New York State Department of State

Division of Code Enforcement & Administration

INSPECTION

OF

CONCRETE AND MASONRY CONSTRUCTION

Lesson 1

INTRODUCTION

- Requirements of Part 1203
  - Provisions shall be made for inspection of the following …

Building Permits

- 1203.3(a)(1)Building Permits
  - required for work that must conform to the Code
- Building Permit Exemptions
  - Must be adopted in the local regulation
  - Does not exempt applicant from meeting Code requirements when applicable

Construction Documents

- Construction documents *shall not* be accepted unless:
  - Meet State Education requirements
  - Sufficient detail and clarity
  - Substantiate the work is code compliant
  - Site plan
    - Existing buildings, wells, septic tanks, location of work, distances

Why do we Inspect?

- Ensure compliance with the approved plans
- Ensure that the owner gets what they paid for
- Control or manage the activities to assist the construction process
- Record the process

Required Inspections

- 1203.3(b)(1) work done under a permit shall remain exposed until inspected
- Permit holder shall notify CEO when work is ready to be inspected
- 1203.3(b)(2) required inspections:

Construction Inspections

- Provisions shall be made for inspection of the following …
  - (i) work site prior to the issuance of a permit;
  - (ii) footing and foundation;
  - (iii) preparation for concrete slab;
  - (iv) framing;
  - (v) building systems, including underground and rough-in;
  - (vi) fire resistant construction;
  - (vii) fire resistant penetrations;
  - (viii) solid fuel burning heating appliances, chimneys, flues or gas vents;
  - (ix) energy code compliance; and
  - (x) a final inspection after all work has been completed.

Site prior to issuing the permit

Footings

Foundations

Concrete

Preparation for the concrete slab

Building systems – underground and rough-in

Concrete Placement

Finished Slab

After Inspection

- 1203.3(3) notify permit holder if work is satisfactory or not
- Work not in compliance remains exposed until corrected, reinspected and found to be satisfactory

Common Errors

- Failure to properly identify soil conditions and bearing capacity
- Design based solely on soil strength
- Failure to create uniform bearing conditions
- Over excavation
- Footing concrete placed on frozen ground

More Errors

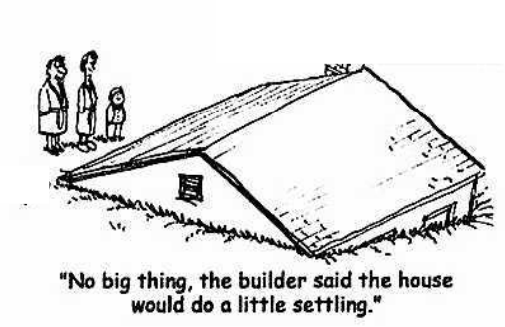
- Footing concrete placed in mud
- Lack of reinforcement at steps
- Unprotected footing drains
- Uncontrolled foundation backfill
- Allowing deep clay deposits to dry

Course Goals

- Develop an awareness of soil load bearing capacities
- Review Code requirements for footings and foundation spaces
- Explore various types of foundation walls
- Review inspection requirements for Concrete and Masonry Construction

SOILS

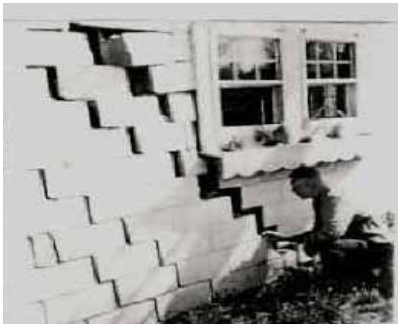
Lesson 2



Foundation Requirements

- R401.2
  - Must carry all loads
  - Transmit loads
  - Be supported by proper soils
    - fill sections must be designed, installed and tested per accepted engineering practice

How do we fix this?



Soil Tests

R401.4

- If soils are known to be of poor quality
- If soil conditions are unknown
  - soils testing by an approved agency shall be required to determine soil bearing values for the site

Presumptive Values

In lieu of a full geotechnical evaluation the load bearing values in table R401.4.1 shall be assumed

TABLE R401.4.1
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS[a]

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500[b]

For SI: 1 pound per square foot = 0.0479 kN/m².

a. Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.

b. Where in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

Foundation and Soil Investigations

- Purpose is to classify soil to determine its bearing properties
- Typical, known soils - just classify
- INVESTIGATE if
  - Unusual soils/conditions
  - Unknown soil

Investigation Methods

- Test pits
- Penetrometer
- Soil boring and sampling
- Subsurface explorations
- Additional studies

Soil Borings

Investigations

TABLE R405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS[a]	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION[b]
Group I	GW	Well-graded gravels, gravel sand mixtures, little or no fines.	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines.	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines.	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines.	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures.	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures.	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures.	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture.	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays.	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays.	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity.	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts.	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils.	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.

b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

The following comes from the soil engineer's commentary:

