determined in accordance with the provisions of subchapter nine of this chapter, on the basis of reduced live load; plus the weight of the foundations; plus the weight of any soil, fill, and slabs on grade that is included within vertical planes projected upward from the extreme limits of the footing to the final ground surface. Live load on grade, or on slabs on

grade, within these limits shall also be included. Impact loads shall be considered in accordance with the provisions of section 27-673 of this article.

§[C26-1102.2] 27-669 Pile reactions. -The loads to be used in computing pile reactions shall be determined as provided in section 27-668 of this article except that where piles penetrate fill, clay, silt, peat, or similar compressible strata, the pile loads shall be increased by the amount of drag exerted by such material, and by any overlaying strata, during consolidation. Computation of the amount of drag shall consider the amount of added fill, the amount of shear strain between pile (or group) and the soil, the ratio of vertical to horizontal pressure in the soil, and the arrangement of the piles. The soil surrounding or underlying the pile cap shall not be considered as providing any vertical support for the cap.

§[C26-1102.3] 27-670 Lateral loads. -

****(a) Earth and ground water pressure**. -Every foundation wall or other wall serving as a retaining structure shall be designed to resist, in addition to the vertical loads acting thereon, the incident lateral earth pressures and surcharges, plus hydrostatic pressures corresponding to the maximum probable ground water level. Retaining walls shall be designed to resist at least the superimposed effects of the total static lateral soil pressure, excluding the pressure caused by any temporary surcharge, plus an earthquake force of $0.045\ w_s h^2$ (horizontal backfill surface), where w_S equals unit weight of soil and h equals wall height. Surcharges which are applied over extended periods of time shall be included in the total static lateral soil pressure and their earthquake lateral force shall be computed and added to the force of $0.045\ w_s h^2$. The earthquake force from backfill shall be distributed as an inverse triangle over the height of the wall. The point of application of the earthquake force from an extended duration surcharge shall be determined on an individual case basis. If the backfill consists of loose saturated granular soil, consideration shall be given to the potential liquefication of the backfill during the seismic loading using reference standard RS 9-6.

(b) Wind and other superstructure loads. -Provision shall be made to resist lateral loads imposed on the superstructure due to wind or other causes.

(c) Soil movements.- Buildings shall not be constructed in areas where the soil is subject to lateral movements unless positive provision is made to prevent such movements.

****Local Law 17-1995.***

§[C26-1102.4] 27-671 Eccentricities. -Eccentricity of loading in foundations, including eccentricity of loading on the bases of retaining walls, shall be investigated and the maximum soil pressure or pile load (considering eccentricity) shall be kept within the safe capacity thereof as established in articles four and eight of this subchapter. Soil pressure and pile load due to eccentricity shall be computed on the basis of straight line distribution of foundation reaction. However, other modes of distribution of the foundation reaction may be assumed, subject to the approval of the commissioner, if it can be demonstrated that the pile and/or soil is capable of sufficient plastic deformation to develop such mode of distribution without failure.

§[C26-1102.5] 27-672 Uplift forces.- Uplift and overturning forces due to wind and hydrostatic pressure shall be considered.

§[C26-1102.6] 27-673 Impact. -Impact forces may be neglected in the design of foundations, except for foundations bearing on loose granular soils, or, regardless of the type of soil material, for foundations supporting cranes, heavy machinery, and* moving equipment, or where the ratio of the live load causing impact to the total of the reactions from live load applied without impact plus dead load exceeds one-third.

****As enacted but "or" probably intended.***

§[C26-1102.7] 27-674 Stability. -The provisions of article twelve of this subchapter shall apply.

ARTICLE 4 ALLOWABLE SOIL BEARING PRESSURES

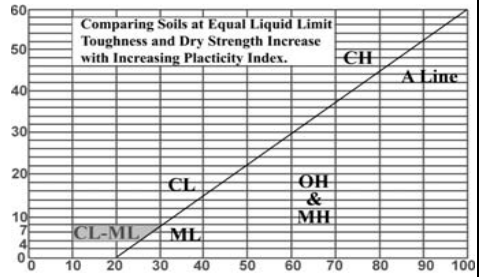
§[C26-1103.1] 27-675 Classification of soil materials. - For purposes of this subchapter, soil materials shall be classified and identified in accordance with table 11-1. In addition, the following supplementary definitions shall apply.

(a) Rock. -

(1) HARD SOUND ROCK. -Includes crystalline rocks such as Fordham geniss**, Ravenswood geniss**, Palisades diabase, Manhattan schist. Characteristics [*sic*] are: the rock rings when struck with pick or bar; does not disintegrate after exposure to air or water; breaks with sharp fresh fracture; cracks are unweathered and less than one-eighth inch wide, generally no closer than three feet apart; core recovery with a double tube, diamond core barrel is generally eighty-five percent or greater for each five foot run.

*****As enacted but "gneiss" probably intended.***

TABLE 11-1 UNIFIED SOIL CLASSIFICATION
(Including Identification and Description)

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (Excluding particles larger than 3 in. and basing fractions on estimated weights)			Information Required for Describing Soils	Laboratory Classification Criteria
1	2		3	4	5			6	7
Coarse-grained Soils More than half of material is *larger* than No. 200 sieve size. The No. 200 sieve size is about the smallest visible to the naked eye.	Gravels More than half of coarse fraction is larger than No. 4 sieve size. (For visual classification, the ¼-in. size may be used as equivalent to the No. 4 sieve size)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixture, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.			For undisturbed soils add information on stratification, degree of compactness, cementation, moisture condition, and drainage characteristics. Give typical name; indicate approximate percentages of sand and gravel, maximum size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Silty sand, gravelly; about 20% hard, angular gravel particles ½-in. maximum size; rounded and subangular sand grains, coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).	Use grain-size curve in identifying the fractions as given under field identification. Determine percentage of gravel and sand from grain-size curve. Depending on percentage of fine (fraction smaller than No. 200 sieve size) coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP, More than 12% GM, GC, SM, SC. 5% to 12% Borderline cases requiring use of dual symbols.	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_e = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			GP	Poorly graded gravels or gravel-sand mixture, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				Not meeting all gradation requirements for GW
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-and-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits below "A" line or P1 less than 4
			GC	Clayey gravels, gravel-and-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with P1 greater than 7
									Above "A" line with P1 between 4 and 7 are borderline cases requiring use of dual symbols.
	Sands More than half of coarse fraction is smaller than No.4 sieve size.	Clean Sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines.	Wide range in grain size and substantial amounts of all intermediate particle sizes.				$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_e = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3
			SP	Poorly graded sands or gravelly sands, little or no fines.	Predominantly one size or a range of sizes with some intermediate sizes missing.				Not meeting all gradation requirements for SW
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures.	Nonplastic fines or fines with low plasticity (for identification procedures see ML below).				Atterberg limits above "A" line or P1 less than 4
			SC	Clayey sands, sand-clay mixtures.	Plastic fines (for identification procedures see CL below).				Atterberg limits above "A" line with Pl greater than 7
									Limits plotting in hatched zone with P1 between 4 and 7 are borderline cases requiring use of dual symbols.
					Identification Procedure on Fraction Smaller than No. 40 Sieve Size.				
					Dry Strength (Crushing Characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)		
Fine-grained Soils More than half of material is *smaller* than No. 200 sieve size.	Silts and Clays Liquid limit is less than 50		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	None to slight	Quick to slow	None	For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions Give typical name; indicate degree and character of plasticity; amount and maximum size of coarse grains; color in wet condition; odor, if any; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Clayey silt, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)	Plasticity Index  **LIQUID LIMIT PLASTICITY CHART** For Laboratory classification of fine-grained soils
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium to high	None to very slow	Medium		
	Silts and Clays Liquid limit is greater than 50		OL	Organic silts and organic silty clays of low plasticity.	Slight to medium	Slow	Slight		
			MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Slight to medium	Slow to none	Slight to medium		
			CH	Inorganic clays of high plasticity, fat clays.	High to very high	None	High		
			OH	Organic clays of medium to high plasticity, organic silts.	Medium to high	None to very slow	Slight to medium		
Highly Organic Soils			Pt	Peat and other highly organic soils.	Readily identified by color, odor, spongy feel and frequently by fibrous texture				

(1) Boundary classifications: Soils possessing characteristics of two groups are designed by combinations of group symbols. For example GM-GC, well-graded gravel-sand mixture with clay binder.
(2) All sieve sizes on this chart are U.S. standard.
(3) Adopted by Corps of Engineers and Bureau of Reclamation, January 1952

032058C

FIELD IDENTIFICATION PROCEDURES FOR FINE-GRAINED SOILS OR FRACTIONS (Notes for Table 11-1)

These procedures are to be performed on the minus No. 40 sieve size particles, approximately 1/64 in. For field classification purposes, screening is not intended, simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (reaction to shaking)

After removing particles larger than No. 40 sieve size, prepare a pat of moist soil with a volume of about one-half cubic inch. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (crushing characteristics)

After removing particles larger than No. 40 sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun or air-drying, and then test its strength by breaking and crumbling between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength, but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty whereas a typical silt has the smooth feel of flour.

Toughness (consistency near plastic limit)

After particles larger than the No. 40 sieve size are removed, a specimen of soil about one-half inch cube in size, is molded to the consistency of putty. If too dry, water must be added and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about one-eighth inch in diameter. The thread is then folded and rerolled repeatedly. During this manipulation, the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity, or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

---

(2) MEDIUM HARD ROCK. -Includes crystalline rocks of paragraph one of this subdivision, plus Inwood marble and serpentine. Characteristics are: all those listed in paragraph one of this subdivision, except that cracks may be one-quarter inch wide and slightly weathered, generally spaced no closer than two feet apart; core recovery with a double tube, diamond core barrel is generally fifty percent or greater for each five foot run.

(3) INTERMEDIATE ROCK. -Includes rocks of paragraphs one and two of this subdivision, plus cemented shales and sandstone of the Newark formation. Characteristics are: the rock gives dull sound when struck with pick or bar; does not disintegrate after exposure to air or water; broken pieces may show weathered surfaces; may contain fracture and weathered zones up to one inch wide spaced as close as one foot; core recovery with a double tube, diamond core barrel is generally thirty-five percent or greater for each five foot run.

(4) SOFT ROCK.- Includes rocks of paragraphs one, two and three of this subdivision in partially weathered condition, plus uncemented shales and sandstones. Characteristics are: rock may soften on exposure to air or water; may contain thoroughly weathered zones up to three inches wide but filled with stiff soil; core recovery with a double tube, diamond core barrel is less than thirty-five percent for each five foot run, but standard penetration resistance in soil sampling is more than fifty blows per foot. Where core recoveries are less than twenty percent and the material is to be used for bearing, a minimum three inches diameter core shall be recovered and the material recovered shall be classified in accordance with table 11-1.

(b) Special soil types. -

(1) FINE SAND.- Soils of group SM, containing more than fifty percent (by weight) of particles passing a number sixty mesh sieve.

(2) HARDPAN.- Soils of groups GM, GC, and SW, generally directly overlying rock, and which are sufficiently cemented to be difficult to remove by picking.

(3) CLAY SOILS.- Soils of each group SC, CL and CH shall be classified according to consistency as hard, medium, or soft in accordance with the following:

a. Hard clay.- A clay requiring picking for removal, a fresh sample of which cannot be molded by pressure of the fingers.

b. Medium clay.- A clay that can be removed by spading, a fresh sample of which can be molded by a substantial pressure of the fingers.

c. Soft clay. -A clay, a fresh sample of which can be molded with slight pressure of the fingers.

(4) SILT SOILS.- Soils of each group ML and MH shall be classified as dense, medium, or loose depending on relative difficulties of removal as described for hard, medium, and soft clays in paragraph three of this subdivision.

(5) VARVED SILT. -A natural soil deposit consisting of alternating thin layers of silt, clay, and sand in which the silt or silt plus sand layers predominate.

§[C26-1103.2] 27-676 Satisfactory bearing material.- The following materials, or any combination of them shall be considered as generally satisfactory bearing materials; hard sound, medium hard, intermediate, and soft rock; hardpan; granular soils of G and S groups;

dense or medium silt soils of groups ML and MH; and hard or medium clay soils of groups CL and CH.

§[C26-1103.3] 27-677 Nominally unsatisfactory bearing material. -Fill material, peat (group Pt), organic silts and clays (grouping OL and OH), soft or loose soils of groups ML, CL, HM and CH, varved silt, or satisfactory bearing materials that contain lenses of, or are underlain by, these materials shall be considered as nominally unsatisfactory bearing materials.

§[C26-1103.4] 27-678 Allowable soil bearing pressures.- The allowable bearing pressures on satisfactory bearing materials shall be those established in table 11-2. The allowable bearing pressures on nominally unsatisfactory bearing materials shall be those established in accordance with section 27-679 of this article. Allowable bearing pressure shall be considered to be the allowable pressure at a point in the soil mass in excess of the stabilized overburden pressure existing at the same point prior to construction operations. The stabilized overburden pressure existing at a point shall be defined as that portion of the weight of the overlying soil material that is supported by granular interaction rather than pore pressure. In general, the magnitude of the stabilized overburden pressure may be approximated as follows:

(a) The overlying soil material shall have been in place for an adequate length of time to produce a stable condition of pore pressure in, or below, the foundation level. Where the bearing stratum consists of soils of classes 5-65 through 8-65, the bearing stratum shall be considered to be fully consolidated except with regard to the weight of that portion of the overlying soil material that consists of added fill material.
(b) Where all or a portion of the overlying soil consists of fill material, the weight of the fill material shall not be included in the stabilized overburden pressure unless the magnitude of stabilized pressure is verified by an architect or engineer on the basis of laboratory or field tests on undisturbed material.
(c) Where the bearing stratum consists of soils of classes 9-65 through 11-65, the stabilized overburden pressure shall be considered as zero unless the magnitude of the stabilized pressure is established by an architect or engineer on the basis of laboratory or field tests on undisturbed material.

