ARCH 1230
BUILDING TECHNOLOGY II

Professor Friedman

Fall 2012

SUBJECT

building technology II
foundations part I

DATE	PROFESSOR
Fall 2012	Friedman

FOUNDATIONS

spread the load into the earth

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this week:

objective:
overview of the function of foundations and the process of designing foundations

- foundation requirements
- foundation settlement
- earth materials
- geotechnical investigation
- excavation
- shoring
- shallow foundations

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FOUNDATIONS MUST SUPPORT ALL POSSIBLE LOADS:

- DEAD LOADS
- LIVE LOADS
- RAIN & SNOW LOADS
- WIND LOADS
- SEISMIC LOADS
- SOIL & HYDROSTATIC PRESSURE

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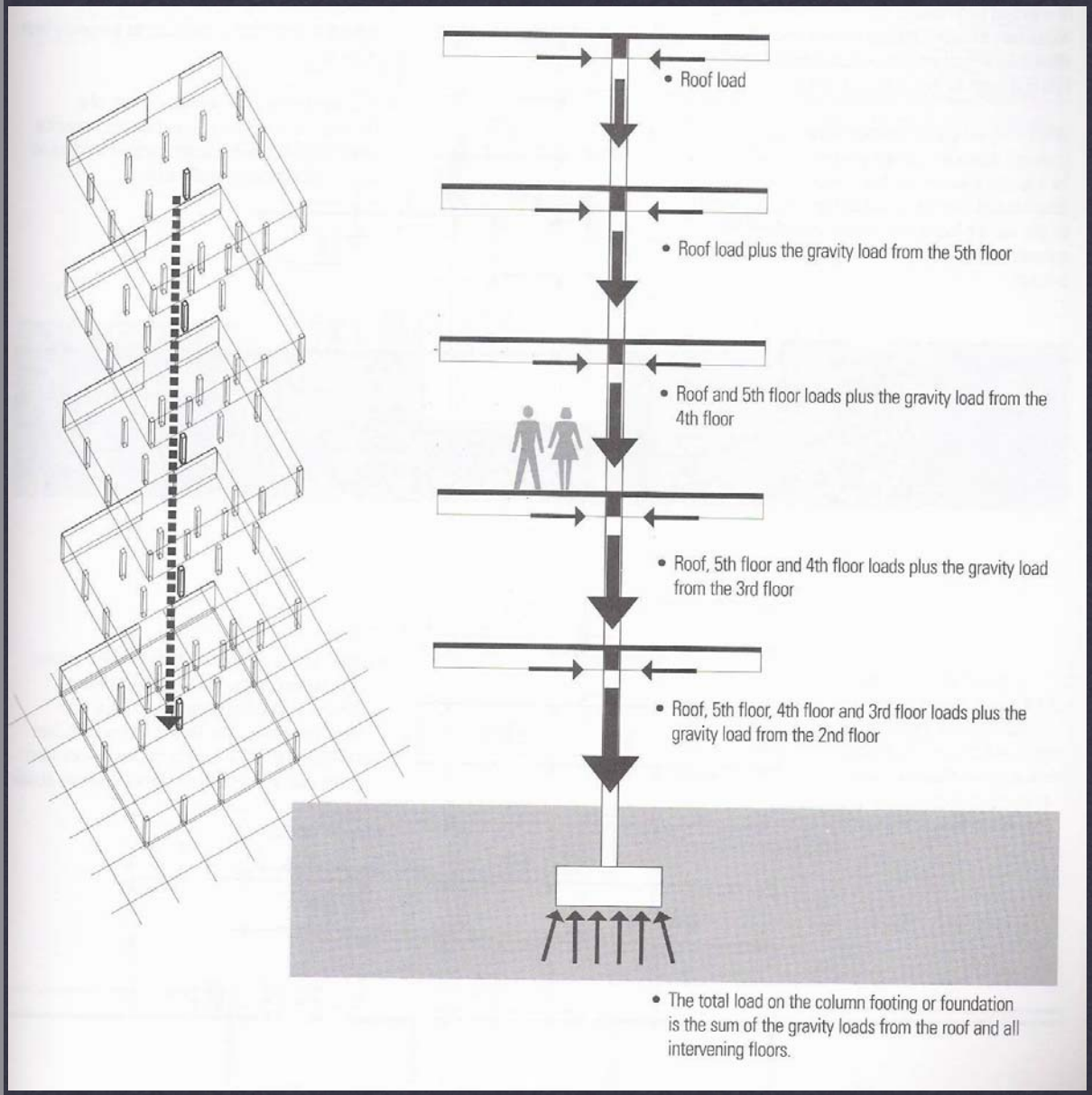

FOUNDATIONS MUST SUPPORT ALL POSSIBLE LOADS:

- DEAD LOADS

Dead Loads- the vertical loads due to the weight of the building and any permanent equipment.
Includes beams, exterior & interior walls, floors, mechanical equipment, and the foundation itself.

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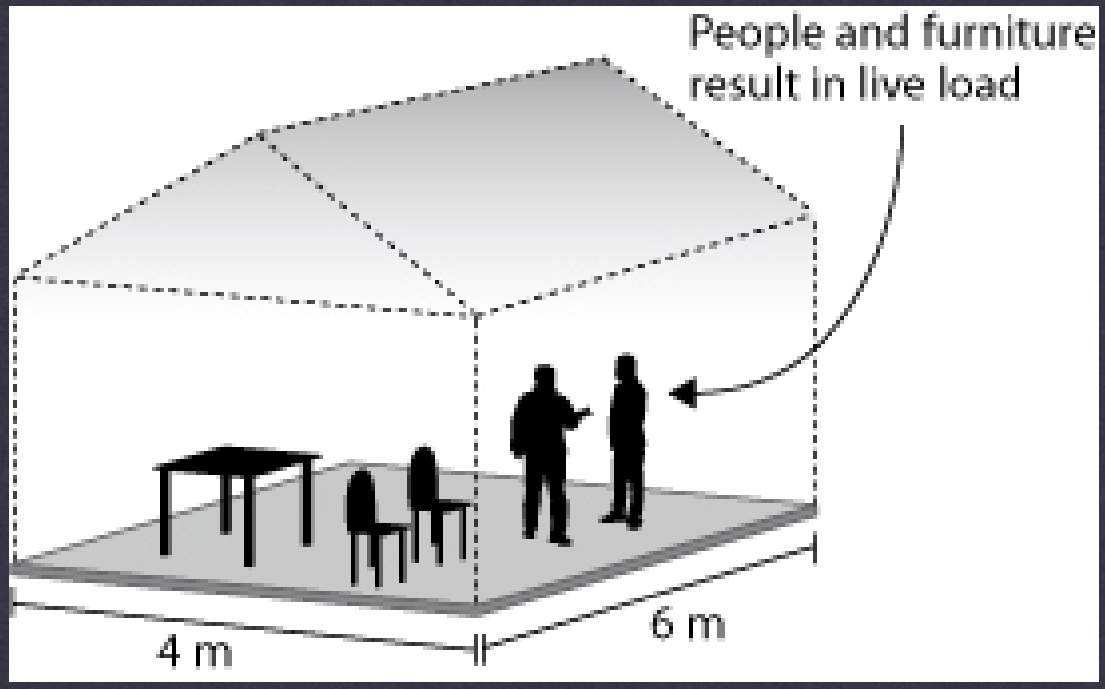

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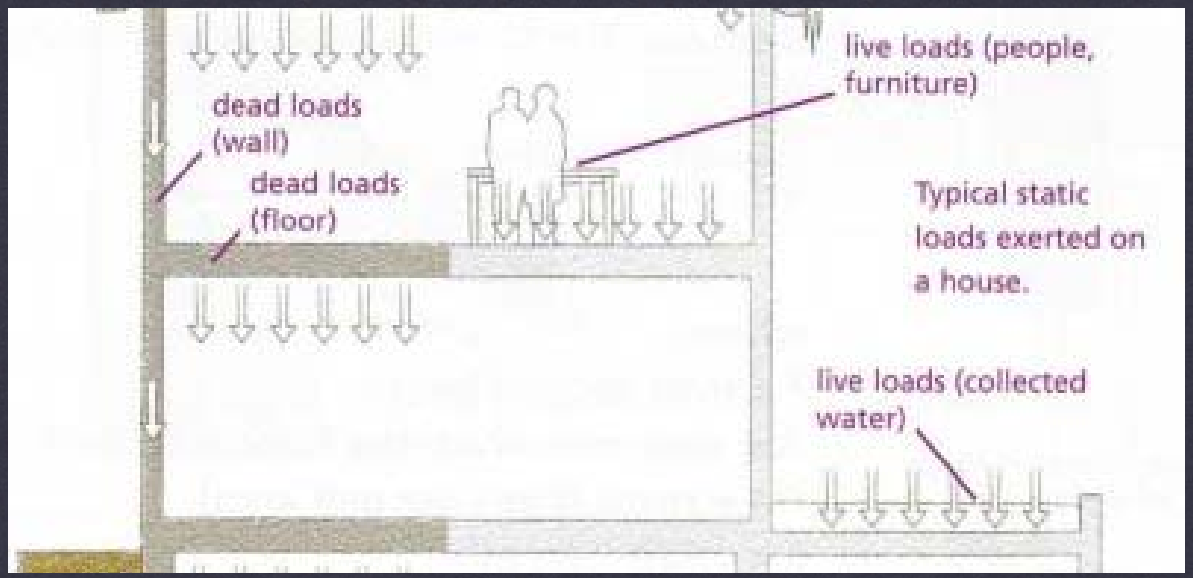

Live Loads- nonpermanent loads caused by the weights of the building's occupants, furnishings, and moveable equipment.

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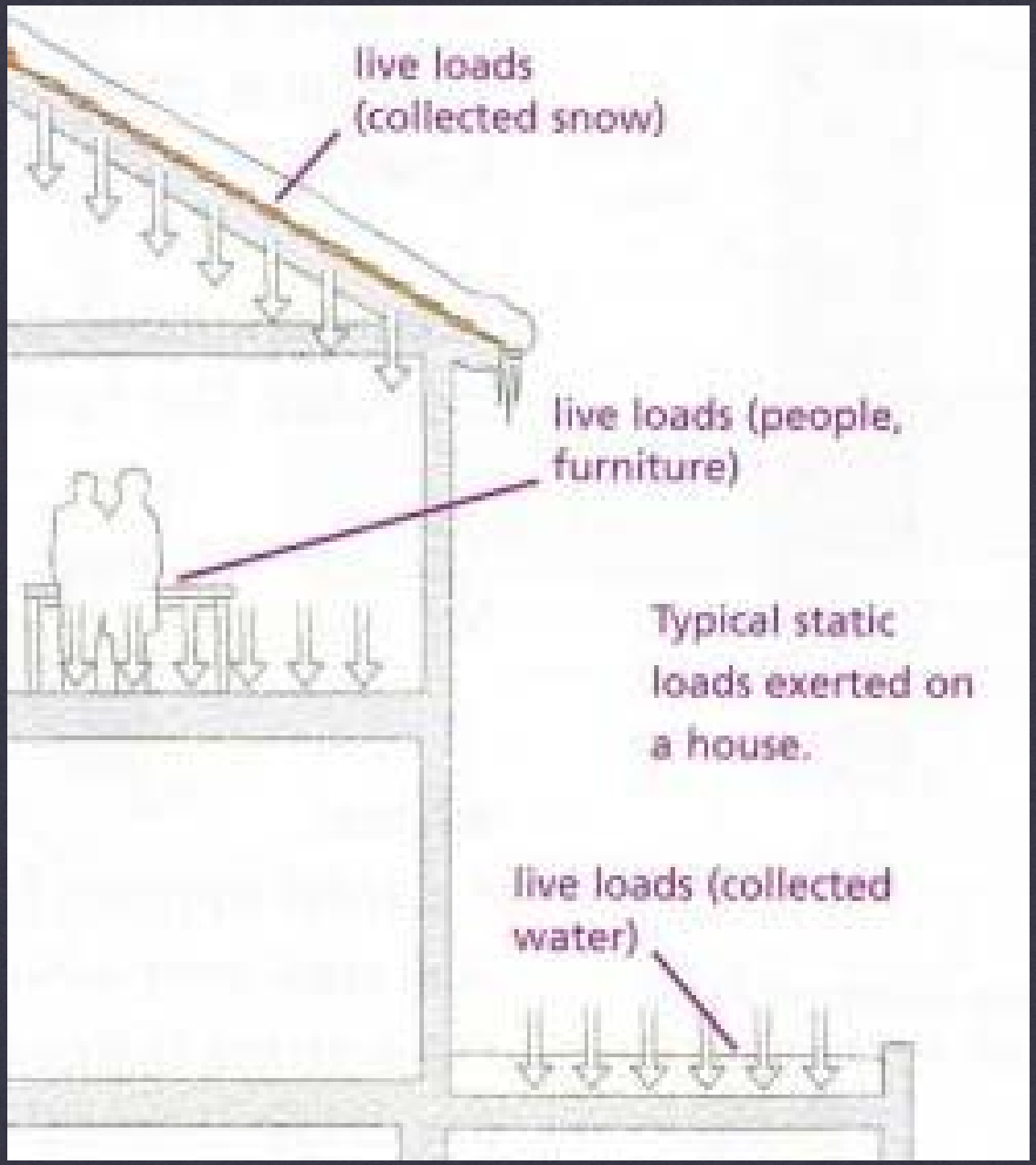