- Proposed Building Foundation: recommended to be continuous strip-column footings and individual column footings, as needed.
- Exterior strip-column footings are suggested to include excavating a foundation trench that is centered about the wall-column centerline.
- Exterior footings are suggested to extend to a minimum depth of four feet, or as required by local code, below adjacent exterior ground surface.
- Discontinuous or "jump" footings are not recommended.
- Where needed, step footings, should have a rise to run ratio of 1 :2,

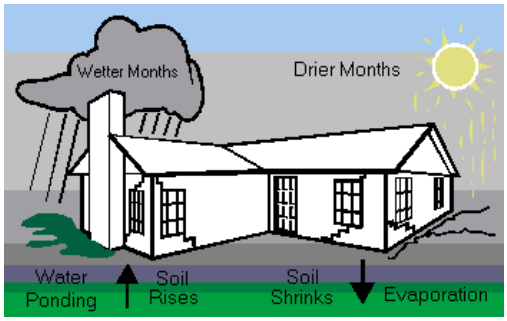
Soil Boring Report

- Soil Engineer's report must be followed
  - Incorporated into working drawings
- Discrepancies must be addressed
  - Corrections required

Removal of Soils

- R401.5
  - Compressible or shifting soils must be removed to a sufficient depth and width

Expansive Soils



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a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.

b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with

Foundations on Expensive Soils

- R403.1.8
  - *Foundations and floor slabs for buildings located on expansive soils shall be designed in accordance with section 1805.8 of the Building Code of New York State*
    - Exception-systems which have performed adequately in similar soil conditions

Slab Footing

FOOTINGS

Lesson 3

As you enter site remember to check

- For copy of prints on site
- Posted building permit
- Setback distances
- Topography of site
- Soil conditions on site

Setting the forms

- Forms must be set on undisturbed soil
- Must be sized as shown on prints
- Footings must be set at the proper elevation
- Footing top surface must be level
- Bottom of footing must have square edges
- Bottom of footings must be within 10 degrees of level or stepped footings will be required

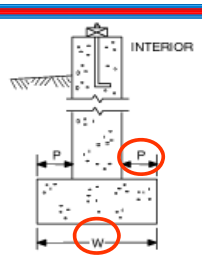
Wall Support

- R403.1
- All exterior walls shall be supported by continuous footings
- Footing must be sized to support all loads based on the soil characteristics
- Footings must be on undisturbed natural soil or engineered fill

Section R403.1.1

Minimum Footing Size

- Spread footings
  - Minimum 6” thick
- Width (W)
  - Table R403.1
- Projection (P)
  - Minimum 2”
  - Max. thickness of footing
- Pier footing size
  - Based on tributary loads



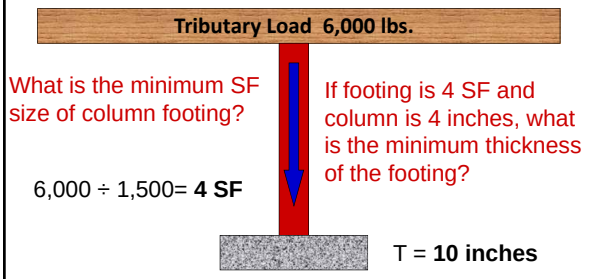
BASEMENT OR CRAWL SPACE WITH CONCRETE WALL AND SPREAD FOOTING

Figure 403.1(1)

Other Footing Requirements: Pier and Column Requirements

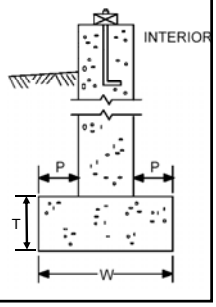
- Sizes based on tributary load and allowable soil pressure
- Tributary load
  - The load that the column supports
- Soil load-bearing value
- Tributary load ÷ soil load bearing value = minimum SF size of column footing

Tributary load ÷ soil load bearing value = minimum SF size of column footing



BC Footing Design

- Minimum dimensions based on
  - Building Code or designer's specifications
  - Load-bearing value of soil
  - Material used
  - Width of foundation wall
- W = width of footing
- T = thickness of footing
- P = Projection on either side of foundation wall

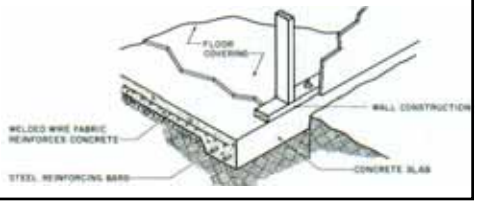


BC Footing Design

- …so designed that the allowable bearing capacity of the soil is not exceeded.
- The minimum width of footings shall be 12 inches. **See 1805.4.1**
- The minimum thickness of footings shall be 8 inches. * **See 1805.4.2.3**
- Footings in expansive soils… designed in accordance with… **See 1805.8**