TABLE 11-2 ALLOWABLE SOIL BEARING PRESSURES

Class of Material	Description See Notes* (1)	Basic Allowable Bearing Values (Tons per sq. ft.) See Notes (10), (11), and (12)	
1-65	Hard Sound Rock…….	60	See Notes (2) and (8).
2-65	Medium Hard Rock……..	40	See Notes (2) and (8).
3-65	Intermediate Rock……	20	See Notes (2) and (8).
4-65	Soft Rock…….	8	
5-65	Hardpan……	—	See Notes (3) and (8).
6-65	Gravel and Gravel Soils (Soil Groups GW, GP, GM, & GC and soils of Soil Groups SW, SP, and SM containing more than 10% of material retained on a No. 4 sieve)……..	—	See Notes (4) and (8) and (9).
7-65	Sands (other than Fine Sands) (Soil Groups SW, SP, & SM but containing not more than 10% of material retained on a No. 4 sieve)……	—	See Notes (5) and (8) and (9).
8-65	Fine Sand…….	—	See Notes (6) and (8) and (9).
9-65	Clays and Clay Soils (Soil Groups SC, CL, & CH)		
	Hard…..……...	5	See Note (7).
	Medium.……..	2	See Note (7).
	Soft.…….	See Sec. 27-679.	
10-65	Silts and Silt Soils (Soil Groups ML & MH)		
	Dense……..	3	
	Medium……...	1.5	
	Loose……...	See Sec. 27-679.	
11-65	Nominally Unsatisfactory Bearing Materials	See Sec. 27-679.	

As enacted but "Note" probably intended.

Notes:

(1) Classification. The soil classifications indicated in this table are those described in section 27-675 of this article. Where there is doubt as to the applicable classification of a soil stratum, the allowable bearing pressure applicable to the lower class of material to which the given stratum might conform shall apply unless the conformance to the higher class of material can be proven by laboratory or field test procedures.

(2) Allowable bearing pressure on rock. The tabulated values of basic allowable bearing pressures apply only for massive rocks or, for sedimentary or foliated rocks, where the strata are level or nearly so, and, then only if the area has ample lateral support. Tilted strata and their relation to nearby slopes or excavations shall receive special consideration.

(3) Allowable bearing pressure on hardpan. For hardpan consisting of well cemented material composed of a predominantly granular matrix and free of lenses of fine grained material and inclusions of soft rock, the basic allowable bearing pressure shall be twelve tons per square foot. For hardpan consisting of poorly cemented material or containing lenses of fine grained material, inclusions of soft rock, or a fine grained matrix, the basic allowable bearing pressure shall be eight tons per square foot.

(4) Allowable bearing pressure on gravel and gravel soils. Values of basic allowable bearing pressure shall be as follows:

(a) For soils of Soils Groups GW,GP, GM, and GC:
Compact, well graded material—ten tons per square foot.
Loose, poorly graded material—six tons per square foot.
Intermediate conditions—Estimate by interpolation between indicated extremes.

(b) For soils of Soil Groups SW, SP, and SM, containing more than ten percent of material retained on a No. 4 sieve :
Compact, well graded material—eight tons per square foot.
Loose, poorly graded material—four tons per square foot.
Intermediate conditions—Estimate by interpolation between indicated extremes.

(5) Allowable bearing pressure on sands. The basic allowable bearing pressure shall be determined from the resistance to penetration of the standard sampling spoon. The basic allowable bearing pressure in tons per square foot shall equal 0.10 times N but not greater than six tons per square foot, nor less than three tons per square foot. The appropriate value for the penetration resistance at various areas of the site shall be made by averaging the measured resistance within a depth of soil below the proposed footing level equal to the width of the footing. Where the average values so obtained do not vary by more than twenty-five percent of the minimum of the average values over the site of the proposed building, the lowest average value shall be used for the design of the entire building. Where the variation exceeds twenty-five percent, the allowable bearing pressure shall be predicated on the lowest average value unless appropriate measures are taken to avoid detrimental amounts of differential settlements of the footings. Where the design bearing pressure on soils of class 7-65 exceeds three tons per square foot, the embedment of the loaded area below the adjacent grade shall not be less than four feet and the width of the loaded area not less than three feet, unless analysis shall demonstrate the proposed construction to have a minimum factor of safety of 2.0 against shear failure of the soil.

(6) Allowable bearing pressure on fine sand. The basic allowable bearing pressure shall be determined from the resistance to penetration of the standard sampling spoon. The basic allowable bearing pressure in tons per square foot shall equal 0.10 times N but not greater than four tons per square foot nor less than two tons per square foot, except that, for loose materials (resistance to penetration of the standard sampling spoon ten blows per foot or less), where the foundation is subjected to vibratory loads from machinery or similar cause, the indicated basic values shall not apply. The allowable bearing pressure shall be established by analysis applying accepted principles of soil mechanics and a report of such analysis satisfactory to the commissioner shall be submitted as a part of the application for the acceptance of the plans.

(7) Allowable bearing pressure on clays and clay soils. The bearing capacity of medium and hard clays and clay soils shall be established on the basis of the strength of such soils as determined by field or laboratory tests and shall provide a factor of safety against failure of the soul of not less than 2.0 computed on the basis of a recognized procedure of soils analysis, shall consider probable settlements of the building, and shall not exceed the tabulated maximum values.

(8) Increases in allowable bearing pressure due to embedment of the foundation. (a) The basic allowable bearing values for rock of classes 1-65, 2-65, and 3-65 shall apply where the loaded area is on the surface of sound rock. Where the loaded area is below the adjacent rock surface and is fully confined by the adjacent rock mass and provided that the rock mass has not been shattered by blasting or otherwise is or has been rendered unsound, these values may be increased ten percent of the base value for each foot of embedment below the surface of the adjacent rock surface in excess of one foot, but shall not exceed twice the basic values. (b) The basic allowable bearing values for soils of classes 5-65 through 8-65 determined in accordance with notes three, four, and five above, shall apply where the loaded area is embedded four feet or less in the bearing stratum. Where the loaded area is embedded more than four feet below the adjacent soil, these values may be increased five percent of the base value of each foot of additional embedment, but shall not exceed twice the basic values. Increases in allowable bearing pressure due to embedment shall not apply to soils of classes 4-65, 9-65, 10-65, or 11-65.

(9) Increase in allowable bearing pressure for limited depth of bearing stratum: The allowable bearing values for soils of classes 6-65, 7-65, and 8-65 determined in accordance with this table and the notes thereto (including note eight), may be increased up to one third where the density of the bearing stratum below the bottom of the footings or the tips of the piles increases with depth provided that: (a) The bearing stratum is not underlain by materials of a lower class. (b) The allowable bearing value of the soil material underlying the bottom of the footings or the tips of the piles increases at least fifty percent within a depth below the footing or the tips of the piles which is not greater than the width of the footing or the width of the polygon circumscribing the pile group. (c) It shall be demonstrated by a recognized means of analysis that the probable settlement of the foundation due to compression, and/or consolidation do not exceed acceptable limits for the proposed building.

(10) Combination of loads. The provisions of section 27-594 of article two of subchapter ten of this chapter shall apply.

(11) Correction for foundations bearing on materials of varying bearing capacities. Where it is shown by borings or otherwise that materials of varying bearing value will be used for support of a building: (1) Where the weakest material does not rank below class 5-65, no modifications shall be required. (2) Where the weakest materials rank as classes 6-65 through 8-65, if the difference in basic allowable bearing values for the several materials does not exceed thirty percent of the allowable value for the poorest material which is to support the foundation, the foundations may be proportioned in direct conformance with the allowable bearing pressures. Where the difference in basic allowable bearing values exceed thirty percent, appropriate measures shall be taken to limit the differential settlements of the different portions of the structure to tolerable values. (3) For materials of classes 9-65 and 10-65, in all cases, appropriate measures shall be taken to equalize the settlements of the different portions of the structure.

(12) Inundated footings. The provisions of this section relating to materials of classes 1-65 through 7-65, shall be deemed equally applicable both to the dry and to the inundated condition of the soil provided: (a) That the subgrade is undisturbed by the construction operations, (b) The bearing area is in a confined condition. For such cases, no reduction in allowable bearing value will be required where the soil supporting the foundation is subject to a rising level of inundation. However, the effects on settlement of a failing level of inundation occurring after construction of the foundation shall be considered in the design.

(d) The stabilized overburden pressure shall not include the weight of any soil removed by excavation and not replaced. For footings, the total stabilized overburden pressure shall not exceed the weight of a one square foot column of soil (considering submerged weight where the soil column is partly submerged) measured from the bottom of the footing to the lowest level of the final grade above the footing. For a box foundation, where the strength of the slab is adequate to stabilize the underlying soil, the stabilized overburden pressure shall not exceed the weight of a one square foot column of soil measured from the bottom of the box to the lowest level of the adjacent grade.

(e) Where the bearing stratum consists of soils of classes 9-65 through 11-65, the allowable bearing pressure shall be adjusted for the effects of rebound due to excavation as determined from consolidation test data.

(f) Where the bearing stratum consists of rock of classes 1-65 through 3-65, the stabilized overburden pressure shall be neglected.

§[C26-1103.5] 27-679 Bearing capacity of nominally unsatisfactory bearing materials.- Whenever soils exploration shows that the proposed foundation would rest on, or be underlain by, nominally unsatisfactory bearing materials, a report based on soil tests and foundation analysis (including analysis of undisturbed samples) shall be submitted by an architect or engineer, demonstrating, subject to the approval of the commissioner, that the proposed construction, under a condition of one hundred percent overload, is safe against failure of the soil materials. The report shall also show that the probable total magnitude and distribution of settlement to be expected under design conditions will not result in instability of the building or stresses in the structure in excess of the allowable values established in subchapter ten of this chapter. In addition, the following provisions shall apply:

(a) Fill materials. -

(1) CONTROLLED FILLS. -Fills shall be considered as satisfactory bearing materials of class 6-65 or 7-65 when placed in accordance with the following procedures, under the provisions for controlled inspection.

(a) Before placement of fill, the existing ground surface shall be stripped of all organic growth, timber, rubbish, and debris. After stripping, the ground surface shall be compacted to the density [described]* in subparagraph d of this paragraph.

Copy in brackets not enacted but probably intended.

(b) Materials for fill shall consist of sand, gravel, crushed stone, crushed gravel, or a mixture of these, and shall contain no organic matter. The fill materials shall contain no particles exceeding four inches in the largest dimension. No more than thirty per cent of the material shall be retained on a three-quarter inch sieve. The material passing the three-quarter inch sieve shall contain, by weight, no more than forty percent passing the one hundred sieve, or twelve percent passing the two hundred sieve.

(c) The grading of the fill shall be determined in accordance with the applicable procedures of reference standards RS 11-1 and RS 11-2.

(d) Fill shall be placed and compacted at its optimum moisture content, in uniform layers not more than twelve inches thick (after compaction) and each layer shall be thoroughly compacted to a density not less than ninety-five percent of the density prescribed in reference standard RS 11-3. The field density shall be verified by in-place density tests made on each lift of the embankment. Fill shall not be placed when frozen or placed on a frozen or wet sub-grade.

(2) UNCONTROLLED FILLS. -Fill material, other than controlled fill, may be used for the support of buildings, other than one-and two-family dwellings, and may be considered as satisfactory bearing material of applicable class, subject to the following:

a. The soil within the building area shall be explored using test pits. At least one test pit, penetrating at least eight feet below the level of the bottom of the proposed footings, shall be provided for every twenty-five hundred square feet of building area. Where such test pits consistently indicate that the fill is composed of material that is free of voids and free of extensive inclusions of mud, organic materials such as paper, garbage, cans, or metallic objects, and debris, the provisions of subparagraphs b and c of this paragraph shall apply. Where the test pits show such voids or inclusions, the additional provisions of subparagraph d of this paragraph shall apply. Borings may be used in lieu of test pits, provided that continuous samples at least four inches in diameter are recovered.

b. The building area shall be additionally explored using one standard boring under each column. These borings shall be carried to a depth sufficient to penetrate into natural ground, but not less than twenty feet below grade, and a sufficient number shall penetrate deeper than twenty feet as required to meet the provisions of section 27-663 of article two of this subchapter. Where such borings show voids or inclusions, the provisions of subparagraph d of this paragraph shall apply.

c. The allowable soil bearing pressure on the fill material shall not exceed two tons per square foot.

d. Wherever the fill shows voids or inclusions as described in subparagraphs a and b of this paragraph, either the fill shall be treated as having no presumptive bearing capacity, or the building shall incorporate adequate strength and stiffness to bridge such voids or inclusions or shall be articulated to prevent damage due to differential or localized settlement of the fill.

(b) Organic silts, organic clays, soft inorganic clay, loose inorganic silt, and varved silt. -

(1) The allowable bearing pressure shall be determined independently of table 11-2 subject to the following:

a. For varved silts, the soil bearing pressure produced by the proposed building shall not exceed two tons per square foot, except that for desiccated or preconsolidated soils, higher bearing pressures will be allowed.
b. For organic silts or clays (groups OL and OH) or for soft or loose soils of groups ML, CL, MH, and CH, the soil bearing pressure produced by the proposed building shall not exceed one ton per square foot except that a value of two tons per square foot will be permitted on soils that are adequately preconsolidated or artificially treated.
(2) The report required in this section shall contain, as a minimum, the following information:
a. Geological profiles through the area defining the stratigraphy.
b. Sufficient laboratory test data on the compressible material to indicate the coefficient of consolidation, coefficient of compressibility, permeability, secondary compression characteristics, and Atterberg limits.
c. Where the design contemplates improvement of the natural bearing capacity and/or reduction in settlements by virtue of preloading, cross sections showing the amount of fill and surcharge to be placed on* design details showing the required time for surcharging shall be indicated, and computations showing the amount of settlement to be expected during surcharging. Records of settlement plate elevations and pore pressure readings, before, during, and after surcharging, shall be filed with the commissioner.
As enacted but "and" probably intended.
d. The estimated amount and rate of settlement expected to occur after the structure has been completed, including the influence of dead and live loads of the structure.
e. A detailed analysis showing that the anticipated future settlement will not adversely affect the performance of the structure.
f. Where sand drains are to be used, computations showing the diameter, spacing, and method of installation of such drains, shall be provided.