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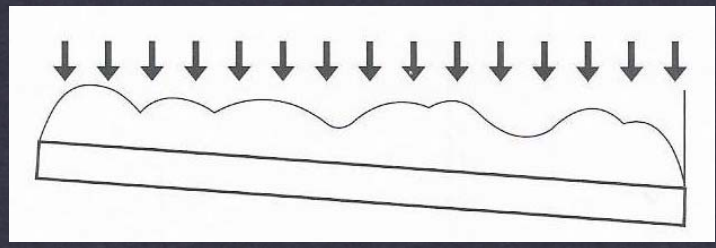

Rain & Snow Loads- act primarily downward on building roofs.

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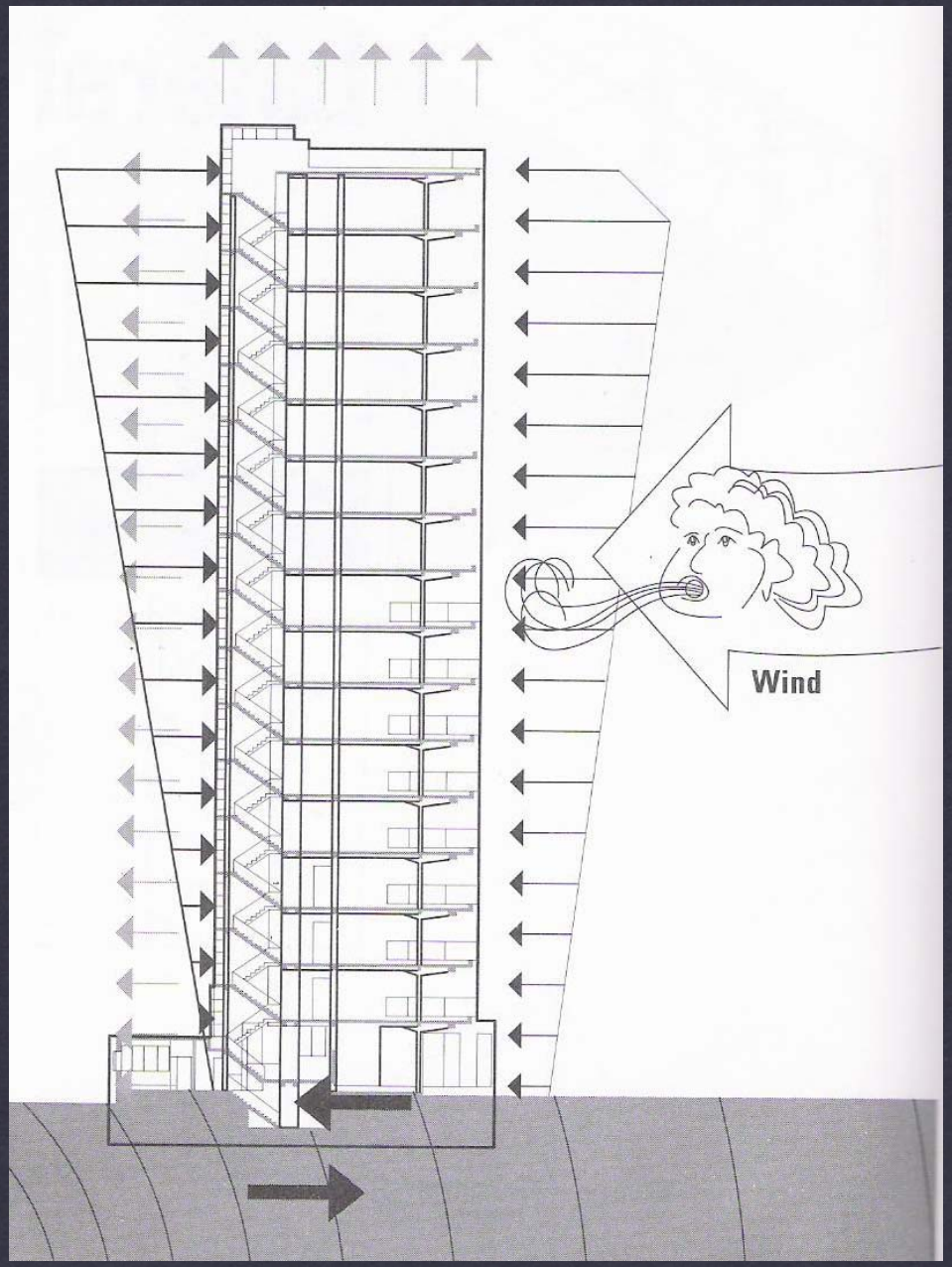

FOUNDATIONS MUST SUPPORT ALL POSSIBLE LOADS:

- DEAD LOADS
- LIVE LOADS
- RAIN & SNOW LOADS
- WIND LOADS

Wind Loads- are dynamic and can act laterally (sideways), downward, or upward on a building.

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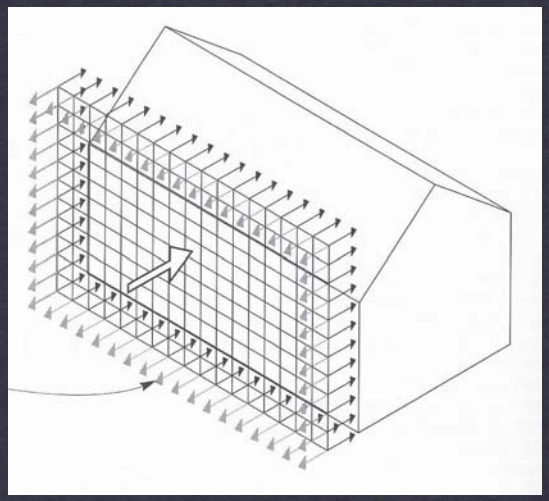

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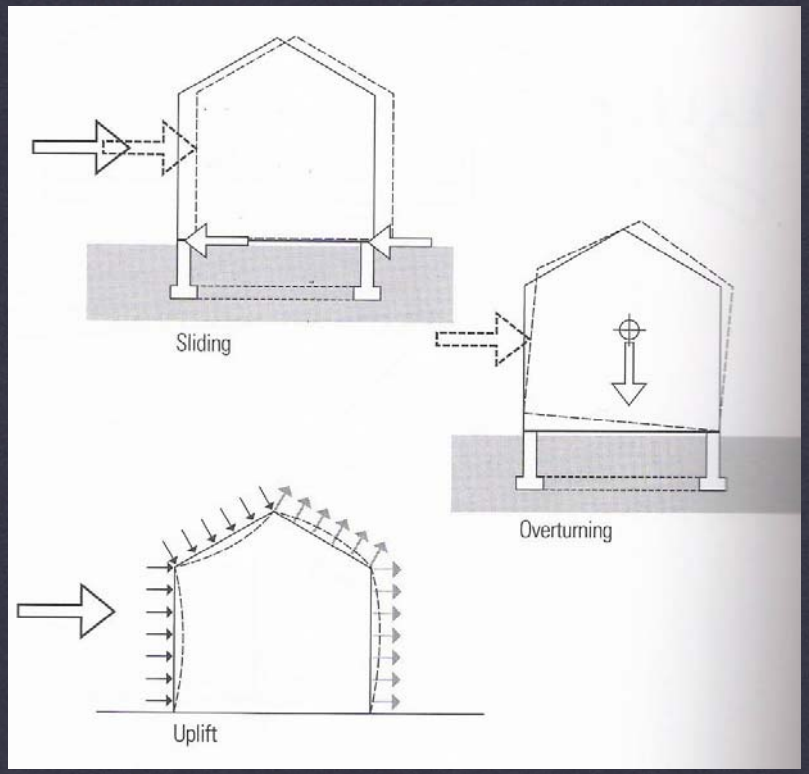

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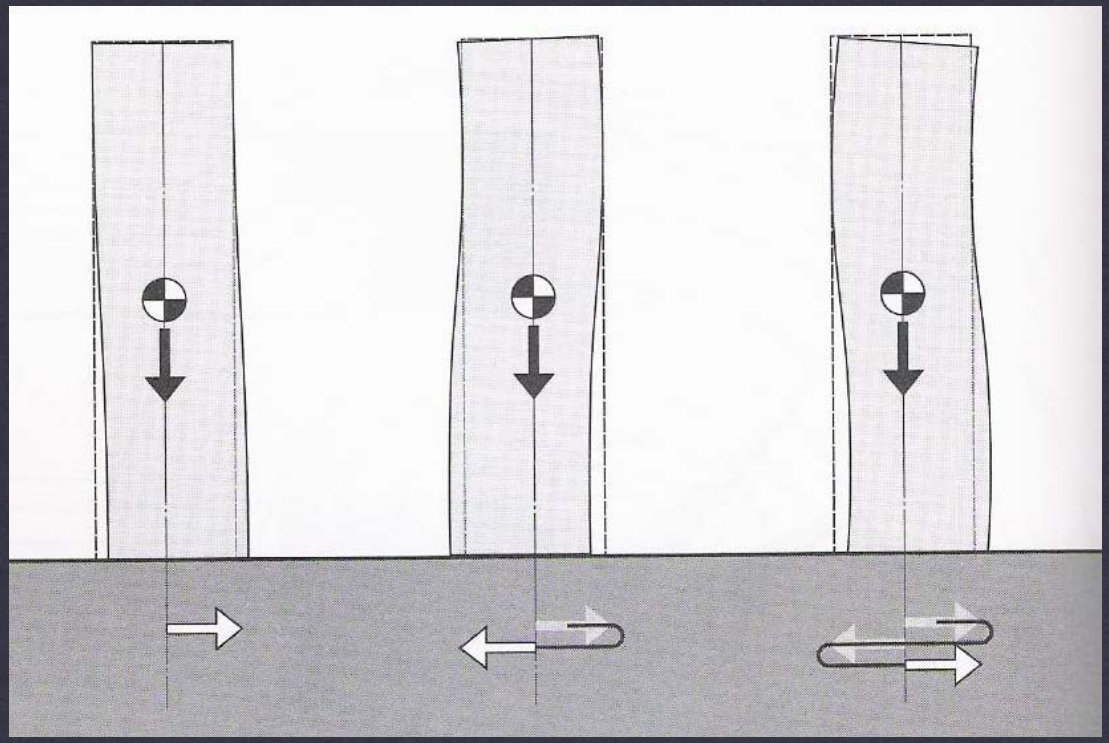

FOUNDATIONS MUST SUPPORT ALL POSSIBLE LOADS:

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- WIND LOADS
- SEISMIC LOADS

Seismic Loads- horizontal and vertical forces caused by the motion of the ground relative to the building during an earthquake.