Types of Footing: NONE at ALL… Slab-on-Grade

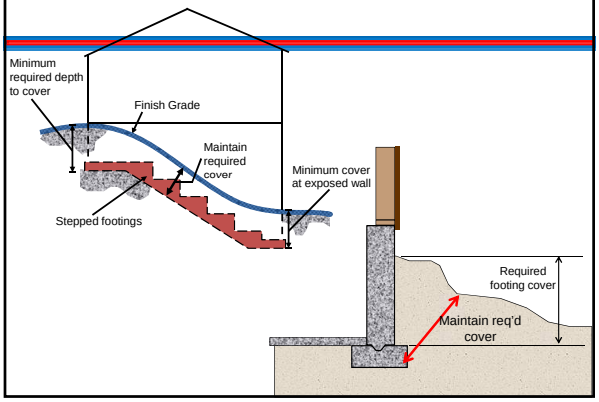
- May be proposed due to regional preference
- May be REQUIRED due to soil characteristics



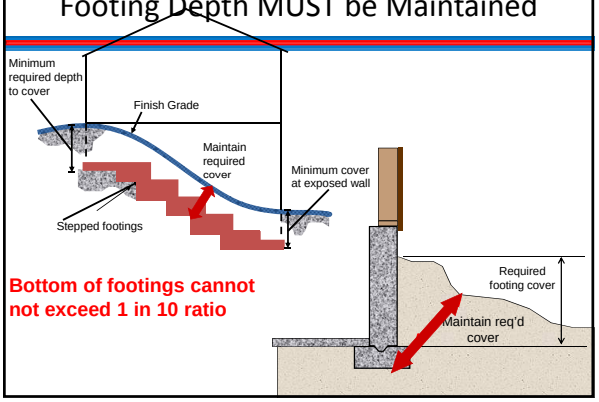
Exterior Footing Requirements: Depth Below Frost

- Placed below frost line
  - Prevents frost heave and settlement
  - Exceptions:
    - Frost-protected footings
    - Footings/foundations on solid rock
    - Free-standing buildings
      - Meeting all 3 conditions
- Never placed on frozen ground

Footing Depth MUST be Maintained

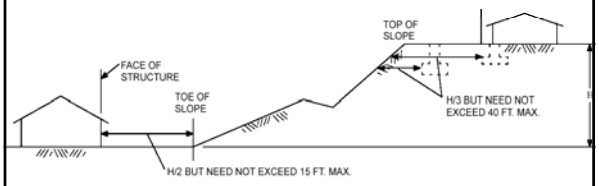


Footing Depth MUST be Maintained



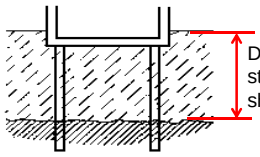
Footings on or Adjacent to Slopes

- Requirements for buildings on or adjacent to slopes steeper than 33.3%

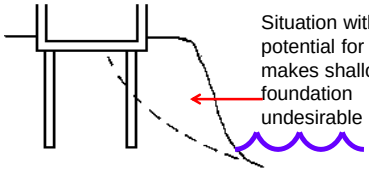


See 1805.3

When "Common" Won't Work: Deep Foundation Systems

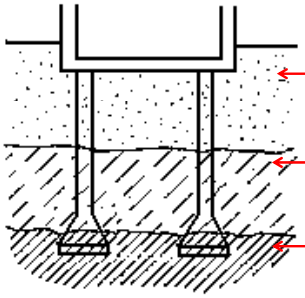


Distance to useable stratum too great for shallow foundation



Situation with high potential for erosion makes shallow foundation undesirable

When "Common" Won't Work: Deep Foundation Systems

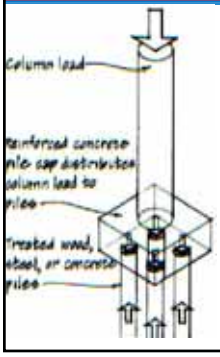


Upper strata suitable for bearing

But underlying soil subject to excessive settlement

Requires use of lower, denser stratum to assure control of settlement

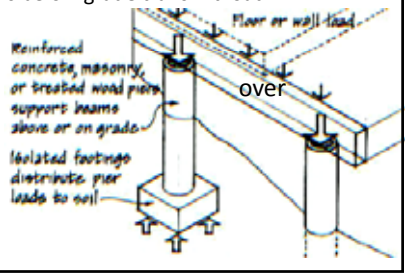
Types of Footings: Deep Foundation System - Piles



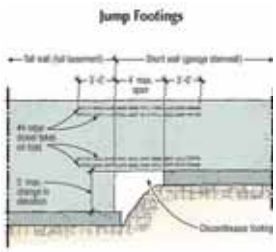
- Specialized footing
  - Transfers load through poor soil to deeper soil of adequate strength
  - Usually pre-cast and driven
- Materials used for pile footings
  - Cast-in-place concrete
  - Pre-cast concrete
  - Steel H piles
  - Treated wood

Types of Footings: Piers

- Specialized footing
  - Short columns below grade transmit load to footing
- Several advantages conventional foundations over