(c) Artificially treated soils. -
Nominally unsatisfactory soil materials that are artificially compacted, cemented, or preconsolidated (including soils compacted by vibration, cemented by chemical injection, or preconsolidated by use of electric current, but not including cases where preconsolidation consists solely of the use of surcharge with or without sand drains) may be used for the support of buildings, and nominally satisfactory soil materials that are similarly treated may be used to resist soil bearing pressures in excess of those indicated in table 11-2 for the soil in its natural state, subject to the following:
(1) The vertical and lateral extent of the soil that is compacted, cemented, or preconsolidated shall conform to the full extent of the distribution of loading that is assumed for purposes of computing the intensities of the soil bearing pressure. The actual soil bearing pressure shall not exceed the limitations of subdivisions (a) and (b) of this section for nominally unsatisfactory bearing materials or, for satisfactory bearing materials, shall not exceed the limitations of table 11-2.
(2) After the treatment procedure, a minimum of one boring shall be made for every sixteen hundred square feet of that portion of the building area that is supported on treated soil, and a sufficient number of samples shall be recovered from the treated soil to demonstrate the efficacy of the treatment.

§[C26-1103.6] 27-680 Utility services. -Where utility service lines are to be laid in soil materials of class 11-65, provision shall be made to prevent damage to such services lines, as follows:
(a) Where the lines enter a structure, including a building, a manhole, or a junction chamber, that is rigidly supported on piles or in firm bearing material, the services shall be supported on piles or bearing materials of adequate firmness to prevent differential settlement of the service lines with respect to the structure; otherwise, provisions, such as oversized sleeves, flexible connections, utility tunnels, or other approved device, shall be made to permit the anticipated differential movement to occur without damage to the service lines.
(b) Where the lines enter a structure that is supported on soil materials of class 11-65 or on soft clay or loose silt deposits, an engineering analysis shall be made of the probable differential settlement of the utility service line with respect to the structure, and provision shall be made to accommodate such displacement, as described in subdivision (a) of this section.

ARTICLE 5 SOIL LOAD BEARING TESTS

§[C26-1104.1] 27-681 Applicability. -Soil load bearing tests made at the option and expense of the owner of the proposed structure and inspected in accordance with the provisions of section 27-132 of article seven of subchapter one of this chapter, controlled inspection, may be accepted by the commissioner as evidence of allowable bearing capacity of a given soil stratum, subject to the following limitations:
(a) The applicability of soil load bearing tests shall be limited to soil materials of classes 5-65 through 10-65.
(b) Soil load bearing tests shall not be used to justify allowable bearing pressures in excess of the maximum allowable bearing values established in table 11-2 for the applicable class of material.
(c) Soil load bearing tests shall not be applicable where the proposed bearing stratum is underlain by a stratum of lower class, unless analysis indicates that the presence of such lower stratum will not create excessive settlements of the building.

§[C26-1104.2] 27-682 Procedure. -

(a) Preparations. -

(1) A sketch showing the layout, levels, number of tests, details of test apparatus, and test procedures shall be filed with the commissioner before conducting such tests. The sketch shall also include the locations and levels of the proposed tests in relation to the contemplated foundation levels as well as the logs of borings that have been made for the building or buildings involved.

(2) The tests shall be made at the levels contemplated for the proposed building footings, and in at least two locations within the limits of the building area. The surfaces at the locations of the proposed tests shall be leveled at the elevations of the proposed test for a clear distance of at least five feet all around the test plate.

(3) The loaded area shall be square and at least twenty-four inches by twenty-four inches.

(4) When load tests are performed on materials affected by drying, suitable methods shall be used to prevent evaporation from the material.

(5) In the event ground water is present *immediatley below, at, or above the level required to be tested, dewatering facilities shall be installed to maintain ground water a minimum of four feet below the level of the test plate during the preparation and duration of the test or tests.

***As enacted but "immediately" probably intended.**

(6) Trenches and other provisions at the ground surface shall be made to prevent inflow of surface water and to remove water that may drain into the test area. The entire test area shall be protected against weather and rainfall for the entire duration of the test.

(7) The load platform providing the support for the test load shall be supported on adequate timber cribbing, which shall not be closer than five feet from the edge of the test plate.

(8) The plate on which the loads are applied shall be of steel having a minimum thickness of two inches and shall be set and centered in a depression in the bottom of the pit or loading area about thirty inches square for a twenty-four inch by twenty-four inch plate and eight inches deep. The area on which the plate is placed shall be scraped to remove any disturbed soil. The area to be tested shall be covered with a thin layer of fine clean sand that shall be smoothed and leveled until a completely level surface for placing the test plate is obtained.

(9) Settlement observations shall be made at four corners of test plate by means of dial extensometers. The extensometers shall provide readings to the nearest 0.001 in. In addition, settlement observations shall be taken using an engineer's level reading to 0.001 ft., properly referenced to a well-established benchmark.

(10) All tests shall be made under the surveillance of the commissioner, who shall be duly notified in order that he or she may be represented.

(b) Loading of the soil. -

(1) Loads shall be applied to the test plate by direct weight or by means of a hydraulic jack. The loading platform or box shall be constructed to provide a concentric load on the plate. If direct weight is employed, the loading increments shall be applied without impact or jar.

The weight of the blocking placed on the plate and the loading platform or box shall be obtained prior to the test and this weight shall be considered as the first increment of load. If a hydraulic jack is employed, facilities for maintaining each increment of desired load constant under increasing settlement shall be provided.

The gauge [*sic*] for the jack and the jack shall be calibrated as a unit not more than two weeks prior to the test.

(2) The unit intensity of the test load shall be one and one-half times the unit intensity of the loading proposed to be imposed on the soil by the design loads. The test load shall be applied in a minimum of six increments at twenty-five percent, fifty percent, seventy-five percent, one hundred percent, one hundred twenty-five percent, and one hundred fifty percent of the proposed working load. Each load increment shall be maintained for a length of time as follows:

a. At the proposed loading and at one hundred fifty percent of load until the settlement is less than 0.005 in. over a period of twenty-four hours.

b. At other loadings until the settlement is 0.001 in. or less, over a period of five minutes.

(3) Under each load increment, settlement observations shall be made and recorded at intervals of one-half minute, one minute, four minutes, and each four minutes thereafter after application of load increment except in the instance of the working load and one hundred fifty percent of working load where, after the four minute reading, the time interval shall be doubled successively until the final settlement limitation is reached and the load is increased or removed.

(4) After the test load and limiting rate of settlement under the test load is reached, loads shall be removed in not less than three equal increments and rebound observations made in the same manner as for the loading increments. The final rebound shall be recorded twenty-four hours after the entire test load has been removed.

(c) Determination of results. -

(1) Subject to the limitations designated in section 27-681 of this article, the soil load test for soils of classes 5-65 through 8-65 shall be considered as tentatively substantiating the ability of the soil to support the proposed unit intensity of loading if the gross settlement of the test plate under the proposed unit intensity of loading does not exceed one-half inch and the total gross settlement after the fifty percent overload is applied does not exceed one inch. This tentative substantiation shall be supported by a report by the architect or engineer on the correlation of

the behavior of the load test to the probable behavior of the full size building. The proposed design load shall be considered as acceptable only upon written acceptance by the commissioner.

(2) For soils of classes 9-65 and 10-65, the soil load test alone shall not be considered as evidence of allowable bearing capacity of the soil, but the data so obtained may be utilized to establish an allowable bearing capacity subject to the provisions of section 27-677 and 27-678 of article four of this subchapter.

(3) In the event that it is desired to conduct load tests on square areas larger than the minimum stipulated above, permission may be granted provided notice of such increase in area is properly filed with the test information required to be submitted to the commissioner. The limiting gross settlements stipulated in paragraph one of this subdivision shall be increased in relation to the increase in width of test plate in accordance with the following formula:

$$S = (9S_1/16)(2B/B + 1)^2$$

where: S = settlement of the larger loaded area (in.)

S_1 = permissible settlement of twenty-four inch by twenty-four inch loaded area, as specified in paragraph one of this subdivision (in.)

B = side dimension of square plate used for test (ft.)

ARTICLE 6 FOOTINGS, FOUNDATION PIERS, AND FOUNDATION WALLS

§[C26-1105.1] 27-683 Materials.- All structural elements of foundations as defined in section 27-585 of article one of subchapter ten shall meet the requirements as to type and minimum quality of materials prescribed in such subchapter. Inspection of materials and construction shall comply with the provisions of section 27-586 of such subchapter.

§[C26-1105.2] 27-684 Footings. - Inspections of subgrade of footings, piers and walls shall comply with the requirements of section 27-723 of article thirteen of this subchapter.

(a) Wood footings. -Wood footings may be used only for wood frame structures. Wood footings shall be given a preservative treatment in accordance with reference standard RS 11-4.

(**b) Pole buildings**. -Buildings not more than one story high may be supported on poles embedded in the ground. Wood poles shall conform to the requirements of reference standard RS 11-5 and shall be given a preservative treatment in accordance with reference standard RS 11-4. Steel poles embedded in the soil shall be protected as required by the provisions of paragraph one of subdivision (c) of section 27-685 of this article.

(c) Grillages. -Grillage beams shall be provided with proper spacers, **stiffners, and diaphragms, or the space between the beams shall be filled with concrete or grout. In addition, all steel grillages shall be fully protected against corrosion by encasement, coating with metal protection of a type satisfactory to the commissioner or by other approved device.

***As enacted but "stiffeners" probably intended.*

(d) Design. -

(1) CONCRETE FOOTINGS. -Concrete footings shall be proportioned in accordance with the provisions of reference standard RS 10-3. Reinforcement shall extend to within four inches of the edges of the footing.

(2) MASONRY FOOTINGS.- Masonry used for the construction of footings shall be of solid units.

a. Reinforced masonry footings shall meet the requirements of reference standard RS 10-2 and shall be proportioned similarly to the proportioning of reinforced concrete footings.

b. Unreinforced masonry footings shall be of such dimension that a sloping plane extending downward from the top of the footing where it intersects the pier *of wall, to the bottom of the footing, and measured at the angle with the horizontal that is indicated below, will be contained entirely within the footing:

**As enacted but "or" probably intended.*

Soil bearing capacity of three tons per square foot or less-sixty degrees.

Soil bearing capacity between three tons per square foot and six tons per square foot-seventy degrees.

Soil bearing capacity greater than six tons per square foot shall be investigated.

The compressive stress in the footing, based on the assumption that the vertical load is uniformly distributed over horizontal sections bounded by said planes, shall not exceed the values given in reference standard RS 10-1.

§[C26-1105.3] 27-685 Foundation piers.-

Foundation piers shall be designed as columns. Reinforced concrete piers shall be designed in accordance with the provisions of reference standard RS 10-3. Reinforced and unreinforced masonry piers shall be designed in accordance with the provisions of reference standards RS 10-2 and RS 10-1. Unreinforced concrete piers shall be designed in accordance with subdivision (b) of this section.

(a) Lateral support. -The equivalent unbraced length of a pier supported by lateral soil pressure may be determined by a recognized method of elastic analysis. Alternatively, such a pier may be assumed to be hinged, but laterally braced at intervals equal to the full height of the pier or eight times the least lateral dimension of the pier, whichever is the lesser value. The provisions of subdivision (e) of this section shall apply.

(b) Unreinforced concrete piers. -Where unreinforced concrete piers are used, the allowable compressive stress shall not exceed 0.25f 'c and the

center of cross section of the pier at any level shall not deviate from the line of action of the resultant of all forces (which line of action shall consider the eccentricities due to all loads and moments acting on the pier) by an amount more than one-sixtieth of its height or one-tenth of its least lateral dimension and the ratio of the height to the least lateral dimension shall not exceed eight. For larger values of the ratio of the height to the least lateral dimensions, or for greater eccentricities, piers shall be reinforced.

(c) Metal shells. -Where piers are encased by a metal shell, the shell may be considered as contributing to the structural strength of the pier provided that the thickness is one-eighth inch or greater, and subject to the following requirements:

(1) Where boring records or site conditions indicate possible deleterious action on the shell, where any portion of the shell is embedded in ash, cinder fill or garbage fill, where the encased piers are used for support of chemical plants, piles of coal, or under other conditions conducive to chemical seepage or corrosive action, or where the encased piers are used for support of electrical generating plants, the metal shells shall be protected against deterioration by encasement, coating, or other device acceptable to the commissioner.

(2) The area of the metal section of the shell multiplied by the efficiency of the horizontal joints shall be considered as equivalent vertical reinforcement of the pier. The area of the metal section of the shell, multiplied by the efficiency of the vertical joints, shall be considered as equivalent spiral reinforcement of the pier.

(d) Minimum dimensions.- The provisions of subdivision (e) of this section shall apply. In addition, the plan dimensions of the pier shall not be less than those of the column above. If the column above is a steel section resting on a base plate, the base plate and pier shall be proportioned for allowable bearing pressures as prescribed in reference standards RS 10-1, RS 10-2, and RS 10-3.

(e) Filling. -The provisions of subdivisions (a) and (d) of this section shall apply only where the fill (or backfill) is placed around the pier as controlled fill, and wherein the level of the fill is raised uniformly around the entire perimeter of the pier. Where the fill operation is not controlled the least lateral dimension of a foundation pier shall be twenty-four inches and the pier shall be proportioned for lateral pressure equal to the pressure of a differential height of fill equal to five feet, applied simultaneously with the other loads on the pier specified in article three of this subchapter.

§[C26-1105.4] 27-686 Foundation walls. -

(a) Concrete.- Concrete foundation walls shall be designed in accordance with the provisions of reference standard RS 10-3 relating to bearing or retaining walls. The equivalent unbraced height of a wall supported by lateral soil pressure may be determined by a recognized method of elastic analysis. Alternatively, such a wall may be assumed to be laterally braced at intervals as follows:

(1) Where fill is placed against both faces of the walls: the full height of the wall or eight times the thickness, whichever is the lesser value.

(2) Where both faces of the wall are not in contact with soil: the height of the unbraced section of the wall or eight times the thickness of the wall, whichever is greater, but not more than the full height of the wall.

(b) Masonry. -Masonry foundation walls shall conform to the provisions of reference standards RS 10-1 and RS 10-2, and the following:

(1) TYPES. -Masonry foundation walls may be of plain or reinforced masonry and shall be of solid units, except that load bearing hollow units will be permitted for support of one- and two-story buildings.

(2) WALL THICKNESS. -Foundation walls of masonry shall be designed and constructed in accordance with the provisions of reference standards RS 10-1 and RS 10-2, supplemented by the provisions of subdivision (a) of this section, relating to unbraced height. The thickness shall be at least six inches.

§[C26-1105.5] 27-687 Construction of footings, foundation piers, and foundation walls. -The provisions of sections 27-661 and 27-723 of this subchapter shall apply. In addition, methods of installation and construction shall satisfy the following conditions:

(a) Footings, piers, or walls shall be founded on undisturbed soil or on satisfactorily compacted or prepared materials.