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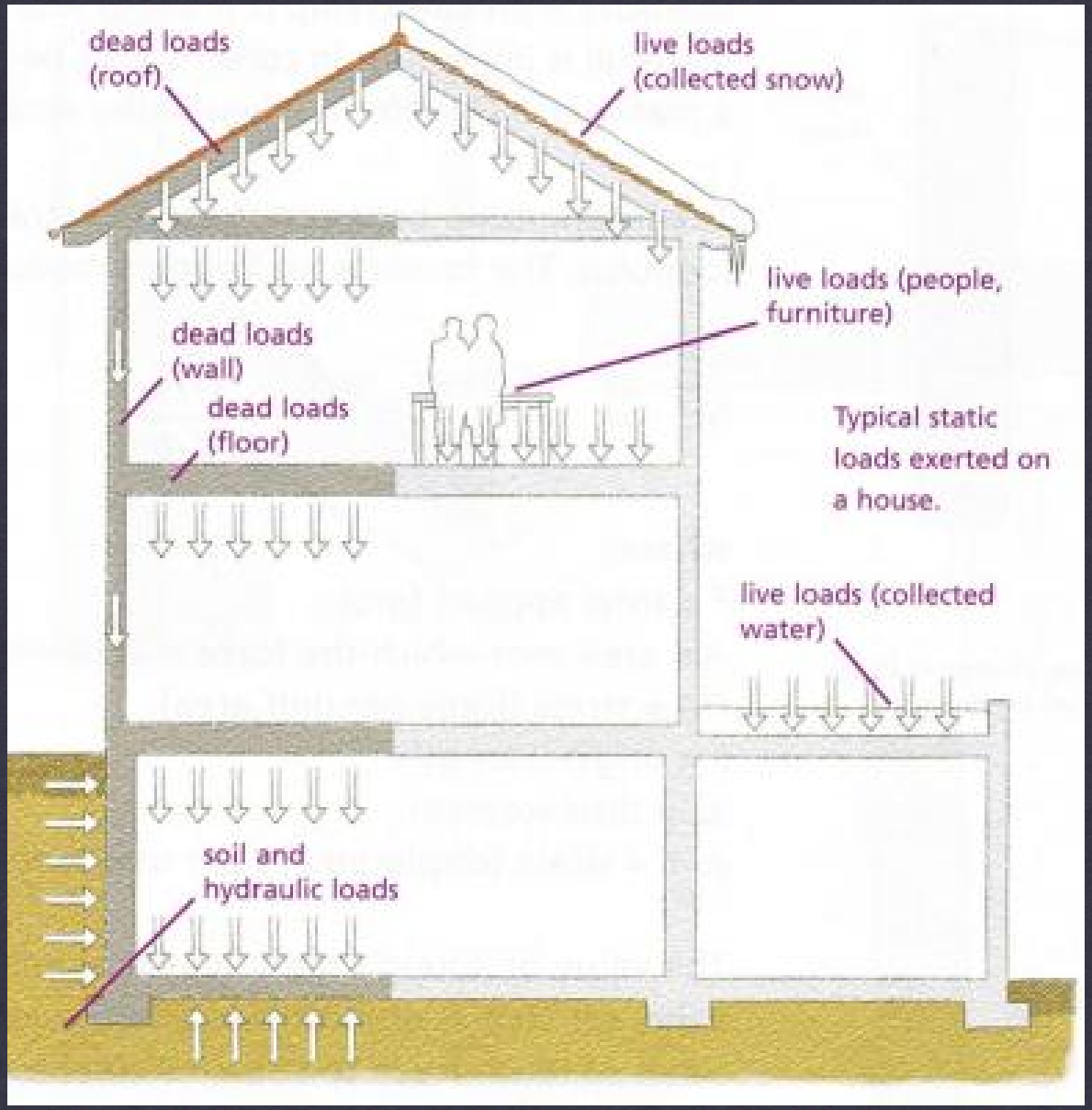

FOUNDATIONS MUST SUPPORT ALL POSSIBLE LOADS:

- DEAD LOADS
- LIVE LOADS
- RAIN & SNOW LOADS
- WIND LOADS
- SEISMIC LOADS
- SOIL & HYDROSTATIC PRESSURE

Soil and Hydrostatic Pressure- horizontal pressures of earth and groundwater against basement walls. Buoyant uplift forces from underground water.

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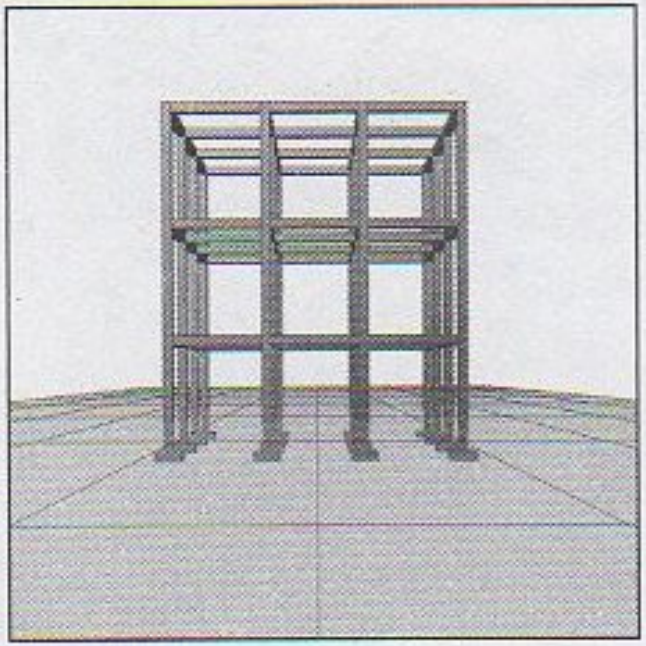
FOUNDATIONS MUST MEET FOLLOWING THREE GENERAL REQUIREMENTS:

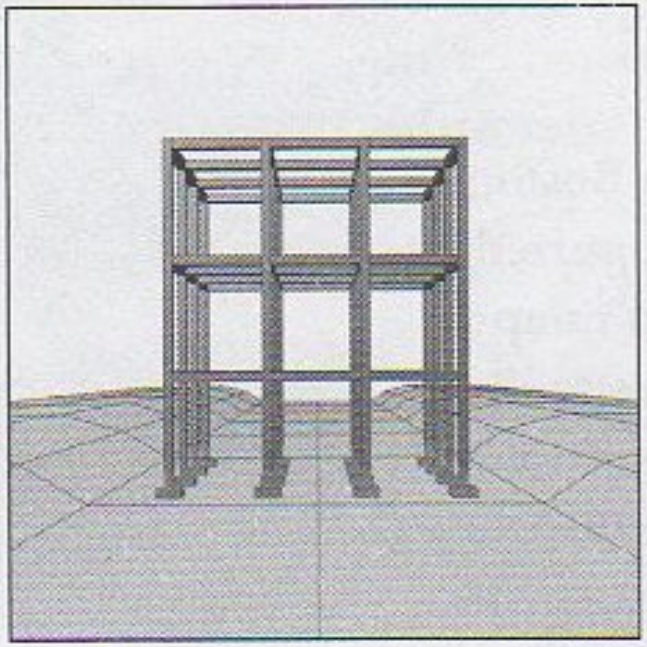
1. MUST BE SAFE AGAINST STRUCTURAL FAILURE THAT COULD RESULT IN COLLAPSE

2. MUST NOT SETTLE DURING LIFE OF BUILDING IN SUCH A WAY THAT WOULD DAMAGE STRUCTURE OR IMPAIR FUNCTION

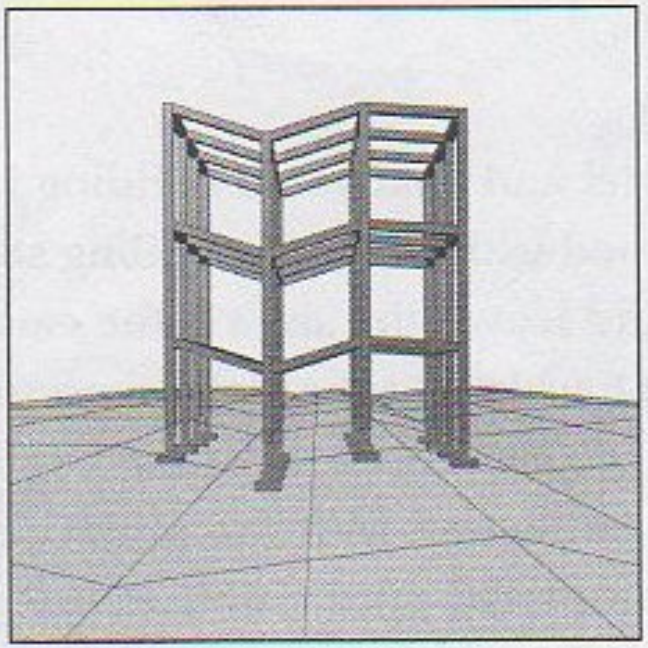
3. MUST BE FEASIBLE, ECONOMICAL, & PRACTICAL (WITH NO IMPACT ON NEIGHBORS)



(a) Building before settlement occurs



(b) Uniform settlement



(c) Differential settlement

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Settlement

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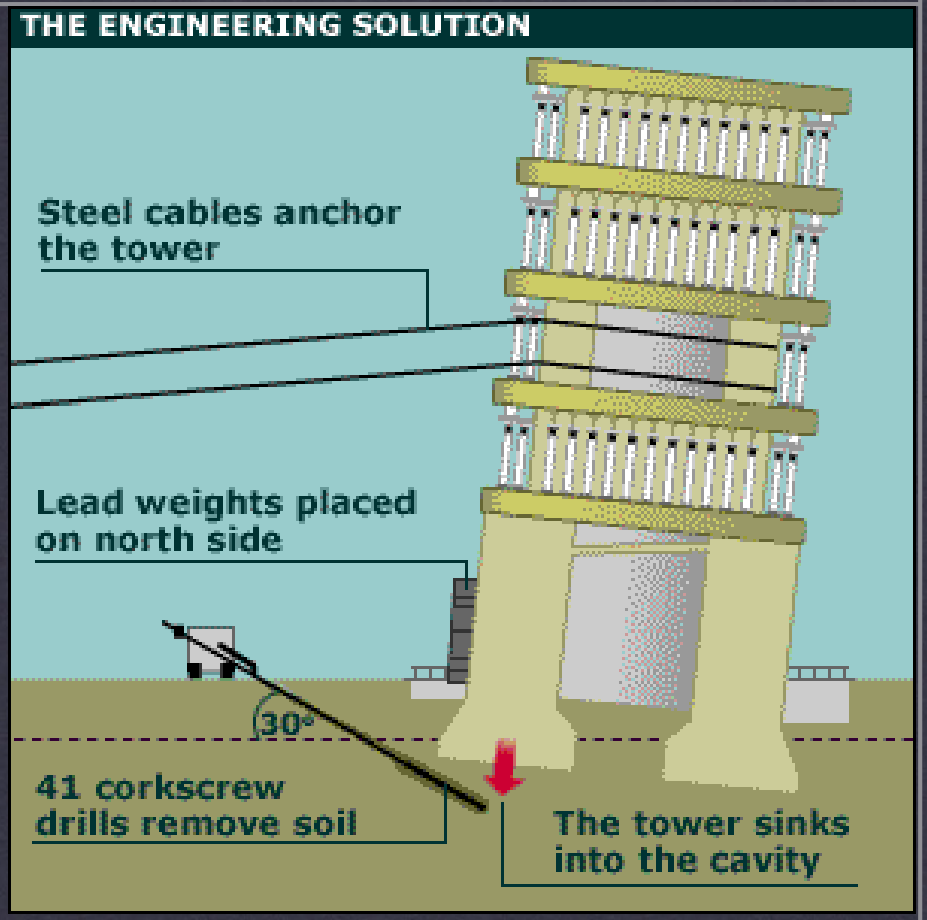

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Earth Materials

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Earth Materials

EARTH MATERIALS ARE CLASSIFIED ACCORDING TO:

- PARTICLE SIZE
- PRESENCE OF ORGANIC CONTENT
- SENSITIVITY TO MOISTURE CONTENT

EARTH MATERIALS CATEGORIES:

- ROCK
- SOIL

A.BOULDER

B.COBBLE

C.GRAVEL

D.SAND

E.SILT

F.CLAY

G.ORGANIC SOILS

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Earth Materials

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			Group Symbols	Typical Names
Coarse-Grained Soils	Gravels	Clean Gravels	GW	Well-graded gravels, gravel–sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel–sand mixtures, little or no fines
		Gravels with Fines	GM	Silty gravels, poorly graded gravel–sand–silt mixtures
			GC	Clayey gravels, poorly graded gravel–sand–clay mixtures
	Sands	Clean Sands	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		Sands with Fines	SM	Silty sands, poorly graded sand–silt mixtures
			SC	Clayey sands, poorly graded sand–clay mixtures
Fine-Grained Soils	Silts and Clays (Liquid limit greater than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silt–clays of low plasticity
	Silts and Clays (Liquid limit less than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity
	Highly Organic Soils		Pt	Peat and other highly organic soils

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EARTH MATERIALS PROPERTIES:

A.STRENGTH OF PARTICLES

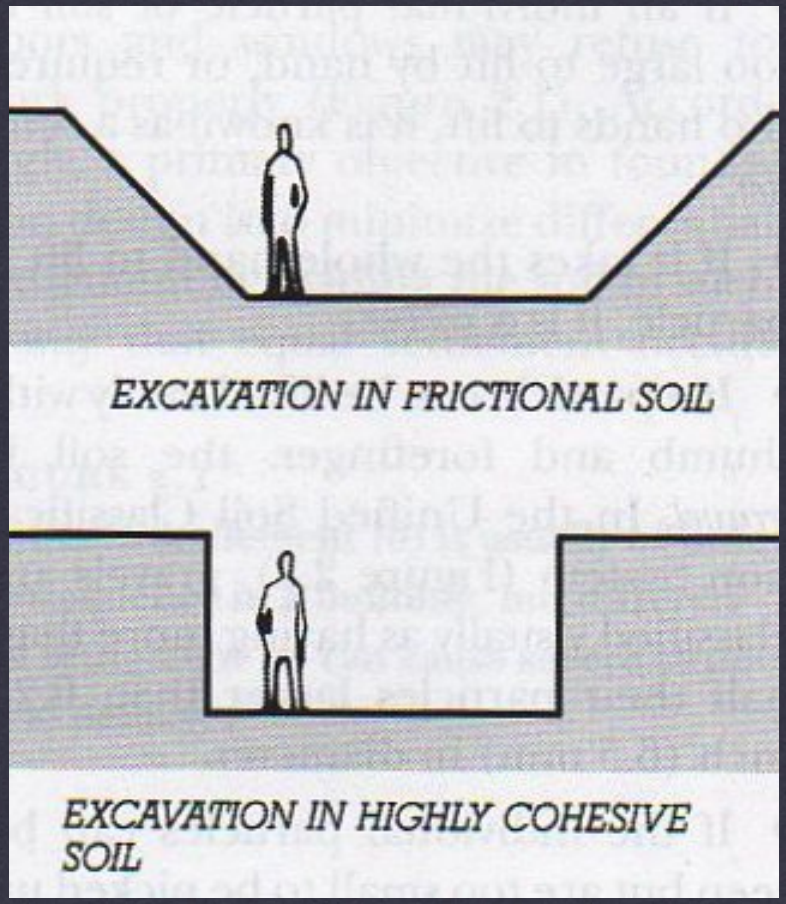
B.SHEAR RESISTANCE (FRICTION BETWEEN PARTICLES)

i. FRICTIONAL OR COHESIONLESS

C.STABILITY

i. POTENTIAL TO CHANGE DUE TO MOISTURE CONTENT

D.DRAINAGE CHARACTERISTICS



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D.DRAINAGE CHARACTERISTICS

-Well graded vs. Uniformly graded

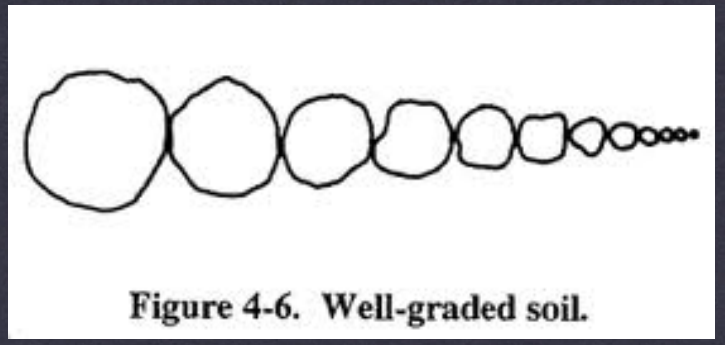


Figure 4-6. Well-graded soil.

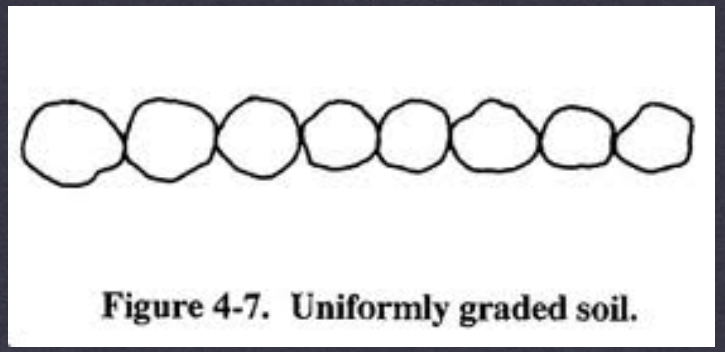
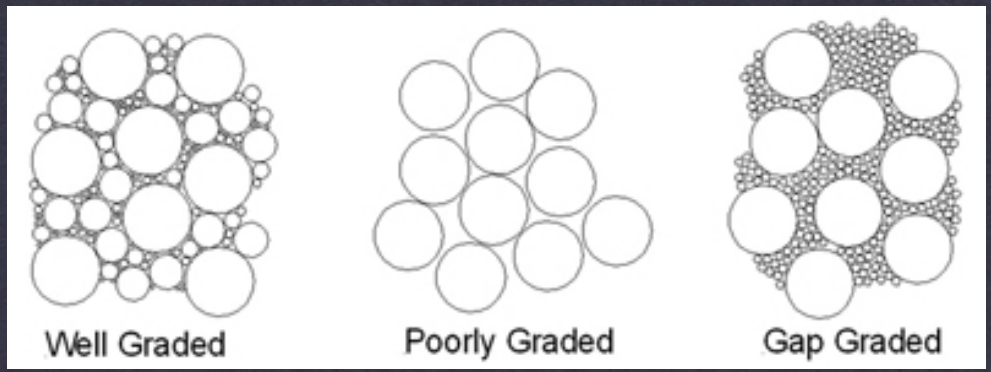


Figure 4-7. Uniformly graded soil.



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Other issues:

1.Frost

2. Expansive soils

3.Erosion

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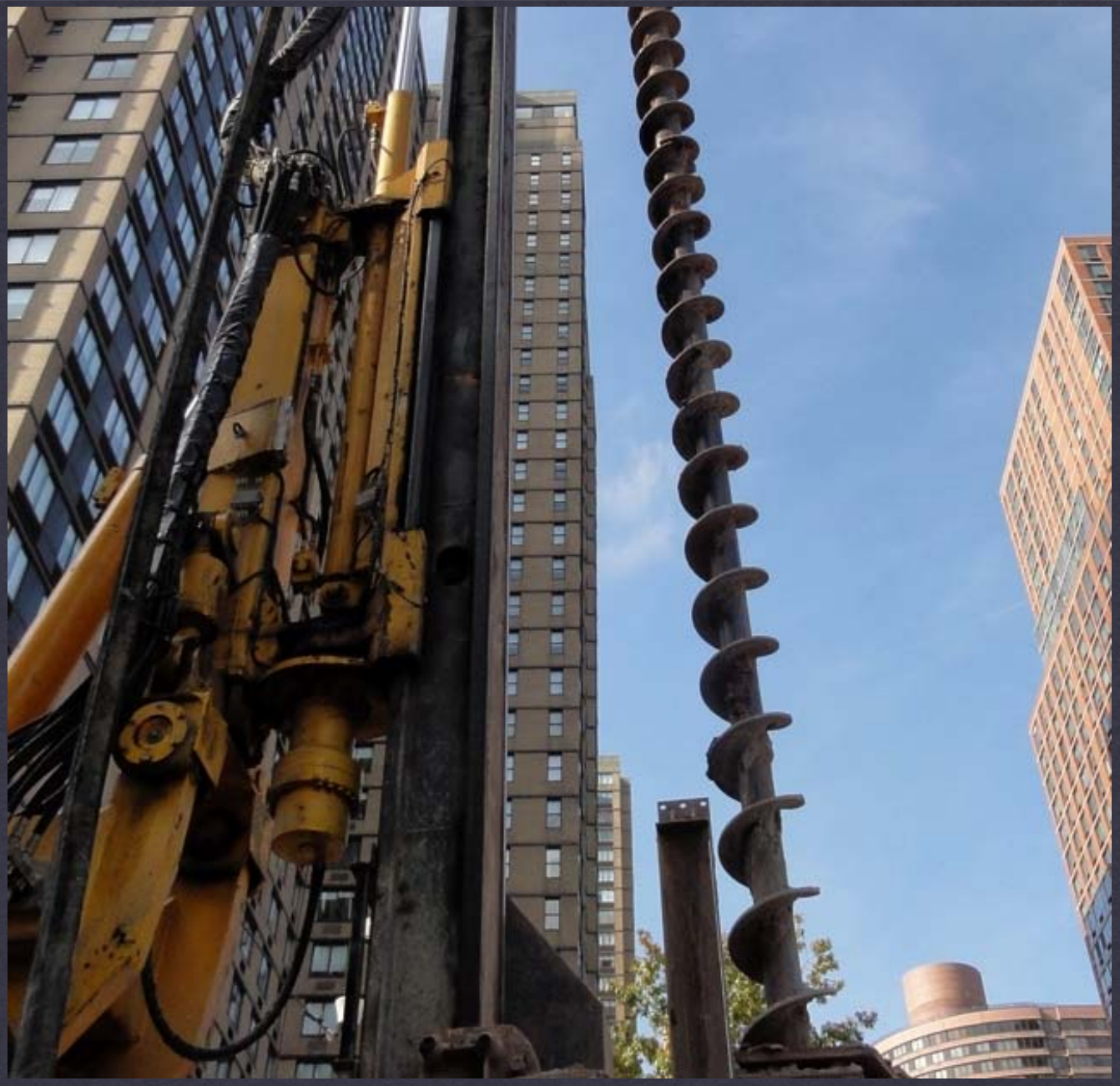

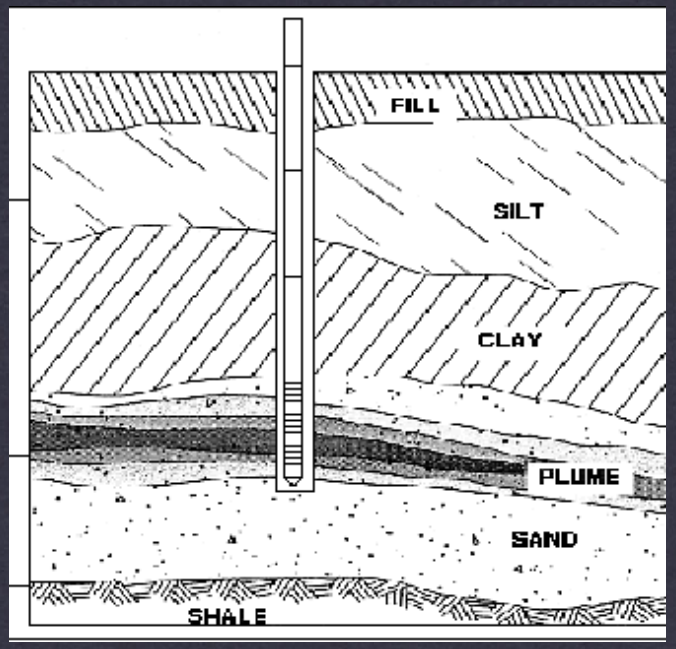

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Geotechnical (Subsurface) Investigation