Jump Footings & Grade Beams



REQUIRE ENGINEERING

FOUNDATIONS

Lesson 4



Foundation Wall Design

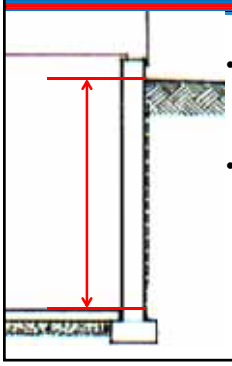
- IF Concrete or Masonary
  - May be ENGINEERED (Chapter 19 or 21)
- Within certain LIMITATIONS, a prescriptive design is permitted
  - Laterally supported top and bottom
  - Tables 1805.5(1) through 1805.5(5)
  - **If Seismic Design Category C or worse … ADDITIONAL limitations apply**

See 1805.5.5

If the Prescriptive Method is Allowed, 1805.5.1 through 1805.5.4

- Foundation wall thickness based on
  - What it supports
  - The soil's characteristics
  - Wall's depth and height
- Materials used in the foundation
  - Reinforcing and compressive strengths
- Reinforcement alternatives

"Unbalanced Backfill"



- *The difference in height of the exterior and interior finish ground levels.*
- *Where an interior concrete slab is provided, height is measured from the exterior finish ground level to the top of the interior concrete slab.*

Tables in Building and Residential Codes

- Should not be used if any of the following conditions exist:
  - Soils which are unidentified
  - Fill sections that were not engineered or properly compacted
  - Soils which are subject to settlement
  - Expansive soils, (these are soils that shrink and swell with change in moisture content)
  - Highly compressive clays
  - Undermined sands and silts

STOP

TABLE 1610.1 SOIL LATERAL LOAD

DESCRIPTION OF BACKFILL MATERIAL[a]	UNIFIED SOIL CLASSIFICATION	DESIGN LATERAL SOIL LOAD[a] (pound per square foot per foot of depth)	
		Active pressure	At-rest pressure
Well-graded, clean gravels; gravel-sand mixes	GW	30	60
Poorly graded clean gravels; gravel-sand mixes	GP	30	60
Silty gravels, poorly graded gravel-sand mixes	GM	40	60
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45	60
Well-graded, clean sands; gravelly sand mixes	SW	30	60
Poorly graded clean sands; sand-gravel mixes	SP	30	60
Silty sands, poorly graded sand-silt mixes	SM	45	60
Sand-silt clay mix with plastic fines	SM-SC	45	100
Clayey sands, poorly graded sand-clay mixes	SC	60	100
Inorganic silts and clayey silts	ML	45	100
Mixture of inorganic silt and clay	ML-CL	60	100
Inorganic clays of low to medium plasticity	CL	60	100
Organic silts and silt clays, low plasticity	OL	Note b	Note b
Inorganic clayey silts, elastic silts	MH	Note b	Note b
Inorganic clays of high plasticity	CH	Note b	Note b
Organic clays and silty clays	OH	Note b	Note b

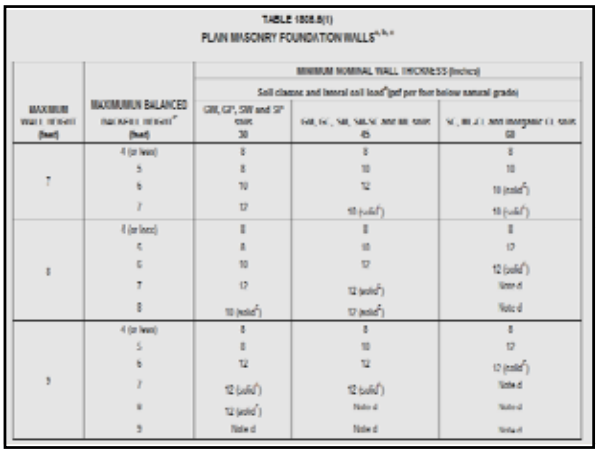


TABLE 1808.8(1)
PLAIN MASONRY FOUNDATION WALLS[a, b, c]

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[c] (feet)	MINIMUM NOMINAL WALL THICKNESS (inches) — Soil classes and lateral soil load[d] (psf per foot below natural grade)		
		GW, GP, SW and SP soils 30	[illegible] 45	[illegible] 60
7	4 (or less)	8	8	8
	5	8	10	10
	6	10	12	10 (solid[e])
	7	12	10 (solid[e])	10 (solid[e])
8	4 (or less)	8	8	8
	5	8	10	12
	6	10	12	12 (solid[e])
	7	12	12 (solid[e])	[illegible]
	8	10 (solid[e])	12 (solid[e])	[illegible]
9	4 (or less)	8	8	8
	5	8	10	12
	6	12	12	12 (solid[e])
	7	12 (solid[e])	12 (solid[e])	[illegible]
	8	12 (solid[e])	[illegible]	[illegible]
	9	[illegible]	[illegible]	[illegible]