(b) Accurate preparation and inspection of the bearing materials directly underlying the foundation shall be possible; and the bearing area shall be substantially level or suitably benched.

(c) Excavation shall be kept substantially free of water during construction of the foundation except that the use of tremie or similar underwater construction will be permitted in the case of foundations bearing directly on rock, provided that the construction procedure will permit thorough cleaning and preparation of the rock surface, and that the surface of the rock is maintained in a clean condition, unfouled by the inflow of soil or settlement of the fluid suspension, until the concrete is in place.

ARTICLE 7 PILE FOUNDATIONS-GENERAL REQUIREMENTS

§[C26-1106.1] 27-688 Administrative requirements. -

(a) Identification of piles. -A plan showing clearly the designation of all piles by an identifying system shall be filed with the commissioner prior to installation of such piles. All detailed records for individual piles shall bear an identification corresponding to that shown on the plan. A copy of such plan shall be available at the site for inspection at all times.

(b) Record of pile driving. -A record of the penetration and behavior of each pile during installation shall be kept by the architect or engineer designated in section 27-721 of article thirteen of this subchapter. Such records shall be prepared on forms furnished by, or satisfactory to, the commissioner and, upon the completion of pile installation, shall be filed with the commissioner together with the records of any additional borings or subsurface information obtained during installation of the piles, and plans showing any deviations of the pile or related constructions (including any corrective measures) from the details and locations shown on the approved plans. Inspection of piling and pile load tests shall conform to the requirements of section 27-721 of article thirteen of this subchapter.

§[C26-1106.2] 27-689 Minimum pile penetrations. -
(a) Required by soil bearing capacity. -The provisions of paragraph one of subdivision (b) of section 27-700 of article eight of this subchapter shall apply.
(b) Required for lateral restraint. -The provisions of section 27-694 of this article shall apply.
(c) Piles located near a lot line. -Piles located near a lot line shall be designed on the assumption that the adjacent lot will be excavated to a depth of ten feet below the nearest legally established curb level. Where such excavation would reduce the embedded length of the pile, the portion of the pile exposed shall be considered as providing no lateral or vertical support, and the load-carrying determination in accordance with the provisions of article eight of this subchapter shall be made after the resistance offered by the soil that is subject to potential excavation has been discounted.

§[C26-1106.3] 27-690 Use of existing piles at demolished structures.- Piles left in place where a structure has been demolished shall not be used for the support of new construction unless satisfactory evidence, including load or hammer testing of representative piles, can be produced indicating the capacity, length, and driving conditions of the piles. The load bearing value for such existing piles shall be the least of the values indicated by: (1) the load or hammer test, (2) the capacity of the pile as a structural member, and (3) the allowable bearing pressure on the soil underlying the pile tips, all in accordance with the provisions of article eight of this subchapter.

§[C26-1106.4] 27-691 Tolerance and modification of design due to field conditions. -
(a) Tolerance in alignment of the pile axis. -If the axis of any pile is installed out of plumb or deviates from the specified batter by more than four percent of the pile length, the design of the foundation shall be modified as may be necessary to resist the resulting vertical and lateral forces. In types of piles for which subsurface inspection is not possible, this determination shall be made on the exposed section of the pile, which section, at the time of checking axial alignment, shall not be less than two feet. In piles which can be checked for axial alignment below the ground surface, the sweep of the pile axis shall not exceed four percent of the embedded length.
(b) Tolerance in location of the head of the pile. -A tolerance of three inches from the designed location shall be permitted in the installation of each pile, without reduction in load capacity of the pile group. Where piles are installed out of position in excess of this amount, the true loading on such piles shall be analytically determined from a survey which defines the actual location of the piles as driven, and using the actual eccentricity in the pile group with respect to the line of action of the applied load. If the total load on any pile, so determined, is in excess of one hundred ten percent of the allowable load bearing capacity, correction shall be made by installing additional piles or by other methods of load distribution as required to reduce the maximum pile load to one hundred ten percent of the capacity.
(c) Bent piles. -Where piles have been bent during installation, and the amount of the bend exceeds the allowable tolerance for alignment of the pile axis in subdivision (a) of this section, the condition shall be investigated and, where required, correction made by the installation of additional piles, by strengthening the bent piles, by reduction in capacity or other means acceptable to the commissioner.

§[C26-1106.5] 27-692 Minimum spacing of piles.-
Piles shall be spaced to meet the following requirements:
(1) Spacing of piles shall provide for adequate distribution of the load on the pile group to the supporting soil, in accordance with the provisions of subdivision (b) of section 27-700 of article eight of this subchapter.
(2) In no case shall the minimum center-to-center spacing of piles be less than twenty-four inches, nor less than the values for specific types of piling as indicated in article ten of this subchapter. Unless special measures are taken to assure that piles will penetrate sufficiently to meet the requirements of section 27-689 of this article without interfering with or intersecting each other, the minimum center-to-center spacing of piles shall be twice the average diameter of the butt for round piles; one and three-quarters times the diagonal for rectangular piles; or, for taper piles, twice the diameter at a level two-thirds of the pile length measured up from the tip. In cases of practical difficulty, the spacing of new piles from existing piles under an adjacent building may be less than the above values provided that the requirements relating to minimum embedment and pile interference are satisfied and that the soil under the proposed and existing buildings is not overloaded by the closer pile grouping.

§[C26-1106.6] 27-693 Minimum section. -Except as provided in article ten of this subchapter for timber piles, no tapered pile shall be less than six inches in diameter at any section, nor have less than an eight inch diameter at cutoff. The taper of any tapered section may be uniform or may occur in steps. No pile of uniform section shall have a diameter of less than eight inches, or, if not circular, a dimension of less than seven and one-half inches. Tapered shoes or points of lesser dimensions may be attached to the tips of piles.

§[C26-1106.7] 27-694 Capping and bracing of piles.

(a) Capping of piles. -

(1) EMBEDMENT. -Tops of all piles shall be embedded at least three inches in concrete caps. Such concrete shall conform to the provisions of article five of subchapter ten of this chapter and shall extend at least four inches beyond the edge of all piles. Alternatively, and only where the piles project above the future grade and will be readily accessible for visual inspection at all times, the tops of the piles may be capped with timber or steel caps, which shall be connected to the piles. Cap plates will not be required for steel H piles embedded in a reinforced concrete cap. Inspection of pile caps shall be as required in section 27-722 of article thirteen of this subchapter.

(2) UPLIFT. -Where piles are subject to uplift, they shall be anchored into the cap to resist at least one and one-half times the amount of such uplift without exceeding the basic allowable stresses as established in subchapter ten.

(3) REINFORCEMENT. -Reinforcement shall be placed to provide at least three inches of clear cover, measured to the surface of the pile cap that is in contact with the ground. All reinforcement adjacent to timber or concrete piling shall have a minimum of one inch of concrete protection. Reinforcement shall extend to within four inches of the edges of the pile cap.

(4) DESIGN. -Except as modified above, concrete pile caps shall be designed in accordance with the provisions of reference standard RS 10-3.

(b) Bracing of piles. -Except for short piles as described in subdivision (c) of this section, every pile shall be laterally braced to conform with one or more of the following provisions:

(1) RIGID CAP. -Three or more piles connected by a rigid cap shall be considered as being braced provided that the piles are located in radial directions from the centroid of the group not less than sixty degrees apart (within a tolerance of three inches in location of the pile). A two-pile group, in a rigid cap, shall be considered to be braced along the axis connecting the two piles.

(2) BRACE BEAMS. -Piles may be braced by the use of brace beams or ties rigidly connecting to at least two other piles in radial directions not less than sixty degrees nor more than one hundred twenty degrees apart. Concrete brace beams shall have minimum dimensions of one-twentieth of the clear distance between pile caps, but not less than eight inches. All brace beams shall be proportioned to resist a minimum axial load equal to three percent of the total axial load capacity of the piles that are to be braced by that beam, plus the moment due to any eccentricity between the centroid of the pile group and the line of action of the applied load. Where underlain by soil of class 9-65, 10-65 or 11-65, brace beams shall be proportioned to support the weight of soil, slab-on-ground, and live load on the slab-on-ground that is contained within vertical planes projected upward from the lateral limits of the brace beam. The design of brace beams to resist these loads shall conform to the provision of subchapter ten of this chapter.

(3) CONCRETE SLAB-ON-GRADE. -A continuous concrete slab or mat on grade, that is five inches or more in thickness and reinforced, and that extends at least forty feet in each direction and is anchored to the pile caps (or in which the piles are embedded at least three inches), may be used in lieu of brace beams for bracing of pile caps, providing that the slab is supported on material having an allowable bearing pressure of one and one-half tons per square foot or better and such material is not underlain by nominally unsatisfactory bearing materials.

(4) OTHER MEANS.- Piles may be braced by anchors, anchor wall, or other means acceptable to the commissioner.

(5) FLOOR SYSTEM.- Single-pile or two-pile groups or a single line of piles may be considered to be adequately braced if connected to, and braced by, a self supporting floor system provided: (1) that the details and dimensions of the floor and the wall or pier are of adequate strength to resist lateral displacement of the pile cap under conditions of maximum eccentricity of the applied load; and (2) that the wall or pier is braced until connection of the floor framing is made and the flooring (or slab) is in place.

(6) SPECIAL REQUIREMENTS FOR BRACING BATTER PILES.- The provisions of paragraphs one through five of this subdivision above shall apply. In addition, provisions shall be made to oppose the lateral thrust resulting from the pile inclination.

(c) Bracing of short piles. -

(1) All pile caps supported by piles that penetrate less than ten feet below cutoff level or less than ten feet below ground level shall be braced against lateral movement. Such bracing may consist of connection to other pile caps that encompass piles embedded more than ten feet below those levels; the use of suitable anchors, connection to a slab-on-grade or the floor system as described in paragraphs three and five of subdivision (b) of this section, or by other equivalent means. The heads of the piles shall be fixed in the cap. In no event shall more than fifty percent of the piles in the foundation of any building penetrate less

than ten feet below cut-off-level or less than ten feet below ground level.
(2) Where the embedded length of piles located near a lot line would be reduced to less than ten feet by excavation of the adjacent site to a depth of ten feet below the nearest established curb level, the provisions of paragraph one of this subdivision shall apply.

§[C26-1106.8] 27-695 Splicing of piles.- Splices shall be constructed so as to provide and maintain true alignment and position of the component parts of the pile during installation and subsequent thereto, and shall be of adequate strength to transmit the vertical and lateral loads (including tensions) and the moments occurring in the pile section at the location of the splice without exceeding the allowable stresses for such materials as established in subdivision (a) of section 27-700 of article eight of this subchapter. Except for piles which can be visually inspected after driving, splices shall develop at least fifty percent of the capacity of the pile in bending. In addition, all pile splices in the upper ten feet of the pile section shall be capable of resisting (at allowable working stresses) the moment and shear that would result from an assumed eccentricity of the pile load of three inches, or the pile shall be braced in accordance with the provisions of section 27-694 of article seven of this subchapter to other piles that do not have splices in the upper ten feet of embedment. For piles located near a lot line, the embedded length of such piles shall be determined on the basis that the adjacent site will be excavated to a depth of ten feet below the nearest established curb level.

§[C26-1106.9] 27-696 General requirements for installation of piles. -
(a) Protection of adjacent property. -Piles shall be installed with adequate provision for the protection of adjacent buildings and property.
(b) Protection of the pile during installation. -Piling shall be handled and installed to the required penetration and resistance by methods that leave their strength unimpaired and that develop and retain the required load-bearing resistance. Any damaged pile shall be satisfactorily repaired or the pile shall be rejected. Subject to the approval of the commissioner, damaged piles may be used at a fraction of the design load as determined by the architect or engineer in lieu of repair or rejection.
(c) Protection of pile materials after installation. -Where boring records or site conditions indicate possible deleterious action on pile materials due to soil constituents, changing water levels, or other causes, such materials shall be adequately protected by preservatives or encasements that will not be rendered ineffective by driving and that will prevent such deleterious action. The following specific provisions shall apply:
(1) Untreated timber piles shall not be used unless the top level of the pile is below the permanent water table. The permanent water table level shall not be assumed higher than the invert level of any sewer, drain, or subsurface structure in the adjacent streets, nor higher than the water level at the site resulting from the lowest drawdown of wells or sumps, but in no case shall untreated timber piles be used where the cut-off level is less than ten feet below the adjacent legal grade. Where treated piles are required, preservative treatment shall consist of impregnation with creosote or a creosote solution or, for piles entirely embedded below grade, a pentachlorophenal solution may be used. Treatment shall be in accordance with all requirements of reference standard RS 11-6.
(2) Piles installed in ash or garbage fills, cinder fills, or which are free-standing in or near a seawater environment, or which are used for the support of chemical plants, coal piles or under similar conditions of chemical seepage or aggressive action, or which are used for support of electrical generating plants, shall be investigated regarding the need for special protective treatment and, where protective treatment is indicated, shall be protected against deterioration by encasement, coating, or other device acceptable to the commissioner.
(d) Equipment. -Equipment and methods for installing piles shall be such that piles are installed in their proper position and alignment, without damage. Equipment shall be maintained in good repair.

§[C26-1106.10] 27-697 Use of uncased concrete pile shafts.- The use of uncased shafts (i.e., where the concrete of the pile shaft is in direct contact with the surrounding soil) will be permitted under the following conditions:
(a) For bored piles. -Where the bored hole is maintained free of water before and during placement of the concrete and the sides and bottom can be inspected prior to such placement, and provided that no displacement pile shall be installed within fifteen feet of any bored pile.
(b) For driven piles (including all piles wherein installation utilizes a temporary casing).- The maximum length of the uncased shaft shall be limited to ten feet unless otherwise permitted by the commissioner. Uncased shafts will be permitted to be formed in soil below the water table but shall not be formed in any soil of class 9-65 that is of medium or soft consistency; in any soil of class 10-65 that is of medium or loose density; or in any soil of class 11-65.