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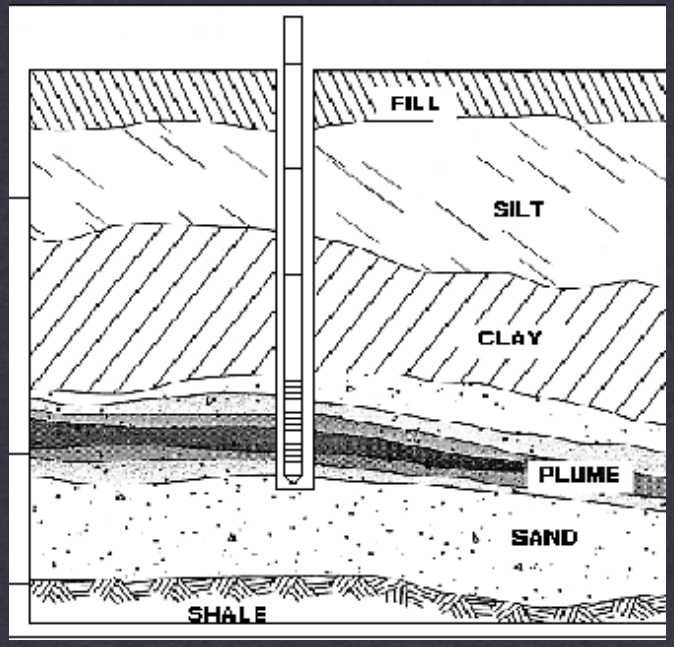
SOIL DESCRIPTION	DEPTH
Topsoil	0.5'
Loose silt, some fine sand and clay (ML)	6.5'
Loose to medium dense fine to coarse sand, some silt, trace of fine gravel (SM)	20.5'
Medium dense fine to coarse sand, some silt (SM)	30.5'
Medium dense silt, some fine sand (ML)	34.5'
Medium dense fine to coarse sand, some silt, trace fine gravel (SP-ML)	40'
Medium dense silt, some fine sand (ML)	43'
Firm to stiff clay, some silt (CL)	52.5'
Very dense fine to coarse sand, some silt, trace fine to coarse gravel (SP-SM)	84'



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Geotechnical (Subsurface) Investigation

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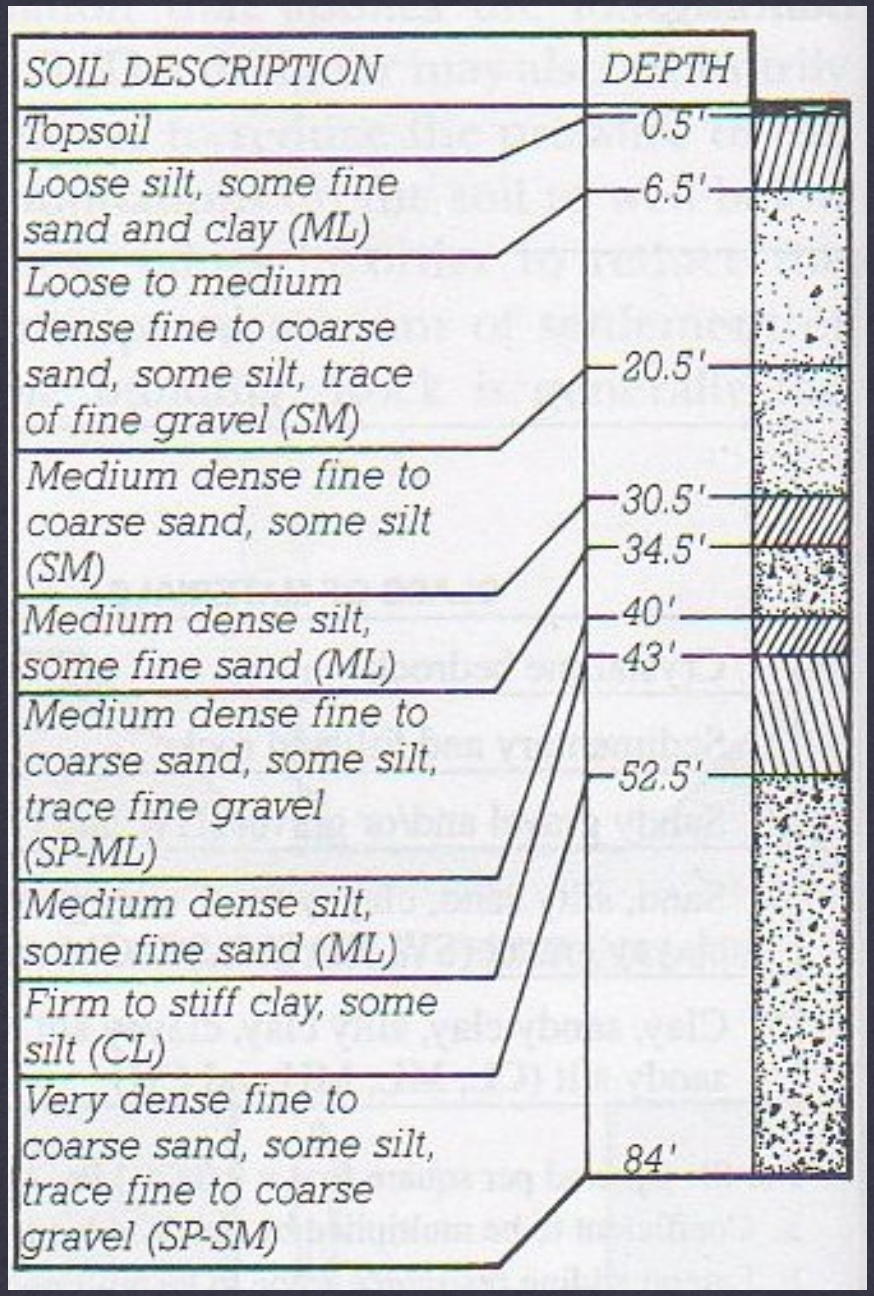

DETERMINE SOIL AND WATER CONDITIONS BENEATH THE SITE:

- DIG A TEST PIT (VIABLE UP TO 16’ DEPTH)
- CORE DRILL TEST BORING (DEPTH LIMIT BASED ON REACH OF EQUIPMENT)

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Geotechnical (Subsurface) Investigation

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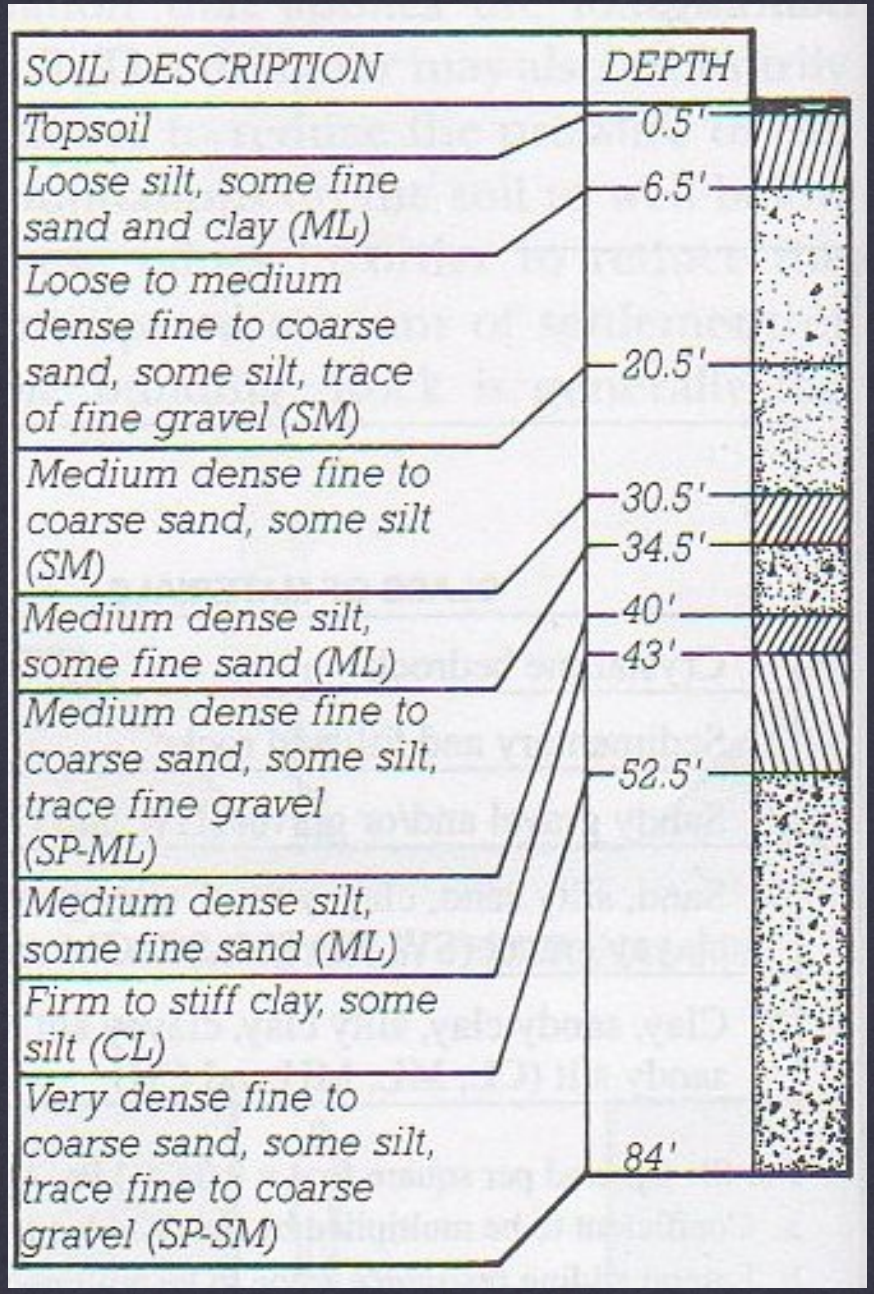

USE TEST PIT OR TEST BORING TO DETERMINE:

- WATER TABLE (WHERE SOIL IS SATURATED)
- SAMPLES TAKEN TO A LABORATORY EXAMINE THE PROPERTIES OF THE EARTH MATERIALS BENEATH THE SITE

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Soil Bearing Capacity

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TABLE 1804.2
ALLOWABLE FOUNDATION AND LATERAL PRESSURE

CLASS OF MATERIALS	ALLOWABLE FOUNDATION PRESSURE (psf)[d]	LATERAL BEARING (psf/f below natural grade)[d]	LATERAL SLIDING	
			Coefficient of friction[a]	Resistance (psf)[b]
1. Crystalline bedrock	12,000	1,200	0.70	—
2. Sedimentary and foliated rock	4,000	400	0.35	—
3. Sandy gravel and/or gravel (GW and GP)	3,000	200	0.35	—
4. Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000	150	0.25	—
5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500[c]	100	—	130

For SI: 1 pound per square foot = 0.0479 kPa, 1 pound per square foot per foot = 0.157 kPa/m.

a. Coefficient to be multiplied by the dead load.

b. Lateral sliding resistance value to be multiplied by the contact area, as limited by Section 1804.3.

c. Where the building official determines that 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.

d. An increase of one-third is permitted when considering load combinations, including wind or earthquake loads, as permitted by Section 1605.3.2.