TABLE 1805.5(5) CONCRETE FOUNDATION WALLS[b, c]

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[a] (feet)	VERTICAL REINFORCEMENT AND SPACING (inches) — Design lateral soil load[a] (psf per foot of depth)								
		30			45			60		
		Minimum wall thickness (inches)								
		7.5	9.5	11.5	7.5	9.5	11.5	7.5	9.5	11.5
5	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
6	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	PC	PC	PC
7	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 48"	PC	PC
	7	PC	PC	PC	#5 at 46"	PC	PC	#6 at 48"	PC	PC
8	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 43"	PC	PC
	7	PC	PC	PC	#5 at 41"	PC	PC	#6 at 43"	PC	PC
	8	#5 at 47"	PC	PC	#6 at 43"	PC	PC	#6 at 32"	#6 at 44"	PC
9	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	PC	PC	#5 at 39"	PC	PC
	7	PC	PC	PC	#5 at 37"	PC	PC	#6 at 38"	#5 at 37"	PC
	8	#5 at 41"	PC	PC	#6 at 38"	#5 at 37"	PC	#7 at 39"	#6 at 39"	#4 at 48"
	9[g]	#6 at 46"	PC	PC	#7 at 41"	#6 at 41"	PC	#7 at 31"	#7 at 41"	#6 at 39"

Table R404.1.1(1) Plain Masonry Foundation Walls

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[c] (feet)	PLAIN MASONRY[a] MINIMUM NOMINAL WALL THICKNESS (inches) — Soil classes[b]		
		GW, GP, SW and SP	GM, GC, SM, SM-SC and ML	SC, MH, ML-CL and inorganic CL
5	4	6 solid[d] or 8	6 solid[d] or 8	6 solid[d] or 8
	5	6 solid[d] or 8	8	10
6	4	6 solid[d] or 8	6 solid[d] or 8	6 solid[d] or 8
	5	6 solid[d] or 8	8	10
	6	8	10	12
7	4	6 solid[d] or 8	8	8
	5	6 solid[d] or 8	10	10
	6	10	12	10 solid[d]
	7	12	10 solid[d]	12 solid[d]
8	4	6 solid[d] or 8	6 solid[d] or 8	8
	5	6 solid[d] or 8	10	12
	6	10	12	12 solid[d]
	7	12	12 solid[d]	Footnote e
	8	10 solid[d]	12 solid[d]	Footnote e
9	4	6 solid[d] or 8	6 solid[d] or 8	8
	5	8	10	12
	6	10	12	12 solid[d]
	7	12	12 solid[d]	Footnote e
	8	12 solid[d]	Footnote e	Footnote e
	9	Footnote e	Footnote e	Footnote e

TABLE R404.1.1(5) CONCRETE FOUNDATION WALLS[h, i, j, k]

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[b] (feet)	Minimum Vertical Reinforcement Size and Spacing[c, d, e, f, l] — Soil classes[a] and design lateral soil (psf per foot of depth)								
		GW, GP, SW and SP 30			GM, GC, SM, SM-SC and ML 45			SC, ML-CL and inorganic CL 60		
		Minimum wall thickness (inches)								
		7.5	9.5	11.5	7.5	9.5	11.5	7.5	9.5	11.5
8	4	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC[g]	PC	PC	PC	PC	PC
	6	PC[g]	PC	PC	PC	PC	PC	#5@43"	PC[g]	PC
	7	PC	PC	PC	#5@41"	PC	PC	#6@43"	PC	PC
	8	#5@47"	PC[g]	PC	#6@43"	PC	PC	#6@32"	#6@44"	PC

Footnotes

- *d. Vertical reinforcement, when required, shall be placed nearest the inside face of the wall…*

  Concrete cover for reinforcement… shall not be less than 1 1/2 inches for No. 5 bars and smaller, and not less than 2 inches for larger bars.

- *l. Where vertical reinforcement is required, horizontal reinforcement shall be provided in accordance with the requirements of Section R404.4.6.2 for ICF foundation walls.*

404.4.6.2 Horizontal reinforcement

- *When vertical reinforcement is required, … foundation walls up to 8 feet in height shall have a minimum of one continuous No. 4 horizontal reinforcing bar placed at 48 inches on center with one bar located within 12 inches of the top of the wall story. Foundation walls greater than 8 feet in height shall have a minimum of one continuous No. 4 horizontal reinforcing bar placed at 36 inches on center with one bar located within 12 inches of the top of the wall story.*

Insulated Concrete Forms (ICF)

"Lego's" for big kids?

Insulated Concrete Forms (ICF)

- Prescriptive provisions are found in the Residential Code:
- R404.4 Insulating concrete form foundation walls. (page 70)
  Three types of ICF are listed in the RCNYS:
  R404.4.2 Flat ICF wall systems
  R404.4.3 Waffle-grid ICF and
  R404.4.4 Screen-grid ICF
- R611 Insulating Concrete Form Wall Construction (page 172) provides additional requirements. (LOTS of them!)