§[C26-1106.11] 27-698 Where more than one pile type, pile capacity, or method of pile installation is used.- Wherever it is proposed to: (1) construct a foundation for a building utilizing piles of more than one type or capacity; (2) modify an existing foundation by the addition of piles of a type or capacity other than those of the existing piling; (3) construct or modify a foundation utilizing different methods or more than one method of installation, or using different types or capacities of equipment

(such as different types of hammers having markedly different striking energies or speeds); or (4) support part of a building on piles and part on footings, the several parts of the building supported on the different types, capacities, or modes of piling shall be separated by suitable joints providing for differential movement, or a report shall be submitted by the architect or engineer establishing to the satisfaction of the commissioner that the proposed construction is adequate and safe, and showing that the probable settlements and differential settlements to be expected will not result in instability of the building or stresses in the structure in excess of the allowable values established in subchapter ten of this chapter. The provisions of subdivision (d) of section 27-700 of article eight of this subchapter relating to required load tests shall apply separately and distinctly to each different type or capacity of piling, method of installation, or type or capacity of equipment used, except where analysis of the probable, comparative behavior of the different types or capacities of the piles or the methods of installation indicates that data on one type or capacity of pile permits a reliable extrapolation of the probable behavior of the piles of other types and capacities.

§[C26-1106.12] 27-699 Pile materials. -
The provisions of sections 27-580 and 27-588 of article one of subchapter ten of this chapter relating to "classification of materials, assemblies and methods of construction" and to the use of "used and unidentified materials" shall apply.

ARTICLE 8 PILE FOUNDATIONS-LOADS

§[C26-1107.1] 27-700 Allowable axial load. -The allowable axial load on a pile shall be the least value permitted by consideration of the following factors (for battered piles, the axial load shall be computed from the resultant of all vertical loads and lateral forces occurring simultaneously):
1. The capacity of the pile as a structural member.
2. The allowable bearing pressure on soil strata underlying the pile tips.
3. The resistance to penetration of the piles, including resistance to driving, resistance to jacking, the rate of penetration, or other, equivalent criteria as established in this section.
4. The capacity as indicated by load test, where load tests are required.
5. The maximum loads prescribed in subdivision (e) of this section.

(a) The capacity of the pile as a structural member.-
(1) EMBEDDED PORTION OF THE PILE. -
The compressive stress on any cross section of a pile produced by that portion of the design load that is considered to be transmitted to that section shall not exceed the allowable values for the construction materials as established in table 11-3. The tensile stress shall not exceed the values established in subchapter ten of this chapter for like material.
(2) PORTION OF THE PILE THAT IS NOT EMBEDDED.- That portion of any pile that is free standing in air or water shall be designed as a column in accordance with the provisions of subchapter ten of this chapter, fixed at a point five feet below the soil contact level in class 8-65 material or better and ten feet below in any other material. The conditions of lateral and rotational restraint offered by the pile cap shall be considered in determining the equivalent unbraced length.
(3) LOAD DISTRIBUTION ALONG EMBEDDED PORTION OF THE PILE. -The portion of the design load acting on any cross-section of a pile may be determined by analysis, considering time dependent changes in distribution of the load. As an alternative method for the purposes of this section, it may be assumed that:
a. For piles embedded forty feet or more in materials of class 10-65 or better, or in controlled fills, and bearing on or in materials of classes 1-65 to 5-65: seventy-five percent of the load shall be assumed to be carried by the tip. For shorter piles, with similar conditions of embedment and bearing, one hundred percent of the load shall be assumed carried by the tip.
b. For piles embedded in materials of class 10-65 or better, or in controlled fills, and bearing on or in materials of classes 6-65 to 10-65 (or controlled fills): the full load shall be assumed to act at a cross section located at two-thirds of the embedded length of the pile measured up from the tip. Where tapered piles are used, the stress at all sections of the pile shall be determined on the basis that the full load acts at a location as described above and that one-third of the full load acts at the tip. The stresses so computed shall not exceed the allowable values in table 11-3.
c. For conditions not covered in subparagraphs a and b of this paragraph three the provisions relating to analysis shall apply.

(b) Allowable bearing pressure on soil strata underlying the pile tips. -
(1) BEARING CAPACITY. -The allowable pile load shall be limited by the provision that the pressures in materials at and below the pile tips, produced by the loads on individual piles and by the aggregate of all piles in a group or foundation, shall not exceed the allowable bearing values established in article four of this subchapter. The provisions of section[s]* 27-678 and 27-679 of article four of this subchapter shall apply. The transfer of load from piles to soil shall be determined by a recognized method of analysis. As an alternative, for purposes of this section, piles or pile groups may be assumed to transfer their loads to the underlying materials by spreading the load uniformly at an angle of sixty degrees with the horizontal, starting at a polygon circumscribing the piles, located as follows:

Copy in brackets not enacted but probably intended.

TABLE 11-3 ALLOWABLE COMPRESSIVE STRESS FOR PILE MATERIALS

Pile Material	Allowable Compressive Stress
Concrete	Concrete—The provisions of Reference Standard RS 10-3 relating to short compression members shall apply. For working stress design use $0.25f'_c$. For ultimate strength design use minimum eccentricity of 5 per cent, phi = 0.70 (phi = 0.75 where a permanent metal shell having a minimum wall thickness of 1/8 inch is used), and load factors as specified in Reference Standard RS 10-3. The above provisions shall be deemed applicable to reinforced and unreinforced sections. For unreinforced sections use Ds = D and d = t (symbols refer to those used in Reference Standard RS 10-3).
	Reinforcing steel—$0.40f_y$ but not greater than 30,000 psi. (The provisions of article five of subchapter ten of this chapter relating to ties, spirals, and percentages of reinforcing steel for reinforced concrete compression members shall apply.)
Timber	See timber piles (section 27-707 of article eight of this subchapter).
Steel	H piles-$0.35f_y$, with f_y not to be taken as greater than 36,000 psi. Minimum thickness of metal shall be 0.40. Pipe piles, shells for cast–in place concrete piles and shells of pipe sections used in caisson piles: 0.35 f_y, (f_y not to be taken as greater than 36,000 psi.) for thickness of 1/8 in. or more. Metal thinner less* than 1/8 in. shall not be considered as contributing to the structural strength of the pile section.
	Core sections for caisson piles: $0.50f_y$ with f_y not to be taken as greater than 36,000 psi.

Notes for Table 11-3:
f'_c = 28 day compressive strength of concrete.
f_y = Minimum specified yield strength of steel.
* "less" not enacted but probably intended.

a. For piles embedded entirely in materials of classes 4-65 to 8-65, or in controlled fill materials, the polygon shall be circumscribed at a level located two-thirds of the embedded length of the pile, measured up from the tip.
b. For piles penetrating through soils of classes 9-65, 10-65, or 11-65 into bearing in soils of class 8-65 or better, the polygon shall be circumscribed at the bottom of the strata of class 9-65, 10-65 or 11-65 materials.
c. In the case of piles having enlarged bases, the lateral distribution of the load to the soil may be assumed to begin at the junction of the shaft and the enlarged base and to extend as follows:
1. In the case where the enlarged base is formed in loose or medium compact (N value less than thirty) soils of class 6-65 or 7-65 that extend twenty feet or more below the junction of the base and shaft, or that are of lesser extent but are directly underlain by soil of class 5-65 or better, the bearing area may be taken at a plane six feet below said junction but not lower than the bottom of the soil strata of class 6-65 or 7-65.
2. Where the enlarged base is formed in compact (N value thirty to sixty) soils of class 6-65 or 7-65, or in any soil of these classes that extends less than twenty feet below the junction of the base and the shaft and that is underlain by soil of class 8-65 or poorer, the bearing area shall be taken at planes less than six feet below said junction, with a lower limit of three feet where the material is very compact (N value sixty, or greater) and the extent of the class 6-65 or 7-65 material is ten feet below the junction of shaft and base. (The provisions of subdivision (e) of section 27-710 of article ten of this subchapter relating to minimum depth of bearing stratum below the junction of base and shaft shall apply.) For conditions intermediate between that described in clause one of this subparagraph and the lower limit conditions described here, the location of the bearing area may be determined by linear interpolation between the indicated limits of N value and extent of bearing material below the junction of shaft and base, giving equal weight to both variables.
3. Where the enlarged base is formed in or on soils of class 4-65 or 5-65, the bearing area shall be taken at a depth below the junction of the shaft and base consonant with the size and depth of the base formed, and as evaluated from the required test piles.
d. For all piles bearing on soils of classes 1-65 to 3-65, analysis of load distribution will not be required if the requirements relating to capacity of the pile as a structural member, to resistance to penetration, to load test where required, and to maximum tabulated loads are satisfied.
e. For piles bearing in soils of classes 9-65 and 10-65, for cases not described above, or for any case where the method of installing the pile utilizes a temporary casing, the provision relating to analysis shall apply.
f. In no case shall the area considered as supporting the load extend beyond the intersection of the sixty degree planes of adjacent piles or pile groups.
(2) BEARING STRATUM.- The plans for the proposed work shall establish, in accordance with the requirements relating to allowable bearing pressure, the bearing strata to which the piles in the various sections of the building are to be penetrated and the approximate elevations of the top of such bearing strata. Where penetration of a given distance into the bearing strata is required for adequate distribution of the loads, such penetration shall be shown on the plans. The indicated elevations of the top of the bearing strata shall be modified by such additional data as may be obtained during construction.

All piles shall penetrate to or into the designated bearing strata.

(c) Capacity as indicated by resistance to penetration.- Where subsurface investigation, as described in article two of this subchapter, or general experience in the area, indicates that the soil that must be penetrated by the pile consists of glacial deposits containing boulders, or fills containing riprap, excavated detritus, masonry, concrete, or other obstructions in sufficient numbers to present a hazard to the installation of the piles, the selection of type of pile and penetration criteria shall be subject to the approval of the commissioner but in no case shall the minimum penetration resistance be less than that stipulated in tables 11-4 and 11-5.

(1) PILES INSTALLED BY USE OF STEAM-POWERED, AIR-POWERED, DIESEL-POWERED OR HYDRAULIC IMPACT HAMMERS. -

a. The minimum required driving resistance and the requirements for hammer energies for various types and capacities of piles are given in tables 11-4 and 11-5. To obtain the required total driving resistance, the indicated driving resistances shall be added to any driving resistance experienced by the pile during installation, but which will be dissipated with time (resistance exerted by non-bearing materials or by materials which are to be excavated). For purposes of this section, the resistance exerted by non-bearing materials may be approximated as the resistance to penetration of the pile recorded when the pile has penetrated to the bottom of the lowest stratum of nominally unsatisfactory bearing material (class 11-65, but not controlled fill) or to the bottom of the lowest stratum of soft or loose deposits of class 9-65 or 10-65 but only where such strata are completely penetrated by the pile. The provisions of articles nine and ten of this subchapter shall also apply.

b. Alternate for similitude method. -The requirement for installation of piling to the penetration resistances given in tables 11-4 and 11-5 will be waived where the following five conditions prevail:

1. The piles bear on, or in, soil of class 5-65 through class 10-65.
2. The stratigraphy, as defined by not less than one boring for every sixteen hundred square feet of building area, shall be reasonably uniform or divisible into areas of uniform conditions.
3. Regardless of pile type or capacity, one load test, as described in subdivision (d) of this section, shall be conducted in each area of uniform conditions, but not less than two typical piles for the entire foundation installation of the building or group of buildings on the site, nor less than one pile for every fifteen thousand square feet of pile foundation area shall be load tested.
4. Except as permitted by the provisions of clause six of this subparagraph, all building piles within the area of influence of a given load-tested pile of satisfactory performance shall be installed to the same or greater driving resistance as the successful load-tested pile. The same or heavier equipment of the same type that was used to install the load-tested pile shall be used to install all other building piles, and the equipment shall be operated identically. Also, all other piles shall be of the same type, shape, external dimension, and equal or greater cross-section as the load-tested pile. All building piles within the area of influence represented by a given satisfactory load-tested pile shall bear in, or on the same bearing stratum as the load test pile.
5. A report by an architect or engineer shall be submitted establishing to the satisfaction of the commissioner, that the soil bearing pressures do not exceed the values permitted by the provisions of article four of this subchapter and that the probable differential settlements will not cause stress conditions in the building in excess of those permitted by the provisions of subchapter ten of this chapter.
6. Where the structure of the building or the spacing and length of the piling is such as to cause the building and its foundation to act as an essentially rigid body, the building piles may be driven to length and/or penetration into the bearing stratum without regard to penetration resistance, subject to the requirement of clause five of this subparagraph, relating to submission of report.

(2) PILES INSTALLED BY JACKING OR OTHER STATIC FORCES.- The carrying capacity of a pile installed by jacking or other static forces shall be not more than fifty percent of the load or force used to install the pile to the required penetration, except for piles jacked into position for underpinning. The working load of a temporary underpinning pile shall not exceed the total jacking force at final penetration. The working load of each permanent underpinning pile shall not exceed the larger of the following values: two-thirds of the total jacking force used to obtain the required penetration if the load is held constant for seven hours without measurable settlement; or one-half of the total jacking force at final penetration if the load is held for a period of one hour without measurable settlement. The jacking resistance used to determine the working load shall not include the resistance offered by non-bearing materials which will be dissipated with time.

(3) PILES INSTALLED BY USE OF VIBRATORY HAMMER. -The capacity of piles installed by vibratory hammer shall not exceed the value established on the principle of similitude, as follows:

a. Comparison piles, as required by the provisions of subdivision (d), of this section, shall be installed using an impact hammer and driving resistances corresponding to the proposed pile capacities as determined in paragraph one of subdivision (c) of this section or to tip elevations and driving resistances as determined by the architect or engineer.