ON SITE AND LABORATORY INVESTIGATION CAN DETERMINE:

- THE ALLOWABLE FOUNDATION PRESSURE FOR THE GIVEN EARTH MATERIALS BENEATH THE SITE

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Excavations

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EXCAVATION PROCESS:

- SLOPED / LAID BACK EXCAVATION

A. ANGLE OF REPOSE

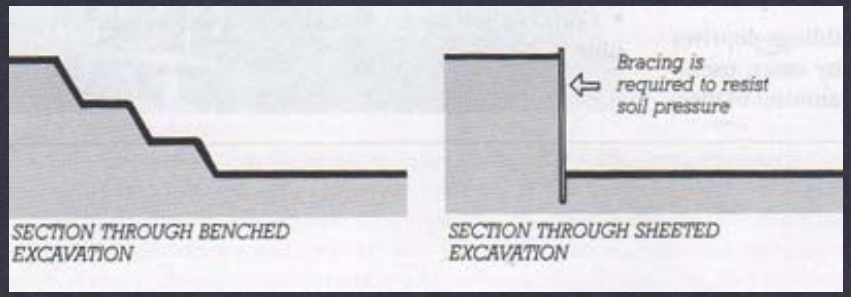
i. BENCHED EXCAVATION

ii. SLOPE SUPPORT/SHORING

A.SOLDIER BEAMS & LAGGING

B.SHEET PILING

C.SLURRY WALL



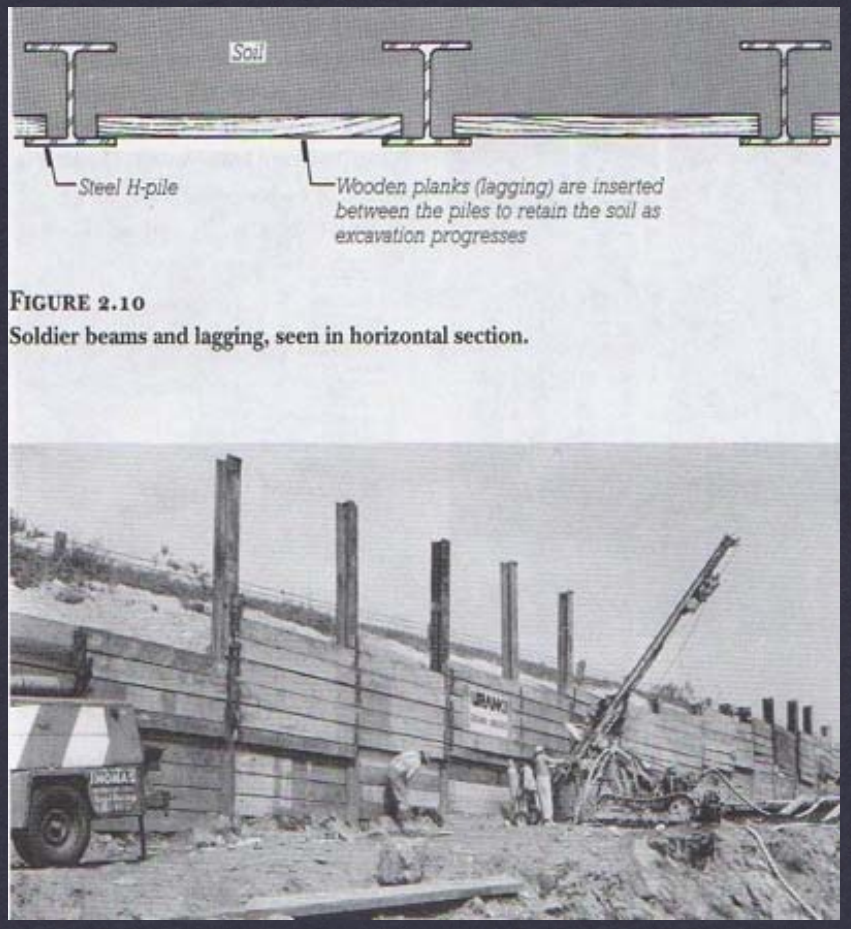


FIGURE 2.10
Soldier beams and lagging, seen in horizontal section.

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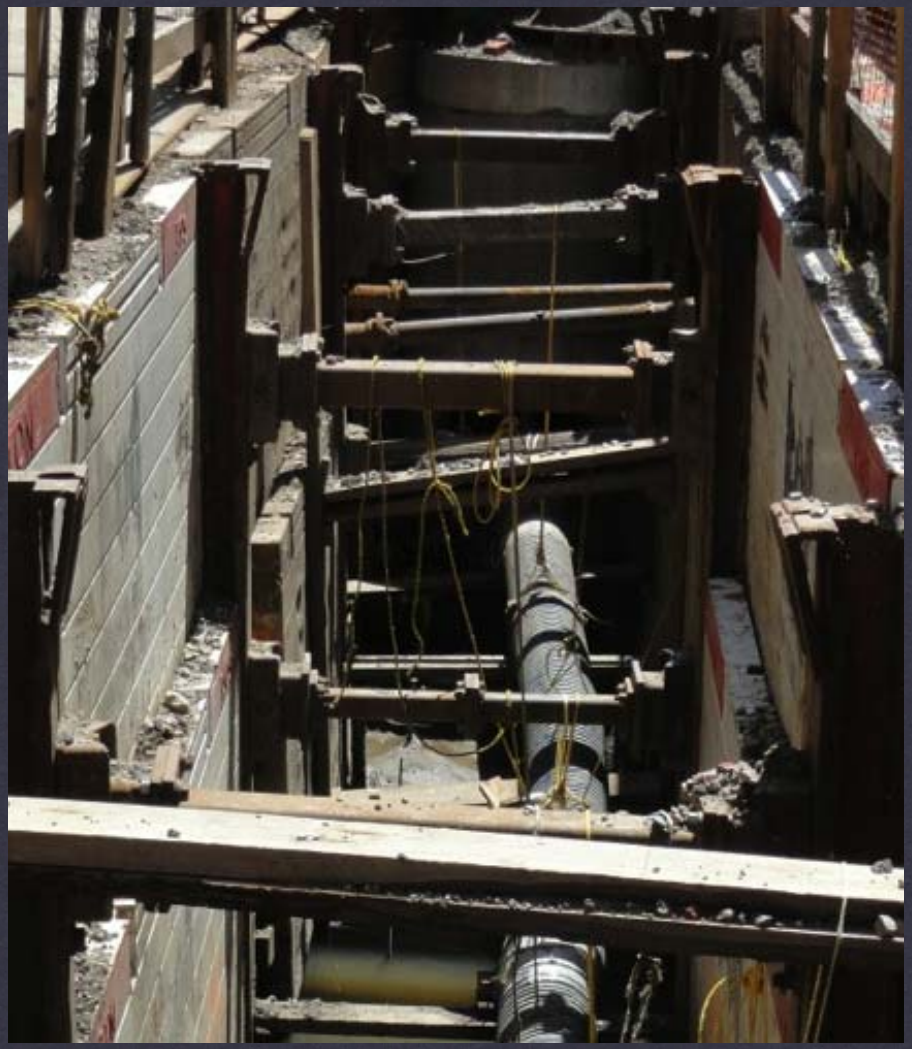

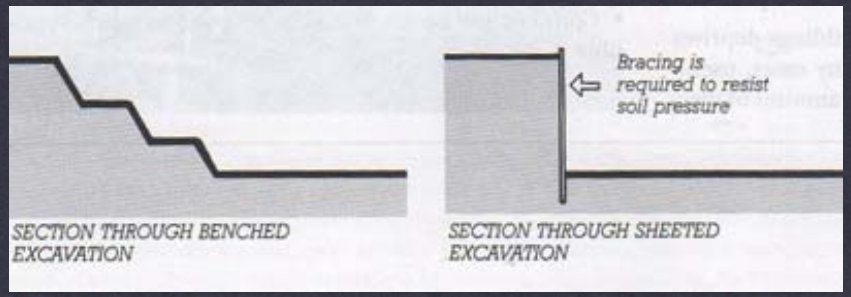

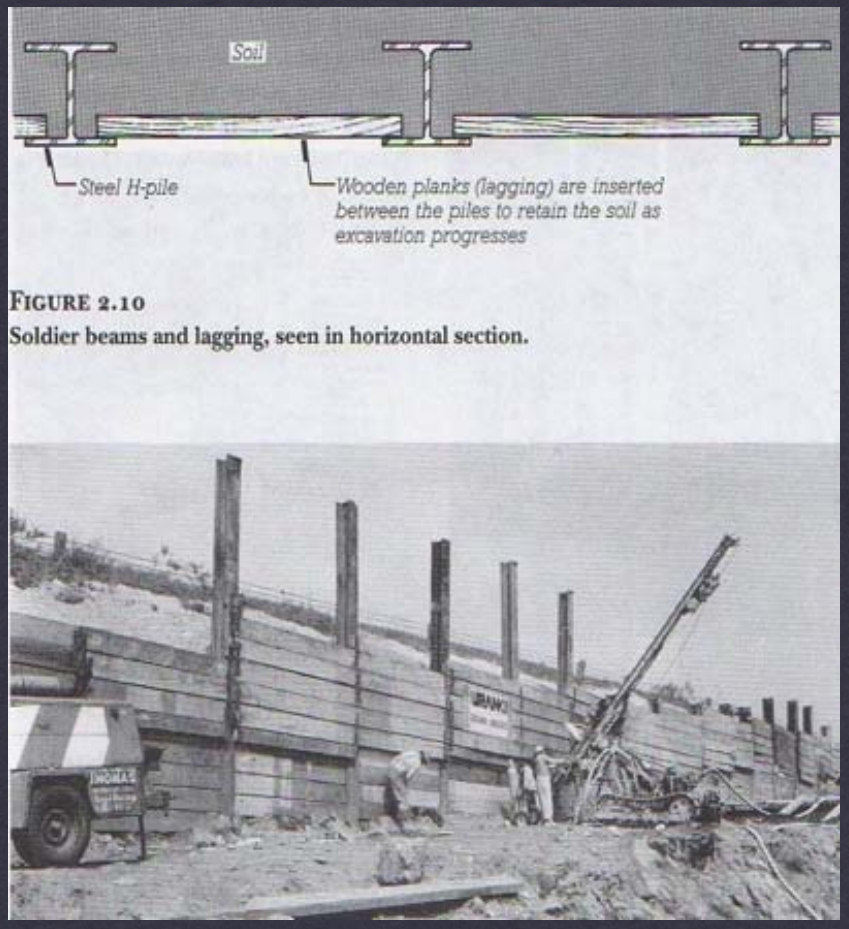

FIGURE 2.10
Soldier beams and lagging, seen in horizontal section.

SOLDIER BEAMS & LAGGING

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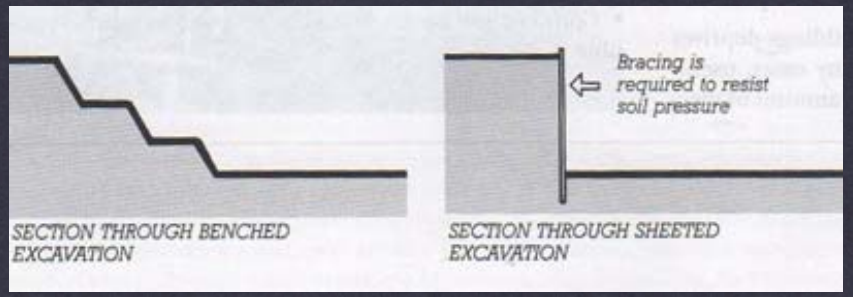