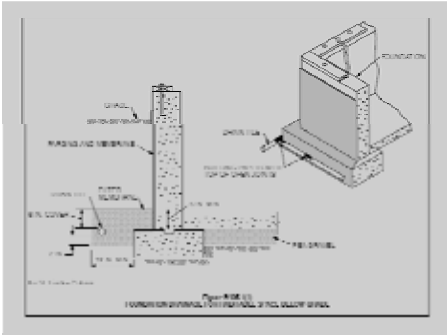
Insulated Concrete Forms (ICF)

- Tables R404.4(1) through R404.4(5) (pages 72-76)
- Provide similar requirements to those for traditional removable form systems.
- Based on wall height, unbalanced backfill and soil classification.
- Footnote b permits the use of a manufacturers table in all categories of ICF.

Insulated Concrete Forms (ICF)

- R 611 Insulating Concrete Form Wall Construction

Foundation Drainage

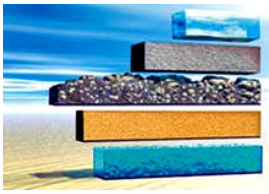


CONCRETE

Lesson 5

What is Concrete?

- Paste + Aggregates = CONCRETE
- "Cement paste" MUST cover the aggregate and fill the voids



Residential Code

- R103.4 Workmanship.
- Repairs, maintenance work, alterations or installations which are caused directly or indirectly by the enforcement of this code shall be executed and installed in a workmanlike manner and installed in accordance with this code and the manufacturer's installation instructions.

Residential Code

- Section R202 DEFINITIONS
  - APPROVED. Acceptable to the code enforcement official as determined to meet the requirements of this code.

Concrete

- R402.2
  - Compressive strength
  - Air entrainment
- Table R402.2 Minimum Specified Compressive Strength of Concrete

Table R402.2

TABLE R402.2 MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH[a] (f'_c)		
	Weathering Potential[b]		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500[c]
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500[c]
Basement walls, foundation walls, exterior walls and other vertical concrete work exposed to the weather	2,500	3,000[d]	3,000[d]
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000[d, e, f]	3,500[d, e, f]

Table R402.2 footnotes

- For SI: 1 pound per square inch = 6.895 kPa.
  a. Strength at 28 days psi.
  b. See Table R301.2(1) for weathering potential.
  c. Concrete in these locations that may be subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Footnote d.
  d. Concrete shall be air-entrained. Total air content (percent by volume of concrete) shall be not less than 5 percent or more than 7 percent.
  e. See Section R402.2 for maximum cementitious materials content.
  f. For garage floors with a steel troweled finish, reduction of the total air content (percent by volume of concrete) to not less than 3 percent is permitted if the specified compressive strength of the concrete is increased to not less than 4,000 psi.

Types of Portland Cement

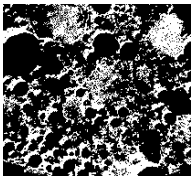
Type	Typical Use
I – Normal	General purpose use
II – Moderate	Moderate sulfate resistance and heat of hydration
III – High early strength	High strengths within 7 days
IV – Low heat of hydration	Minimizes hydration heat
V – Sulfate resisting	Resists severe sulfate exposure
IA, IIA , or IIIA – are air entrained	Improves resistance to freeze/thaw and deicing chemicals

Concrete Admixtures

- Specified by the designer
- Added for the beneficial effect immediately before or during mixing
- Classified according to function:
  - Air-entraining
  - Water-reducing
  - Retarding
  - Accelerating
  - Super plasticizers
  - Specialty

Concrete Air Entrainment

- For freeze/thaw and chemical deicing resistance
- Improves workability
- Tiny “bubbles” relieve pressures
- Usually 5% - 8% of concrete volume



Why Test Concrete?

- Material is as specified
- Estimate actual in-place strength
- Verifies adequacy of mix proportions
- Quality control
- Assures specific properties are obtained

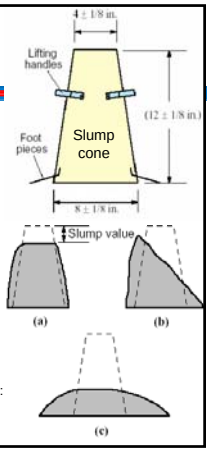
Concrete Test Methods

- Fresh
  - Slump
  - Air content
  - Unit weight
  - Compressive strength
- Hardened
  - Various strength tests

Slump Test

A measure of consistency and workability

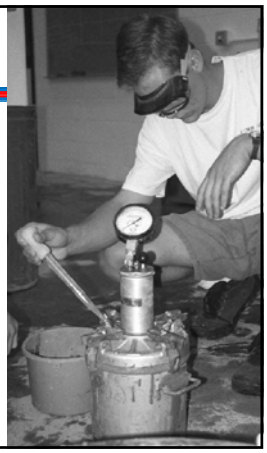
- Described in ASTM C143
- Slump is the difference between the height of the mold and the height of the concrete specimen