TABLE 11-4 MINIMUM DRIVING RESISTANCE AND MINIMUM HAMMER ENERGY FOR STEEL H-PILES, PIPE PILES, PRECAST AND CAST-IN-PLACE CONCRETE PILES AND COMPOSITE PILES (other that timber)

		Minimum Driving Resistance [a,c,[d]*,e]				
Pile Capacity (tons)	Hammer[b] Energy (ft. lbs.)	Friction Piles (blows/ft.)	Piles Bearing on Hardpan (Soil Class 5-65) (blows/ft.)	Non- Displacement Piles Bearing on Decomposed Rock (Soil Class 4-65) (blows/ft.)	Displacement Piles Bearing on Decomposed Rock (Soil Class 4-65) (blows/ft.)	Piles Bearing on Rock (Soil Classes 1-65, 2-65, & 3-65)
Up to 20	15,000	19	19	48	48	
	19,000	15	15	27	27	
	24,000	11	11	16	16	
30	15,000	30	30	72	72	
	19,000	23	23	40	40	
	24,000	18	18	26	26	
40	15,000	44	50	96	96	
	19,000	32	36	53	53	
	24,000	24	30	34	34	
50	15,000	72	96	120	120	5 Blows per ¼ inch (Minimum hammer energy of 15,000 ft. lbs.)
	19,000	49	54	80	80	
	24,000	35	37	60	60	
	32,000	24	25	40	40	
60	15,000	96		240	240	
	19,000	63		150	150	
	24,000	44		100	100	
	32,000	30		50	50	
70 & 80	19,000 24,000 32,000		5 Blows per ¼ inch (Minimum hammer energy of 15,000 ft. lbs.)	5 Blows per ¼ inch (Minimum hammer energy of 19,000 ft. lbs.)		
100 Over 100[**]						

Copy in brackets not enacted but probably intended.
****Appears with no corresponding hammer energy on original text.***

Notes for Table 11-4:

[a.] Final driving resistance shall be the sum of tabulated values plus resistance exerted by non-bearing materials. The driving resistance of non-bearing materials shall be taken as the resistance experienced by the pile during driving, but which will be dissipated with time and may be approximated as described in subparagraph a of paragraph one of subdivision (c) of this section.

[b.] The hammer energy indicated is the rated energy.

[c.] Sustained driving resistance—where piles are to bear in soil classes 4-65 and 5-65, the minimum driving resistance shall be maintained for the last six inches, unless a higher sustained driving resistance requirement is established by load test. Where piles are to bear in soil classes 6-65 through 10-65, the minimum driving resistance shall be maintained for the last twelve inches unless load testing demonstrates a requirement for higher sustained driving resistance. No pile need be driven to a resistance to penetration (in blows per inch) more than twice the resistance indicated in this table, nor beyond the point at which there is not measurable net penetration under the hammer blow.

[d.] The tabulated values assume that the ratio of total weight of pile to weight of striking part of the hammer does not exceed 3.5. If a larger ratio is to be used, or for other conditions for which no values are tabulated, the driving resistance shall be as approved by the commissioner.

[e.] For intermediate values of pile capacity, minimum requirements for driving resistance may be determined by straight line interpolation.

TABLE 11-5 MINIMUM DRIVING RESISTANCE AND HAMMER ENERGY FOR TIMBER PILES

Pile Capacity (tons)	Minimum Driving Resistance (blows-in.) to be added to driving resistance exerted by non-bearing materials [1,3,4]	Hammer Energy (ft.-lbs.) [2]
Up to 20	Formula in Note[4] shall apply	7,500-12,000
Over 20 to 25		9,000-12,000 14,000-16,000
Over 25 to 30		12,000-16,000 (single-acting hammers)
Greater than 30		15,000-20,000 (double-acting hammers)

Notes for Table 11-5:

[1]The driving resistance exerted by non-bearing materials is the resistance experienced by the pile during driving, but which will be dissipated with time and may be approximated as described in subparagraph a of paragraph one of subdivision (c) of this section.

[2]The hammer energy indicated is the rated energy.

[3]Sustained driving resistance. Where piles are to bear in soil classes 4-65 and 5-65, the minimum driving resistance shall be maintained for the last six inches, unless a higher sustained driving resistance requirement is established by load test. Where piles are to bear in soil classes 6-65 thru 10-65, the minimum driving resistance measured in blows per inch shall be maintained for the last twelve inches, unless load testing demonstrates a requirement for higher sustained driving resistance. No pile need to be driven to a resistance to penetration (in blows per inch) more than twice the resistance indicated in this table nor beyond the point at which there is no measurable net penetration under the hammer blow.

[4]The minimum driving resistance shall be determined by the following formula:

$$P=\frac{2W_hH}{s+0.1} \quad \text{or} \quad P=\frac{2E}{s+0.1}$$

Where: P = Allowable pile load in pounds.
W_p = Weight driven in pounds.
W_h = Weight of striking part of hammer in pounds
H = Actual height of fall of striking part of hammer in feet.
E = Rated energy delivered by the hammer per blow in foot lbs.
s = Penetration of pile per blow, in inches, after the pile has been driven to a depth where successive blows produce approximately equal net penetration.

The value $\frac{W_p}{W_h}$ shall not exceed three.

---

b. For each comparison pile, install an identical index pile by use of the vibratory hammer at a location at least four feet, but not more than six feet, from each comparison pile. The index piles shall be installed to the same tip elevation as the comparison pile, except that where the comparison piles bear on soils of classes 1-65 to 5-65, the index piles shall bear in, or on, similar material. All driving data for the index pile shall be recorded.

c. The index piles shall be load tested in accordance with the provisions of subdivision (d) of this section. Should the specified load test criteria indicate inadequate capacity of the index piles, steps a, b, and c shall be repeated using longer, larger, or other types of piles.

d. All building piles within the area of influence of a given, satisfactorily tested index pile shall be installed to the same or lesser rate of penetration (in. per min.) as of the successful index pile. The same equipment that was used to install the index pile, identically operated as to rpm, manifold pressure, etc., shall be used to install the building piles. Also, all building piles shall be of the same type, size, and shape as the index pile. All building piles within the area of influence as represented by a given satisfactorily tested index pile shall bear in, or on, the same bearing stratum as the index pile.

(d) Capacity as indicated by load test. -Load test of piling shall be required as follows:

(1) PILES INSTALLED BY STATIC FORCES. -The load bearing capacity of all types and capacities of piles installed by static forces, other than caisson piles and underpinning piles, shall be demonstrated by load test.

(2) PILES DRIVEN BY IMPACT HAMMERS. -The load bearing capacity of piles installed by impact hammers shall be demonstrated by load test when the proposed pile capacity exceeds the following values:

a. Caisson piles-no load test required.

b. Piles installed open end to rock of class 1-65, 2-65 or 3-65-one hundred tons, except as provided in subparagraph d of this paragraph, and except that no load tests will be required for piles up to two hundred tons capacity wherein the pile load does not exceed eighty percent of the load determined on the basis of limiting stresses in the pile materials and provided that the pipe or shell be driven to the resistance indicated in table 11-4.

c. Piles bearing on rock or hardpan (soil classes 1-65 to 5-65) other than as described in subparagraph b of this paragraph, and except as provided in subparagraph d of this paragraph-forty tons.

d. Piles bearing on materials of class eight or better, wherein, on the assumption that one hundred percent of the load reaches the pile tip, (or, in case of piles having an enlarged base or other enlargement of the bearing area, the top of the enlargement), the bearing pressure on the soil underlying the tips or bases can be demonstrated to be equal to or less than the values of basic allowable pressure indicated in table 11-2-provided that the class and density of the bearing material supporting the piles be confirmed by not less than one boring at each column location, then the commissioner may reduce the required number of load tests.

e. All other types of piles-thirty tons.

(3) PILES INSTALLED BY USE OF VIBRATORY HAMMERS. -The load bearing capacity of all types and capacities of piles (other than caisson piles) shall be demonstrated by load test.

(4) LOAD TEST PROCEDURES. -Before any load test is made, the proposed apparatus and structure to be used in making the load test shall be satisfactory to the commissioner and when required by him or her, all load

tests shall be made under the commissioner's surveillance or that of his or her representative. A complete record of such tests shall be filed with the commissioner.

a. Areas of the foundation site within which the subsurface soil conditions are substantially similar in character shall be established. In addition, for friction piles bearing on*, or on, soil materials of class 6-65, or poorer, the uniformity of each such area shall be verified by installing at least three penetration-test piles, distributed over the area. Continuous records of penetration resistance shall be made for such piles. If the records of penetration resistance are not similar or are not in reasonable agreement with the information obtained from the borings, the assumed areas of similar subsurface conditions shall be modified in accordance with the information derived from the penetration-test piles and additional penetration-test piles shall be installed as required to verify the uniformity of such areas.

As enacted but "in" probably intended.

b. For piles installed by jacking or other static forces or by impact hammer, one load test shall be conducted in each area of uniform conditions, but not less than two typical piles for the entire foundation installation of the building or group of buildings on the site, and not less than one pile for each fifteen thousand square feet of the area of the building wherein said piles are to be used shall be load tested. For piles installed by use of vibratory hammers, one comparison pile shall be installed and one index pile shall be load tested in each area of uniform conditions, but not less than two index piles shall be tested for the entire foundation installation of the building or group of buildings on the site, nor less than one index pile be tested for every seventy-five hundred square feet of pile foundation area. For piles whose capacity is determined on the basis of similitude, the provisions of subparagraph b of paragraph one of subdivision (c) of this section shall apply.

c. The load test shall be conducted by a method that will maintain constant load under increasing settlement. Settlement observations shall be made by means of dial extensometers. The extensometers shall provide readings to the nearest one one-thousandth of an inch. In addition, settlement observations shall be taken using an engineer's level reading to one one-thousandth of a foot, properly referenced to a well-established benchmark.

1. Test loads shall be applied by direct weight or by means of a hydraulic jack. The loading platform or box shall be carefully constructed to provide a concentric load on the pile. If direct weight is employed, the loading increments shall be applied without impact or jar. The weight of the loading platform or box shall be obtained prior to the test and this weight shall be considered as the first increment of load. If a hydraulic jack is employed, facilities for maintaining each increment of desired load constant under increasing settlement shall be provided. The gauge and the jack shall be calibrated as a unit for each project.

2. The test load shall be twice the proposed working load of the pile. The test load shall be applied in seven increments at a load of fifty percent, seventy-five percent, one hundred percent, one hundred twenty-five percent, one hundred fifty percent, one hundred seventy-five percent, and two hundred percent of the proposed working load. After the proposed working load has been applied and for each increment thereafter, the test load shall remain in place until there is no measurable settlement in a two hour period. The total test load shall remain in place until settlement does not exceed one one-thousandth of a foot in forty-eight hours. The total load shall be removed in decrements not exceeding twenty-five percent of the total load at one hour intervals or longer. The rebound shall be recorded after each decrement is removed, and the final rebound shall be recorded twenty-four hours after the entire test load has been removed.

3. Under each load increment, settlement observations shall be made and recorded at one-half minute, one minute, two minutes, four minutes, and each four minutes thereafter after application of load increment, except in the instance of the total load where, after the four minute reading, the time interval shall be successively doubled until the final settlement limitation is reached and the load is removed.

4. The allowable pile load shall be the lesser of the two values computed as follows:

(a) Fifty (50) percent of the applied load causing a net settlement of the pile of not more than one one-hundredth of an inch per ton of applied load. Net settlement in this paragraph means gross settlement due to the total test load minus the rebound after removing one hundred percent of the test load.

(b) Fifty (50) percent of the applied load causing a net settlement of the pile of three-quarters of an inch. Net settlement in this paragraph means the gross settlement as defined in subclause (a) of clause 4 of this subparagraph, less the amount of elastic shortening in the pile section due to total test load.

(5) FOUNDATION PILES. -Except as provided in clause six of subparagraph b of paragraph one of subdivision (c) of this section, all building piles within the area of influence of a given load-tested pile of satisfactory performance, shall be installed to the same or greater penetration resistance (or static load) as the successful load-tested pile. The same equipment (or heavier equipment of the same type) that was used to install the load-tested pile shall be used to install all other building piles, and the equipment shall be operated identically. Also all other piles shall be of the same type, shape, external dimension, and equal or greater cross section as the load-tested pile. All building piles within the area of influence represented by a given satisfactory load-tested pile shall bear in, or on the same bearing stratum as the load-tested pile. For friction piles where the actual pile lengths vary more than fifty percent from that of the test pile, the commissioner may require investigation to determine the adequacy of the piles.

(6) PILE GROUPS.- When the commissioner has reasons to doubt the safe load sustaining capacity of pile groups, he or she may require at the expense of the owner, group load tests up to one hundred fifty percent of the proposed group load.

(7) "CASING-OFF".- Any temporary supporting capacity that the soil might provide to the pile during a load test, but which would be dissipated with time, shall be obviated by "casing-off" or by other suitable means. For

purposes of this section, temporary supporting capacity shall include the resistances offered by any strata of nominally unsatisfactory bearing materials (class 11-65, other than controlled fill) or of soft or loose deposits of class 9-65 or 10-65 that are completely penetrated by the pile, or any resistance offered by granular soils that will be dissipated by reason of vibration.

(e) Maximum loads. -

(1) BASIC MAXIMUM LOADS. -Except as permitted by the provisions of paragraph two of this subdivision, the maximum allowable pile load, determined in accordance with the provisions of subdivisions (a) through (d) of this section, shall not exceed the values specified in table 11-6.

(2) SUBSTANTIATION OF HIGHER ALLOWABLE LOADS. -The pile capacities tabulated in table 11-6 may be exceeded where a higher value can be substantiated on the basis of test and analysis, as follows:

a. Load tests. -The provisions of subdivision (d) of this section shall be supplemented, as follows:

1. Not less than one single-pile load test shall be conducted for each ten thousand square feet of pile foundation area.

2. Final load increment shall remain in place for a total of not less than ninety-six hours.

3. Single test piles shall be subjected to cyclical loading or suitably instrumented so that the movements of the pile tip and butt may be independently determined. Other alternate methods or devices, acceptable to the commissioner which will permit evaluation of the transfer of load from piles to soil may be used.

4. Where the commissioner deems necessary, the provisions of paragraph six of subdivision (d) of this section relating to group load tests shall apply. If required, group load tests shall be performed in groups of numerically average size. Except where the proposed foundation is limited to single and/or two pile groups, each test group shall contain not less than three piles.

5. Individual pile loadings shall not exceed those determined from the single pile load tests.

6. The provisions of paragraph two of subdivision (d) of this section shall apply.

b. Analysis and report.- A report shall be submitted by the architect or engineer establishing to the satisfaction of the commissioner (on the basis of soil and load tests and foundation analysis, including analysis of the group action of the piles) that the proposed construction under a one hundred percent overload of the foundation is safe against failure of the pile and soil materials, and showing that the probable total magnitude and distribution of settlement to be expected under design conditions will not result in instability of the building or stresses in the structure in excess of the allowable values established in subchapter ten of this chapter.

c. Penetration resistance.- The penetration resistance shall not be less than that required by the provisions of subdivision (c) of this section or, where applicable values are not indicated therein, shall be determined from the required load tests. The pile material shall be capable of withstanding the driving stresses without being damaged.