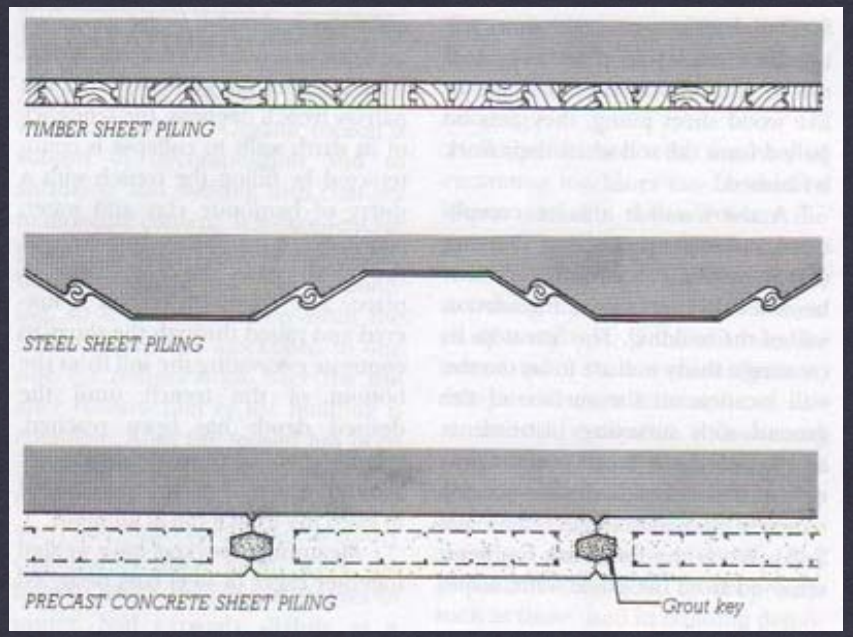

SHEET PILING

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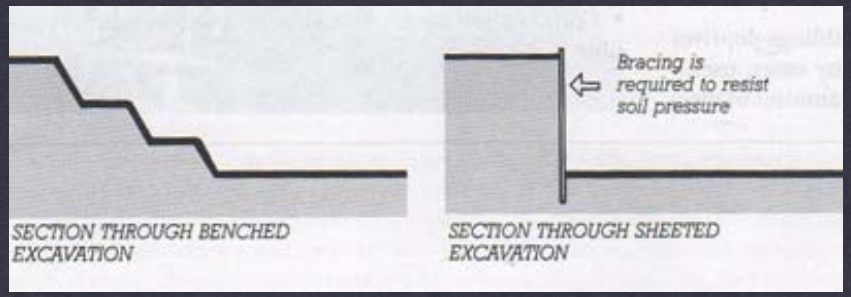
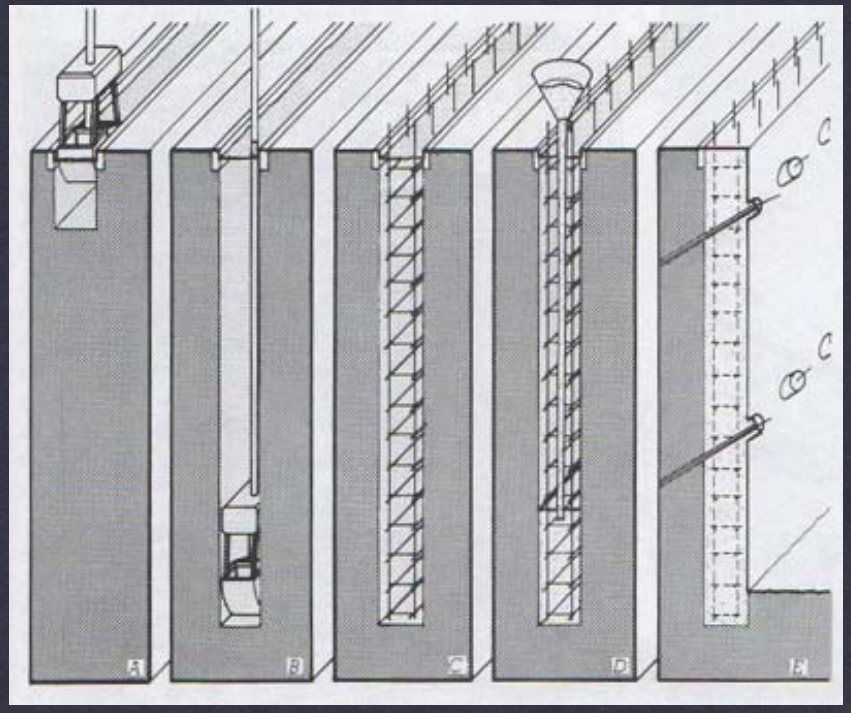
SLURRY WALL





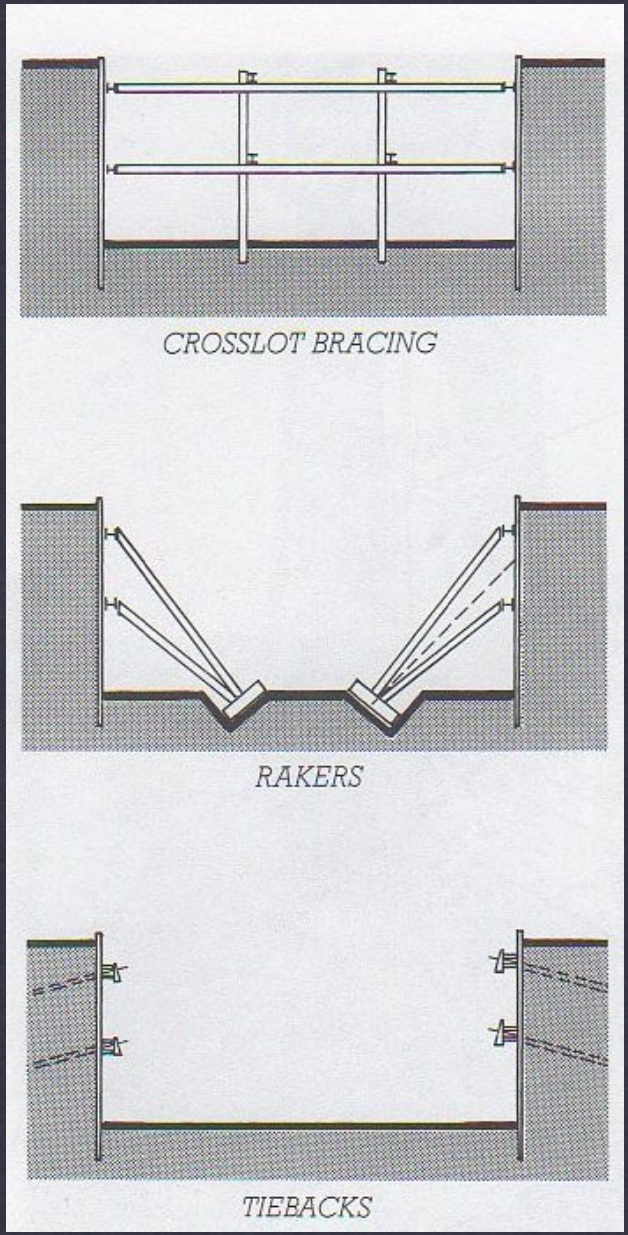
SLOPE SUPPORT

- BRACING

D. CROSSLOT

E.RAKERS

F.TIEBACKS



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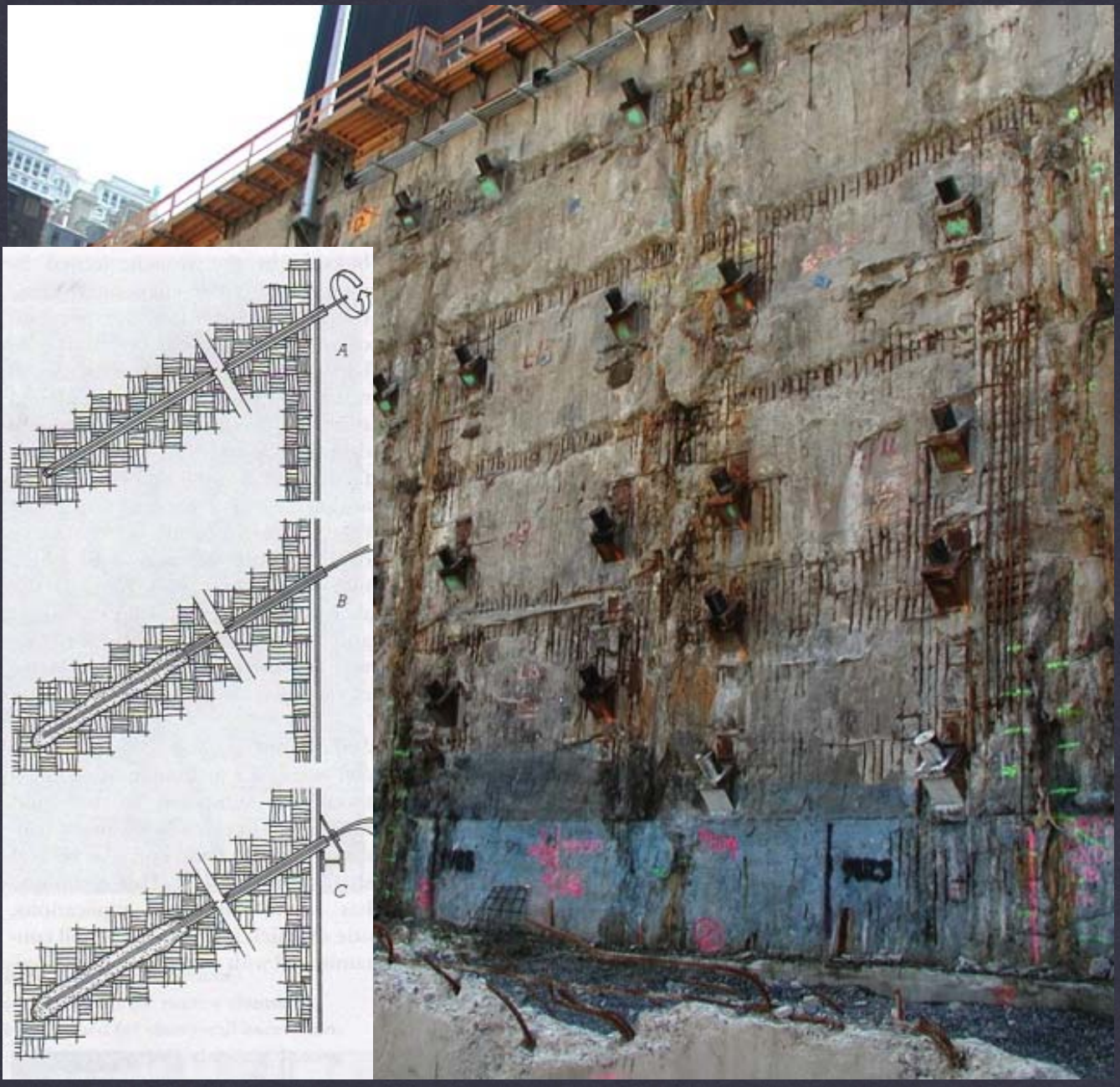

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Spread the Load into the Earth

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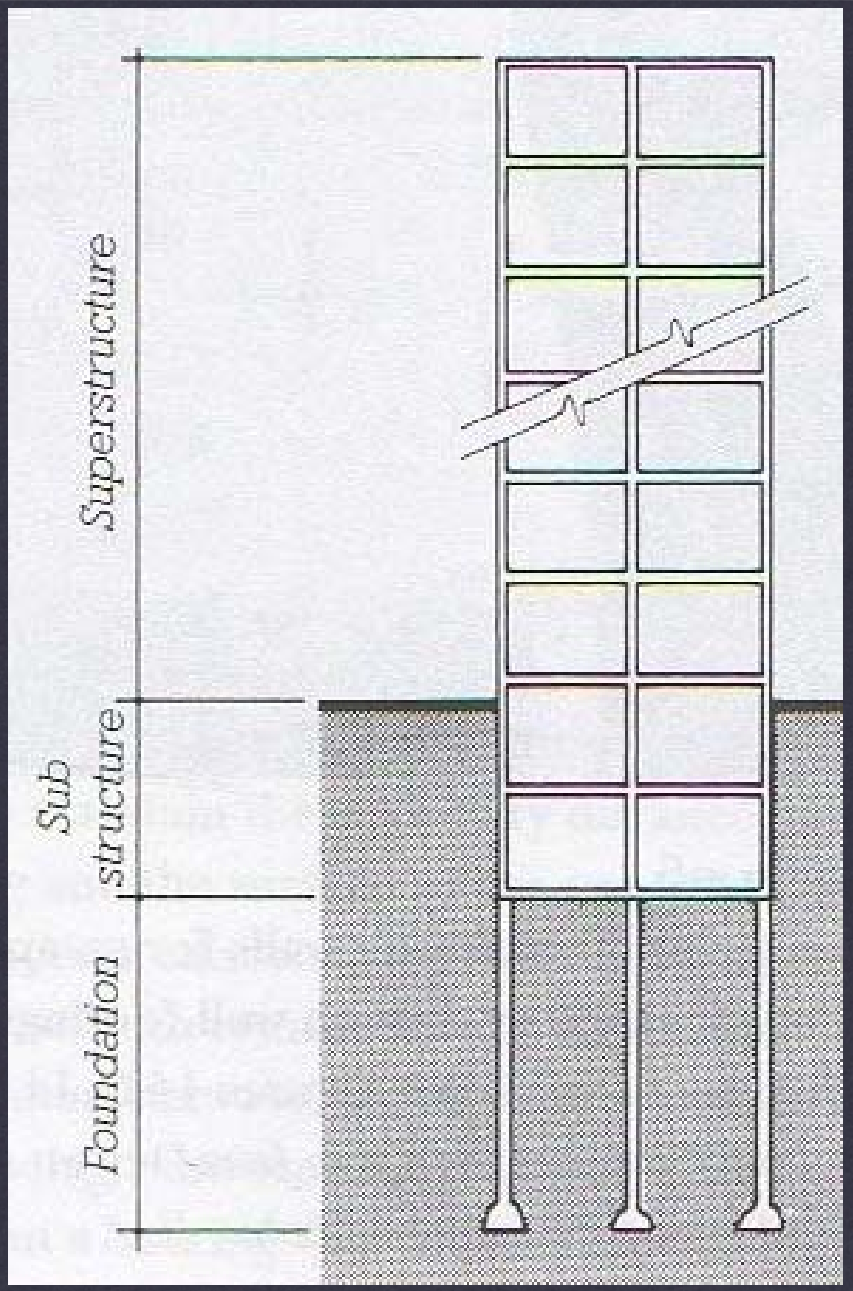