Types of slump concrete:
(a) True slump
(b) Shear slump
(c) Collapse slump

Air Content

- Pressure Method (ASTM C231) is a common method
- Measures concrete volume change when subjected to a given pressure



Casting Cylinders

Compressive Strength

An indicator of cured concrete strength

- Test for specified design strength
  - Cylinders broken at 7 and 28 days
- Passing the tests:
  - No test > 500 psi design strength
  - AND average of design strength

Chapter 19 Responsibilities

- Designer
- Plant
- Contractor
- Special Inspector
- Code Enforcement Official

Documentation and Inspection

1901.4 and 1901.5

- Construction documentation for structural concrete
  - Strength, size, location of structural elements and reinforcement
  - Details
- Comply with Chapter 17 for special inspections

Verification: CEO

What to Use: Durability Requirements

Section 1904

- Required concrete properties, such as
  - Air entrainment
  - Water-cementitious materials ratios
  - Compressive strength requirements
- Are based on exposure to…
  - Freezing and thawing conditions
  - Deicing chemicals
  - Sulfate-containing solutions

Responsibility: Designer
Verification: CEO

Concrete exposed to deicing chemicals

ACI 318, Section 4.2.3 limits amount of

Slag, fly ash, silica fume

TABLE 4.2.3—REQUIREMENTS FOR CONCRETE EXPOSED TO DEICING CHEMICALS

Cementitious materials	Maximum percent of total cementitious materials by weight*
Fly ash or other pozzolans conforming to ASTM C 618	25
Slag conforming to ASTM C 989	50
Silica fume conforming to ASTM C 1240	10
Total of fly ash or other pozzolans, slag, and silica fume	50†
Total of fly ash or other pozzolans and silica fume	35†

Concrete Footings: Workmanship and Placement

- Strength
- Thickness
- Placement through, under, or in water
- Protection from freezing and water
- Forming

General Principles Of Concrete Placement

- Place continuously and evenly
- Do not promote segregation
- Avoid lateral flow
- Fill forms continuously
- Spade, tamp and vibrate
- Do not retemper concrete
- Protect from extreme hot or cold
- Avoid cold joints

How to Use It: Concrete Quality

1905.1 – 1905.6

Strength and durability ensured through

- Proportioning
- Testing by "Qualified technicians"

Responsibility: Designer and Plant

How to Use It: Placing

1905.7 - 1905.9

- Equipment and place prepared BEFORE concrete placement
- Mixed
- Conveyed without
  - Separation/loss of materials
  - Delays or interruption

Per appropriate standard:

ACI 318 Section 5.7

Responsibility: Plant and Contractor
Verification: Code Enforcement Official

How to Use It: Placing

1905.10

Depositing considerations:

- Segregation
- Placement timing
- Continuous operation
- Construction joints
- Consolidation

Per appropriate standard

Responsibility: Plant and Contractor
Verification: Code Enforcement Official

Curing Concrete

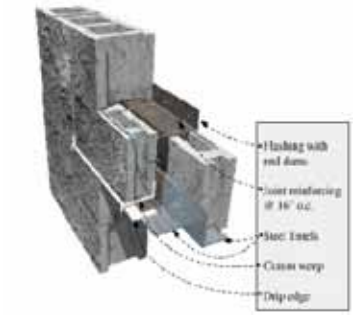
1905.11 - 1905.13

- Curing
  - Maintain above 50ºF in a moist condition
- Cold weather requirements
  - Heat/protect
  - Everything free from frost
  - No frozen materials
- Hot weather requirements
  - Prevent excessive temperatures/water evaporation

Per appropriate standard

Lesson 6

MASONRY



Components of Masonry Construction

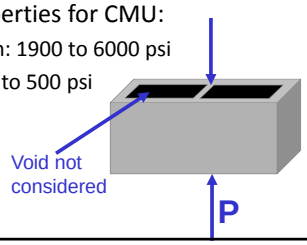
- Masonry units
- Mortar
- Reinforcement
- Grout
- Accessory Materials

Types of Masonry Units

- Clay masonry units (brick)
- Concrete masonry units (concrete block)
- Stone (artificial shape)
- Rock (natural shape)
- Glass
- Tile (roofing, floor, wall, etc.)
- Adobe (unfired clay)

Strength Properties of CMU's

- Compressive strength on NET area
  - Voids not considered, only effective area that resists loads
- Typical strength properties for CMU:
  - Compressive strength: 1900 to 6000 psi
  - Tensile strength: 250 to 500 psi



Mortar

- Basic ingredients:
  - Cement
  - Lime
  - Sand
  - Water
  - Admixtures
- ASTM C270 for mortar for masonry

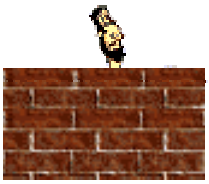
What Mortar Does

- Separates units
- Bonds units
- Provides strength
- Seals against moisture between units
- Equalizes unit size variations
- Seals unit irregularities