(f) Combination of loads.- The provisions of section 27-594 of subchapter ten of this chapter shall apply.

§[C26-1107.2] 27-701 Allowable lateral load.- For plumb piles fully embedded in the ground, the lateral load applied at the top of the pile shall not exceed one ton per pile unless it has been demonstrated by tests that the pile will resist a lateral load of two hundred percent of the proposed working lateral load without lateral movement of more than one inch at the ground level and will resist the proposed working lateral load without a movement of more than three-eighths of an inch at the ground level. For piles projecting above the ground level the shear and bending stresses computed on the basis of cantilever action to a level of five feet below grade in soils of class 8-65 or better and to ten feet below grade in poorer soils shall not exceed the allowable values for like materials established in subchapter ten of this chapter. The provisions of subdivision (f) of section 27-700 of this article relating to combination of loads shall apply.

TABLE 11-6 BASIC MAXIMUM PILE LOADS

Type of pile	Basic maximum pile load (tons)
Caisson piles……..	No upper limit
Open-end pipe (or tube) piles bearing on rock of classes 1-65, 2-65, and 3-65…….	18 in. O.D. and greater — 250; less than 18 in. O.D. — 200
Closed-end pipe (or tube) piles, H piles, cast-in-place concrete and compacted concrete piles bearing on rock of classes 1-65, 2-65, and 3-65……..	150
Piles (other than timber piles) bearing on soft rock (classes 4-65)	
1) Displacement piles such as pipe, cast-in-place concrete, and compacted concrete piles……...	60
2) Non-displacement piles such as open-end pipe and H piles……...	80
Piles (other than timber piles) bearing on hardpan (class 5-65) overlying rock…….	100
Piles (other than timber piles) that receive their principal support other than by direct bearing on soils of classes 1-65 to 5-65……	60
Timber piles	
Bearing in soils of classes 1-65 to 5-65……...	25
Bearing in soils of classes 6-65 to 10-65…….	30

§[C26-1107.3] 27-702 Uplift capacity. -A minimum factor of safety against withdrawal of two shall be provided, except that the factor of safety against withdrawal shall be greater than two when the piles are subjected to dynamic uplift loads. The uplift capacity shall be demonstrated by pull-out tests, except where a factor of safety of three or more based on analysis is used, pull-out tests need not be conducted.

ARTICLE 9 PILE DRIVING OPERATIONS

§[C26-1108.0] 27-703 Exceptions.- The provisions of sections 27-704 and 27-705 of this article shall not apply to piles driven with a vibratory hammer or other equipment wherein the energy of impact cannot be evaluated.

§[C26-1108.1] 27-704 Equipment. -
(a) General.- The hammer shall travel freely in the leads. The cushion or cap block shall be replaced, if crushed. The hammer shall deliver its rated energy, and measurements shall be made of the fall of the ram or other suitable data shall be observed at intervals as required to verify the actual energy delivered at the termination of driving.
(b) Cushion or cap block.- The cushion or cap block shall be a solid block of hardwood with its grains parallel to the axis of the pile and enclosed in a tight-fitting steel housing, or shall be an equivalent assemblage. If laminated materials are used, the type and construction of these materials shall be such that their strength is equal to, or greater than, hardwood. Wood chips, pieces of rope, hose, shavings, or automobile tires and similar materials shall not be used. Cap blocks shall be replaced if burned, crushed, or otherwise damaged.
(c) Followers.- Followers shall not be used unless permitted in writing by the architect or engineer, and only when necessary to accomplish such installation. They shall be of steel or hardwood of such size, shape, length, and weight as to permit driving the pile in the desired location and to the required depth and resistance. The required driving resistance tabulated in tables 11-4 and 11-5 shall be increased to compensate for the loss of energy in the hammer blow. The follower shall be a single length section, shall be provided with a socket or hood carefully fitted to the top of the pile to minimize loss of energy and to prevent damage to the pile, and shall have sufficient rigidity to prevent "whip" during driving.

§[C26-1108.2] 27-705 Procedures. -
(a) Continuous driving.- Driving of piles preliminary to final seating shall be continuous for an interval adequate to break or prevent the development of freeze. The hammer shall be operated at its rated speed during this interval.
(b) Jetting.- Jetting, augering and other methods of pre-excavation shall not be used unless permitted in writing by the architect or engineer. When permitted, such procedures shall be carried out in a manner which will not impair the carrying capacity of the piles already in place or the safety of existing adjacent structures. Jetting or augering shall be stopped at least three feet above the final expected pile-tip elevation and at least three feet above the tip elevation of any pile previously driven within six feet of the jet or auger, except that where piles are to be end bearing on rock or hardpan, jetting or augering may be carried to the surface of the rock or hardpan. Piles shall be carried down beyond the depth of jetting, augering or other pre-excavation until the required resistance is obtained. If there is evidence that jetting or other procedures have disturbed the load-bearing capacities of previously installed piles, those piles that have been disturbed shall be restored to conditions meeting the requirements of this article by redriving or by other methods acceptable to the architect or engineer. Redriving or other remedial measures shall be instituted after the jetting or other operations in the area have been completed.
(c) Sequence of installation. -Individual piles and pile groups shall be installed in such sequence that: (1) the carrying capacity of previously installed piles is not reduced; (2) the soil surrounding the piles is not compacted to the extent that other piles in the group cannot be installed properly; and (3) ground movement that would damage adjacent buildings or utilities is prevented. In general, in any group, driving shall start from one side and proceed progressively toward the other side of the group or shall start from the middle and proceed toward the edges of the group.
(d) Heaved piles. -In soils in which the installation of piles causes previously installed piles to heave, accurate level marks shall be put on all piles immediately after installation, and all piles that have been heaved by an amount in excess of one-quarter of an inch shall be redriven to the required resistance.
(e) Penetration measurements.- Penetration measurements made for the purpose of determining resistance to driving shall not be made when pile heads are damaged to an extent that may affect measured penetration, nor shall they be made immediately after fresh cushion blocks have been inserted under the striking part of the hammer.

ARTICLE 10 PILE TYPES-SPECIFIC REQUIREMENTS

§[C26-1109.1] 27-706 Scope. - Types of pile construction and installation that are not described in this section will be permitted for use only where acceptable to the commissioner.

§[C26-1109.2] 27-707 Timber piles. -
(a) Materials. -Timber piles shall conform in quality to class A or B of reference standard RS 11-7.
(1) SIZE OF PILES. -Piles shall be of adequate size to resist the applied loads without creating stresses in the

pile materials in excess of twelve hundred psi for piles of southern pine, Douglas fir, oak, or other wood of comparable strength; or eight hundred fifty psi for piles of cedar, Norway pine, spruce or other wood of comparable strength. Except as provided in paragraph two of this subdivision, for piles forty feet or more in length and of thirty tons capacity or less, the following sizes or classes of piles shall be deemed to be adequate for considerations of stress in the pile material:

a. Piles of twenty-five to thirty tons capacity-Class A or minimum eight inch tip with uniform taper.

b. Piles of less than twenty-five tons capacity-Class A or B or minimum six inch tip with uniform taper.

(2) PILES DRIVEN TO END BEARING. -All timber piles, regardless of capacity, driven to end bearing on soils of classes 1-65 through 5-65 shall be class A or shall have a minimum eight inch tip and a uniform taper.

(3) SPECIES OF WOOD. -Any species of wood may be used that conforms to the provisions of reference standard RS 11-7 and that will stand the driving stresses.

(4) PEELING. -Unless treated, piles need not be peeled.

(b) Limitations on use. -Where timber piles are to be driven to end bearing on soils of classes 1-65 through 5-65 by use of an impact hammer, the installation of each such pile shall be under the personal supervision of an architect or engineer, and the operations of driving such piles, the observations of penetration resistance, and the operation of the equipment shall be so conducted as to terminate driving directly when the pile reaches bearing on the hard material. A report, prepared by the architect or engineer, describing the procedures, equipment, and precautions followed to prevent injury to the piling shall be submitted to the commissioner.

(c) Lagged and inverted piles. -The use of lagged or inverted piles will be permitted. Double lagging shall be adequately connected to the basic pile material to transfer the full pile load from the basic pile material to the lagging without exceeding values of allowable stress as established in subchapter ten of this chapter. The connection for single lagging shall be proportioned for half the pile load. The diameter of any inverted timber pile at any section shall be adequate to resist the applied load without exceeding the stresses indicated in paragraph one of subdivision (a) of this section, but in no case shall it be less than eight inches.

(d) Installation. -

(1) All broomed, crushed, or otherwise damaged materials at the head of the pile shall be removed before capping.

(2) Any sudden decrease in driving resistance shall be investigated with regard to the possibility of breakage of the pile, and if such sudden decrease in driving resistance cannot be correlated to boring data or some incident in the driving, and if the pile cannot be removed for inspection, it shall be considered as adequate cause for rejection of the pile.

§[C26-1109.3] 27-708 Precast concrete piles (including prestressed sections). -

(a) Materials. -Materials for precast concrete piles shall conform to the requirements of article five of subchapter ten of this chapter.

(b) Construction. -

(1) HANDLING. -Precast concrete piles shall be proportioned, cast, cured, handled, and driven so as to resist the stresses induced by handling and driving as well as by loads. Handling stresses shall be computed on the basis of fifty percent of the weight of the pile as an allowance for impact. Handling equipment shall be constructed so as to equalize the reactions on the several lines of the pile pickups. Loading conditions induced by handling and driving shall be considered as of infrequent occurrence.

(2) DIMENSIONS. -The minimum lateral dimension of the pile shall be ten inches, except for the taper at the tip.

(3) STRUCTURAL DESIGN. -Piles shall be proportioned in accordance with the provisions of article eight of this subchapter, subject to the following additional requirements:

a. For a length equal to at least three times the minimum lateral dimension at each end of the pile, lateral tie reinforcement consisting of 0.225 in. diameter rods or larger shall be spaced not more than three inches center-to center, or an equivalent spiral shall be provided. Elsewhere, the spacing of the ties or the pitch of the spiral may be increased to twelve inches. The minimum amount of longitudinal reinforcement shall be two percent of the concrete section placed in a symmetrical pattern of at least four bars. If prestressed piles are used, the minimum residual compression in the pile section shall be seven hundred psi. For piles designed with voids, the three inch spacing of the ties or spiral at each end of the pile shall be extended for a distance of twelve feet or one-third the length of the pile, whichever is smaller.

b. For piles designed with voids, the minimum wall thickness of the concrete in any section of the piles shall be four inches. Voids may extend through either or both ends of the pile. If the void extends through the lower end of the pile, the pile head shall be vented to prevent buildup of internal hydraulic pressure during driving.

c. Reinforcing steel shall be covered with at least one and one-half inches of concrete on the surface against the ground.

(c) Tolerances. -Voids, when used, shall be located within three-eighths of an inch of the position shown in the plans. The maximum departure of the pile axis from a straight line, measured while the pile is not subject to bending forces, shall not exceed one-eighth of an inch in ten feet or three-eighths of an inch in forty feet or, 0.1 percent of the pile length.

(d) Installation. -Precast concrete piles shall not be handled or driven until they have cured sufficiently to develop the necessary strength.

§[C26-1109.4] 27-709 Cast-in-place concrete piles. -
(a) Description. -Cast-in-place concrete piles shall be cast in shells previously installed in the ground or, with the limitations indicated in section 27-697 of article seven of this subchapter, may be cast in an uncased hole. Cast-in-place piles may be tapered or cylindrical, or a combination of tapered and cylindrical shapes.
(b) Materials. -Concrete for cast-in-place concrete piles shall conform to the requirements of article five of subchapter ten of this chapter. Slump shall be five inches plus or minus one inch. Where the pile shell is assumed to contribute to the capacity of the pile as a structural member, the shell shall be of metal and shall conform to the provisions of article six of subchapter ten of this chapter or section 27-712 of this article. Where the pile shell is not assumed to contribute to the capacity of the pile as a structural member, the shell may be of any material that will adequately resist the driving stresses and maintain an open well to receive the concrete. End closures for shells shall not project more than one-half inch beyond the outer limits of the pile when bearing in soils of class 6-65 or lower.
(c) Installation. -
(1) After installation to final depth and immediately before filling with concrete, the inside of the tube, shell, or bore shall be thoroughly cleaned to the bottom and inspected by lowering a drop light or by means of a light beam. To be accepted: (a) the pile shall be free of collapsed sections of shell and the pile shell shall not show any tears; (b) the pile shall be free of water except that a minor amount of water may be allowed to occur in the pile if it be absorbed by placing a suitable amount of dry cement-sand mixture in the tip end of the pile; and (c) the alignment of the pile shall conform to the provisions of section 27-691 of article seven of this subchapter. If the bottom of the casing is out of sight, the shape and alignment of the casing shall be surveyed with a suitable instrument, or the pile rejected.
(2) Concrete shall be placed by such methods that the entire volume of the tube, shell, or bore is filled and in a manner that will preclude separation of the ingredients.
(3) No concrete shall be placed in a cast-in-place pile until all piles within a radius of fifteen feet, or within the heave range, have been driven.
(4) Rejected pile shells shall be filled with concrete or sand.
(5) The concrete cap shall not be placed until at least one hour after all piles within the cap group are completely filled.