How to Use It: Construction

2104

- 2104.1 Masonry Construction



Responsibility: Contractor
Verification: Code Enforcement Official

Chapter 4 – Foundations

Section 403 Footings

- ***403.1.4.1 Frost protection. …****buildings and structures shall be protected from frost …*
  - **Exceptions:**
    1. … accessory structures… 600 square feet or less , of LIGHT-FRAMED CONSTRUCTION, …
    2. …accessory structures… 400 square feet or less, of OTHER THAN LIGHT-FRAMED CONSTRUCTION, …
    3. Decks adjoining but …

Table R404.1.1(1) Plain Masonry Foundation Walls

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT[c] (feet)	PLAIN MASONRY[a] MINIMUM NOMINAL WALL THICKNESS (inches)		
		Soil classes[b]		
		GW, GP, SW and SP	GM, GC, SM, SM-SC and ML	SC, MH, ML-CL and inorganic CL
5	4	6 solid[d] or 8	6 solid[d] or 8	6 solid[d] or 8
	5	6 solid[d] or 8	8	10
6	4	6 solid[d] or 8	6 solid[d] or 8	6 solid[d] or 8
	5	6 solid[d] or 8	8	10
	6	8	10	12
7	4	6 solid[d] or 8	8	8
	5	6 solid[d] or 8	10	10
	6	10	12	10 solid[d]
	7	12	10 solid[d]	12 solid[d]
8	4	6 solid[d] or 8	6 solid[d] or 8	8
	5	6 solid[d] or 8	10	12
	6	10	12	12 solid[d]
	7	12	12 solid[d]	Footnote e
	8	10 solid[d]	12 solid[d]	Footnote e
9	4	6 solid[d] or 8	6 solid[d] or 8	8
	5	8	10	12
	6	10	12	12 solid[d]
	7	12	12 solid[d]	Footnote e
	8	12 solid[d]	Footnote e	Footnote e
	9	Footnote e	Footnote e	Footnote e

Table R403.1

- Should not be used if any of the following conditions exist:
  - Fill sections that were not engineered or properly compacted
  - Soils which are subject to settlement
  - Expansive soils, (these are soils that shrink and swell with change in moisture content)
  - Highly compressive clays
  - Unconfined sands and silts

How to Use It: Cold Weather Construction

2104.3

DURING Construction		
Temperature	Component	Requirement
Below 40 F	Glass block	Not permitted
	Water and aggregate	For mortar and grout, heated, not above 140 F
	Mortar sand and mixing water	Heated to produce mortar temperature between 40°F - 120°F
Below 32°F	Mortar	Maintain above freezing until used
	Grout sand and mixing water	Heated to produce grout temperature between 70°F - 120°F, maintain grout above 70°F until used
Below 25°F	Masonry surfaces	Heated to 40°F
	Masonry structure	Install wind break if wind velocity > 15 mph
	Grouted wall	Heated to 40°F prior to grouting
Below 20°F	Masonry structure	Enclose and heat to > 32°F

How to Use It: Cold Weather Construction

2104.3

COMPLETED Construction	
Mean Daily Temperature*	Requirement
Glass Units	Maintain above 40 F for 48 hours
Between 40°F and 25°F	Weather-resistant membrane protection for 24 hours
Between 25°F and 20°F	Covered with insulating blankets or equal, 24 to 48 hours
Below 20°F	Enclose and heat to maintain > 32°F, 24 to 48 hours

* when either the ambient temperature falls below 40°F (4°C) or the temperature of masonry units is below 40°F (4°C).

How to Use It: Hot Weather

2104.4

- 2104.4 Hot weather construction provisions, IF
  - Ambient temperature > 90ºF AND wind velocity > 8 mph
- 2104.4.3 Fog spraying of brick
- 2104.5 Wetting of brick

Responsibility: Contractor
Verification: Code Enforcement Official

The Empirical Method

(Good Enough for Grandpa)

- 8 feet (2438 mm) in height
- Drain surface
- Lateral support… prior to backfilling;
- Length of foundation walls between perpendicular masonry walls or pilasters
- Backfill is granular, soil conditions are nonexpansive; and
- Masonry is laid in running bond using

TABLE 2109.5.3.1 FOUNDATION WALLCONSTRUCTION

WALL CONSTRUCTION	NOMINAL WALL THICKNESS (inches)	MAXIMUM DEPTH OF UNBALANCED BACKFILL (feet)
Fully grouted masonry	8	7
	10	8
	12	8
Hollow unit masonry	8	5
	10	6
	12	7
Solid unit masonry	8	5
	10	7
	12	7

SUMMARY

- Footings and foundations must be sized to carry loads of the structure
- Bearing capacity of the soil will effect the design of foundation systems
- Seismic category and sites prone to flooding may also effect designs
- All footings and foundations must be inspected to verify they are constructed to the design shown on the approved plans