§[C26-1109.5] 27-710 Compacted concrete piles. -
(a) Description.- A "compacted concrete pile" shall denote a concrete pile formed with an enlarged base in which the concrete in the base is placed in small batches that are compacted prior to attaining an initial set. The concrete in the shaft of the pile shall be placed as specified in section 27-709 of this article for cast-in-place concrete piles if a permanent casting is provided, or in small batches that are compacted.
(b) Materials. -Concrete for compacted concrete piles shall conform to the requirements of article five of subchapter ten of this chapter. Concrete to be compacted shall have a minimum compressive strength at the age of twenty-eight days of four thousand psi and shall be mixed with sufficient water to permit hydration of the cement, but the slump shall be zero. The concrete shall be placed and compacted before initial set can occur. Non-compacted concrete, if used for the pile shafts, shall conform to the requirements for cast-in-place concrete piles.
(c) Spacing.- Minimum spacing between compacted concrete piles shall be four feet six inches, center to center, except that where the shafts of such piles are cased for their full length, this spacing may be reduced to three feet six inches. Where a question exists as to possible damage to adjacent previously driven piles, these minimums shall be increased.
(d) Installation. -
(1) The base shall be formed by ramming concrete, in batches of approximately five cubic feet or less, from a drive casing and into the soil. Unless specifically otherwise permitted by the commissioner, a minimum of twenty blows of at least one hundred forty thousand foot-pounds per blow shall be required for extrusion of the last five cubic feet of concrete. The total quantity of concrete extruded from the drive casing to form the base shall be equal to or greater than the quantity so extruded in the case of the nearest successful applicable test pile, except that a compactive effort in excess of thirty blows, each of one hundred forty thousand foot-pounds, will not be required for extrusion of the last five cubic feet.
(2) After the expanded base has been formed, the shaft shall be constructed. Where a cased shaft is to be used, a steel shell shall be inserted into the drive casing and anchored to the expanded base by placing a fresh charge of concrete in the shell and driving it into the base. The shell may then be filled with concrete to cut-off elevation after the removal of the drive casing, in accordance with the provisions relating to cast-in-place concrete piles. Any annular space remaining between the shell and surrounding soil shall be suitably filled to assure proper lateral support of the shaft, unless there is sufficient recovery of the ground to provide the necessary support. Where an uncased shaft is to be used, the provisions of section 27-697 of article seven of this subchapter shall apply, and the concrete for the shaft shall be placed by ramming or by the use of approved pressure devices as the drive casing is withdrawn. Where ramming is used, the concrete batches being rammed shall not exceed five cubic feet in volume, not less than two blows of thirty thousand foot-pounds each shall be applied to compact each batch of concrete, and the bottom of the drive casing shall be kept below the level of the concrete at all times.

(3) The outside diameter of the permanent shaft shall not be more than four inches less than the inside diameter of the drive casing.
(4) Except where uncased shafts are used, as described in section 27-697 of article seven of this subchapter, no concrete shall be placed in the pile shafts until all piles within a radius of fifteen feet, or within the heave range, have been driven.
(e) Bearing material. -The enlarged base of the pile shall be formed in, or on the same type of bearing material as is used to support the nearest applicable load test pile and at a similar depth therein. In addition, the enlarged base shall be underlain by a minimum depth of ten feet (measured from the junction of the shaft and base) of soil materials of classes 1-65 to 7-65, except that, where installation of the base is permitted to be performed with blows of less energy than the one hundred forty thousand foot-pounds indicated in paragraph one of subdivision (d) of this section, the requirement for a ten foot depth of class 1-65 to 7-65 material may be reduced, subject to the approval of the architect or engineer and the approval [*sic*] of the commissioner.

§[C26-1109.6] 27-711 Steel H sections. -
(a) Materials.- Steel H sections may be of any type of steel permitted by the provisions of reference standard RS 10-5. The use of built-up sections or sections of other than "H" form will be permitted if the several components of the section are adequately connected to develop the strength of the adjacent components and if the ratio of width to thickness of the component parts does not exceed the values for conventional "H" sections.
(b) Limitations on use. -The tips of all steel H piles having a thickness of metal less than one-half inch, which are driven to end bearing on rock of class 1-65 through 3-65 by an impact hammer, shall be reinforced. The installation of all steel H piles by impact hammer to end bearing on rock of classes 1-65 through 3-65 shall be under the personal inspection of an architect or engineer, and the operations of driving such piles, the observations of penetration resistance, and the operation of the equipment shall be conducted so as to terminate driving directly when the pile reaches refusal on the rock surface.

§[C26-1109.7] 27-712 Concrete-filled pipe piles. -
(a) Materials.- The pipe shall conform to the provisions of reference standard RS 11-8. Concrete shall conform to the requirements of article five of subchapter ten of this chapter.
(b) Minimum dimensions. -
(1) Pipe installed open-end and having a nominal outside diameter of less than fourteen inches shall be at least one-quarter inch thick. For diameters from fourteen inches to eighteen inches, the minimum thickness shall be 0.310 in. For diameters over eighteen inches, the minimum thickness shall be 0.375 in.
(2) Steel pipe piles installed with ends closed shall have a minimum nominal wall thickness of at least 0.125 in.
(3) For piles which receive their principal support by friction, closure or splice plates shall not project more than three-eighths of an inch beyond the outer limit of the pipe section.
(c) Installation. -
(1) Pipe shells driven open-end shall be cleaned to the bottom of the shell after driving.
(2) After driving and cleaning the pipe, open-end piles driven to end bearing on rock or hardpan shall be reseated to full bearing by redriving, to the resistance indicated in Table 11-4. If the pipe shell shows two inches or more of penetration on redriving, the pipe shall be recleaned and redriven in successive cycles until the penetration on redriving is less than two inches.
(3) Pipe shells shall be inspected before filling with concrete, shall be clean, and shall meet the requirements for alignment and condition of the shell as specified with regard to the shells of cast-in-place piles. If leakage of water into the pipe occurs, the provisions of paragraph five of subdivision (e) of section 27-713 of this article shall apply.
(4) Placing of concrete fill in pipe shells shall conform to the requirements for placing concrete fill in cast-in-place piles.

§[C26-1109.8] 27-713 Caisson piles. -
(a) Description.- Caisson piles shall denote concrete filled pipe piles that are socketed into bedrocks of class 1-65, 2-65 or 3-65 and constructed with steel cores.
(b) Materials.- Pipe or shell and concrete shall conform to the requirements for concrete filled pipe piles, except that the minimum compressive strength of the concrete at the age of twenty-eight days shall be thirty-five hundred psi. Steel cores shall conform to the requirements for steel H piles. Reinforcing steel cages shall be covered with at least one and one-half inches of concrete.
(c) Design of rock socket. -The design of the rock socket shall be predicated on the sum of the allowable bearing pressure on the bottom of the socket plus bond along the sides of the socket. The allowable bearing pressure on the surface of the rock at the bottom of the socket shall be as established in section 27-678 of article four of this subchapter increased for embedment in accordance with note eight of table 11-2, provided that the strength of the concrete fill in the socket, computed as 0.45 f 'c is of comparable magnitude. The allowable bond stress between the concrete and the sides of the socket shall be taken as two hundred psi. The provisions of subdivision (c) of section 27-700 of article eight of this subchapter relative to penetration resistance shall not apply.
(d) Spacing and minimum dimensions. -
(1) Minimum diameter of a caisson shall be eighteen inches with a minimum shell thickness of three-eighths of an inch. Minimum depth of the rock socket shall be equal to the diameter of the pipe.
(2) The center-to-center spacing of caissons shall be at least two and one-half times the outside diameter of the shell.

(e) Installation. -
(1) The steel shell shall be installed through overburden, the material within the shell shall be removed, and the shell seated in the rock sufficiently to stop the inflow of soil. Where required to extend the shells, splices are to be welded. A suitable steel driving shoe shall be welded to the bottom of each caisson.
(2) A socket shall then be drilled in the rock to the required depth and shall be approximately of the same diameter as the inside diameter of the shell. Before placement of concrete, the socket and shell shall be thoroughly cleaned and the rock inspected to verify that the rock is of the class on which the design has been predicated, or of a better class. In case visual inspection cannot be made because of inability to unwater the caissons by standard pumping methods, drilling logs and screenings from the rock drilling operation may be utilized to determine the class of rock in the socket.
(3) Where more than one section of steel core is required, the mating ends of the sections shall be spliced so as to safely withstand the handling stresses to which they may be subjected. The ends shall be milled or field ground to insure contact. The steel core shall be centrally installed in the caisson before grouting and concreting, shall not be more than one inch above the rock at the bottom of the socket, and shall be full length of the caisson or extend a sufficient distance up into the shaft to transmit the load in the steel core into the concrete of the caisson. A minimum-weight thirty-six pounds stub core beam shall be installed in the socket for caissons not requiring steel cores in order to lock the caissons into the rock. In these cases, the length of the steel cores shall be twice the socket depth.
(4) Concrete and grout shall be placed so that it completely fills the shell, the socket, and the space between the steel core and shell, and in a manner that will preclude separation of the ingredients.
(5) If the leakage of water into the caisson is minor, the caisson shall be pumped out and one cubic yard of grout shall be placed in the caissons and then the balance of the concrete installed. If the leakage of water makes it inadvisable to attempt to place concrete in the dry, the shell shall be filled to its top with clean water, and the concrete placed by the tremie method to the top of the caisson in one continuous operation or by using a seal of grout of the same strength as the specified concrete. The grout seal, if used, shall be deposited by means of a grout pipe to an elevation of at least three feet above the cutting edge, and after a sufficient time has elapsed to allow the grout to set, the caisson shall be pumped dry and the remaining space filled with concrete.

§[C26-1109.9] 27-714 Composite piles. -Composite piles include those consisting of two types of pile joined together. The maximum allowable load shall be that allowed for the component of lesser strength used to make up the full pile length. The connection or joint between the two components shall be constructed so as to prevent the separation of the upper and lower components during construction and thereafter. The details and methods of making joints shall be designed.

ARTICLE 11 UNDERPINNING

§[C26-1110.1] 27-715 General requirements. -
Where support of adjacent structures or properties is required, such support may be provided by underpinning, sheeting, and bracing, or by other means acceptable to the commissioner. Except as specifically permitted otherwise, underpinning piers, walls, piles, and footings shall be designed and installed in accordance with the applicable provisions of this subchapter relating to piers, walls, piles, and footings used in new construction and shall be inspected as provided in section 27-724 of article thirteen of this subchapter**.**

§[C26-1110.2] 27-716 Use of rock support in lieu of underpinning.- Existing structures founded at a level above the level of adjacent new construction may be supported on hard rock in lieu of underpinning, the use of sheeting and bracing, or the construction of retaining walls, provided that a report by the architect or engineer is submitted substantiating the safety of the proposed construction and verifying that an "in-place" inspection has been made of the rock exposed and of the jointing therein in the excavation.

ARTICLE 12 STABILITY

§[C26-1111.1] 27-717 General.- The possibility of overturning and sliding of the building shall be considered.

§[C26-1111.2] 27-718 Factor of safety. -
(a) Overturning.- The minimum factor of safety against overturning of the structure as a whole shall be one and one-half. Stability against overturning shall be provided by the dead load of the building, by the allowable uplift capacity of piling, by anchors, by the weight of soil directly overlying footings provided that such soil cannot be excavated without recourse to major modification of the building, or by any combination of these factors.
(b) Sliding. -The minimum factor of safety against sliding of the structure under lateral load shall be one and one-half. Resistance to lateral loads shall be provided by friction between the foundation and the underlying soil, by passive earth pressure, by batter piles, or by plum piles, subject to the following:
(1) The resistance to lateral loads due to passive earth pressure shall be discounted where the abutting soil could be removed, inadvertently, by excavation.
(2) In the case of pile supported structures, frictional resistance between the foundation and the underlying soil shall be discounted.

(3) The available resistance to friction between the foundation and the underlying soil shall be predicated on an assumed friction factor of one-half for soils of classes 1-65 through 8-65. A greater value of coefficient of friction may be used subject to verification by analysis and test. For soils of poorer classes, the stability shall be analyzed by accepted procedures of soil mechanics.

ARTICLE 13 INSPECTION

§[C26-1112.1] 27-719 General. -The applicable provisions of article seven of subchapter one of this chapter shall apply.

§[C26-1112.2] 27-720 Boring and test pit operations.- Boring and test pit operations shall be subject to controlled inspection, except that fifty percent or less of the required number of borings and/or test pits may be inspected by an architect or engineer other than the architect or engineer designated for controlled inspection. The records of borings and/or test pits shall be attested to as follows:

(a) The architect or engineer shall file a report stating which borings and/or test pits were performed under his or her inspection and whether such inspection was performed personally or otherwise. If the inspection was not made personally by the architect or engineer, the name and address of the inspector shall be noted. It shall be stated: that the borings and/or test pits so inspected were made and were carried to the depths indicated; that, to the best of the architect's or engineer's knowledge and belief, the description and classification of the soils are a true description of the samples recovered from the respective borings and/or test pits; that such samples were recovered at the levels indicated; and that the boring and/or test pit work progressed in such manner that the samples recovered are reasonably representative of the subsurface conditions.

(b) The accuracy of the other data indicated on the boring records shall be attested to by the drilling contractor or by the driller making the borings.

§[C26-1112.3] 27-721 Piling.- The installation of all piling shall be subject to controlled inspection. Such inspection shall be performed only by an architect or engineer resident at the site, except that where more than one pile rig is working at a site, inspection of the work may be performed by nonlicensed or nonregistered personnel working under the resident architect or engineer, who need act only in a supervisory capacity. This exception shall not apply, however, in the cases of timber or steel piles driven to end bearing as described in article ten of this subchapter. Materials for piling shall be subject to inspection requirements as prescribed in subchapter ten of this chapter for those or like materials. In all cases, an inspector shall be assigned to observe the operations of each rig.

§[C26-1112.4] 27-722 Footings, foundation piers, foundation walls and pile caps. -The provisions of section 27-683 of article six of this subchapter shall apply.

§[C26-1112.5] 27-723 Subgrade for footings, foundation piers, and foundation walls. -The soil material directly underlying footings, foundation piers, and foundation walls shall be inspected by an architect or engineer after excavation and immediately prior to construction of the footings. If such inspection indicates that the soil conditions do not conform to those assumed for purposes of design and described on the plans, or are unsatisfactory due to disturbance, then additional excavation, reduction in allowable bearing pressure, or other remedial measures shall be adopted, as required. A copy of a report or reports on such inspection or inspections describing the conditions found and any necessary modification of the design, and bearing the signature of the architect or engineer making the inspections, shall be filed with the commissioner. In addition, notification shall be received by the department at least two working days prior to construction of the footing, pier, or foundation walls, that the subgrade is ready for inspection unless the requirements of section 27-209 of article twenty-one of subchapter one of this chapter have been met.

§[C26-1112.6] 27-724 Construction required for or affecting the support of adjacent properties or buildings.- Except in cases where a proposed excavation will extend less than ten feet below the legally established grade, all underpinning operations and the construction and excavation of temporary or permanent cofferdams, caissons, braced excavated surfaces, or other constructions or excavations required for or affecting the support of adjacent properties or buildings shall be subject to controlled inspection. The details of underpinning, cofferdams, caissons, bracing, or other constructions required for the support of adjacent properties or buildings shall be shown on the plans or prepared in the form of shop or detail drawings and shall be approved by the architect or engineer who prepared the plans.

This page is intended to be left blank