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Shallow Foundations

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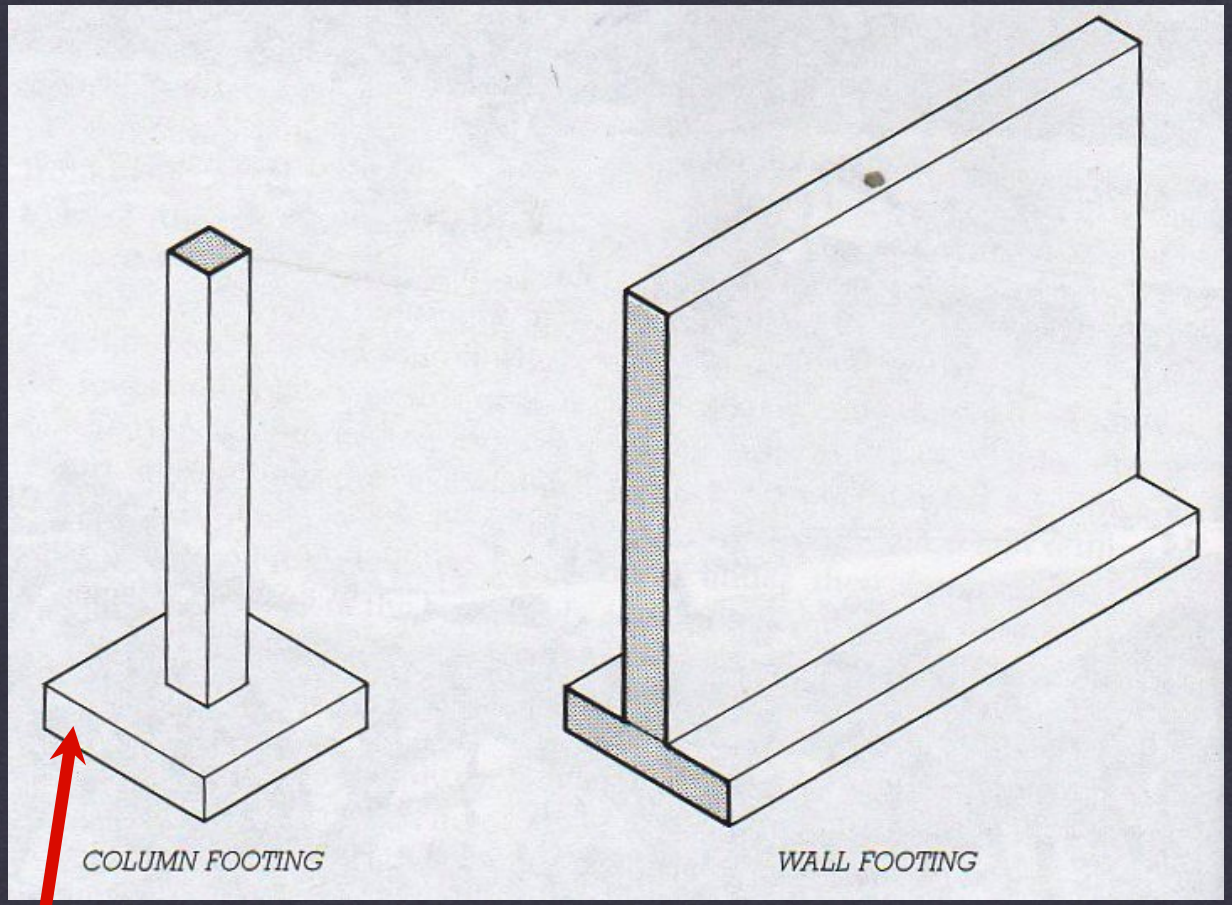
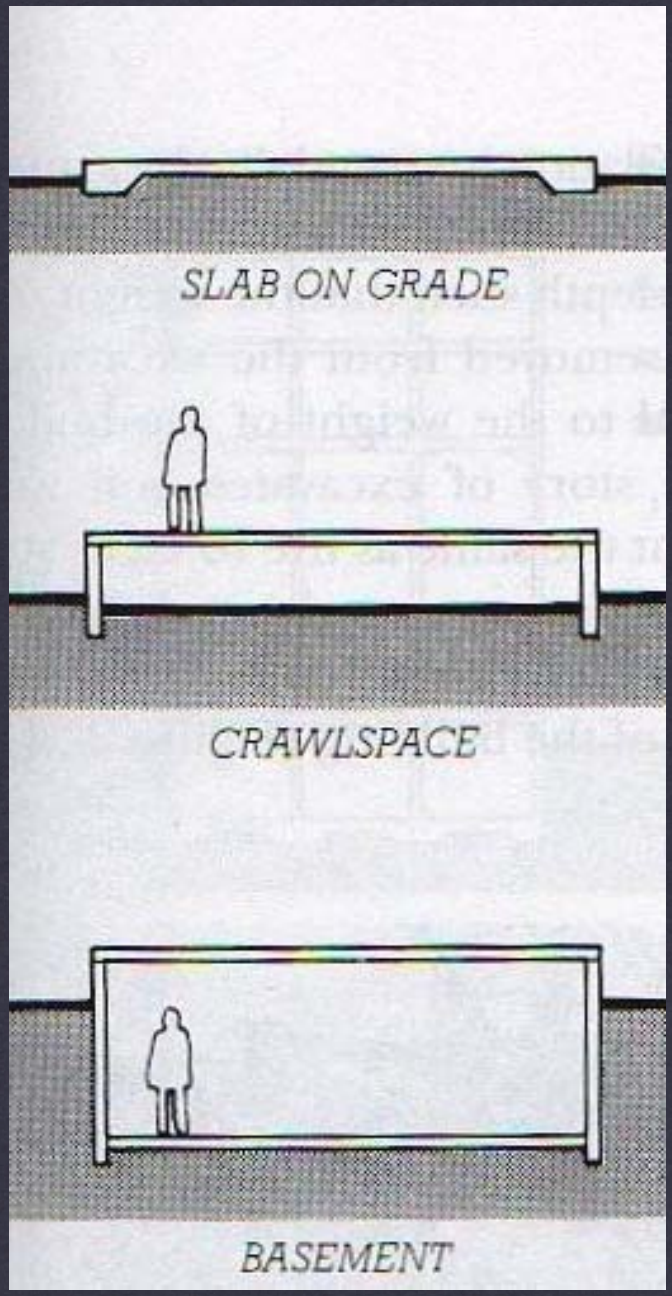
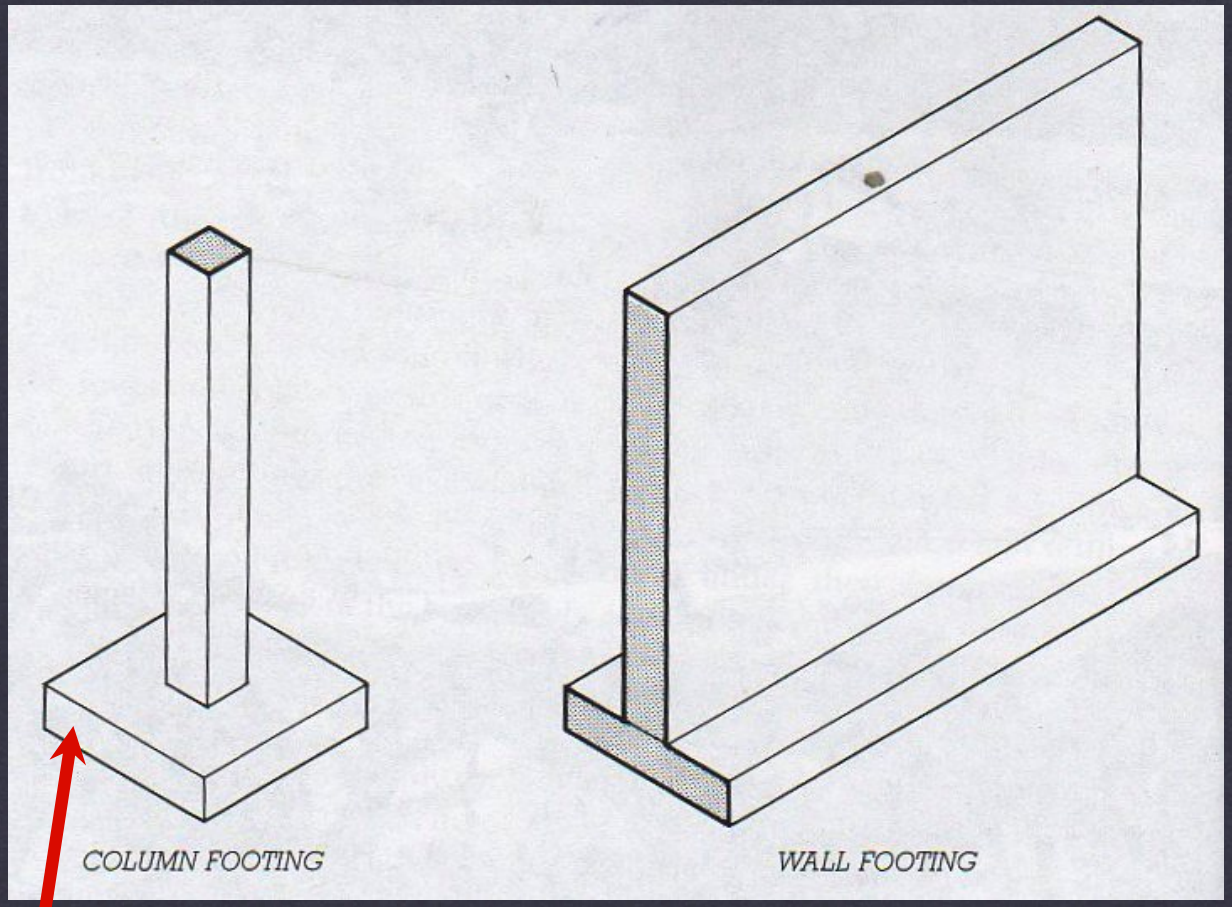


SPREAD FOOTING SITS UNDER VERTICAL FOUNDATION WALL OR COLUMN



Shallow Foundations

SPREAD FOOTING



SPREAD FOOTING SITS UNDER VERTICAL FOUNDATION WALL OR COLUMN

TAKES LOAD OF STRUCTURE ABOVE AND SPREADS IT ONTO THE EARTH MATERIAL BELOW.
THE WIDTH OF THE SPREAD FOOTING IS DETERMINED BY THE ALLOWABLE BEARING PRESSURE AS DEFINED BY THE GEOTECHNICAL ENGINEER.

FOUNDATIONS

Professor Friedman

Shallow Foundations

ARCH 1230

FOUNDATIONS

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Shallow Foundations

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Floating Foundations

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FLOATING FOUNDATION

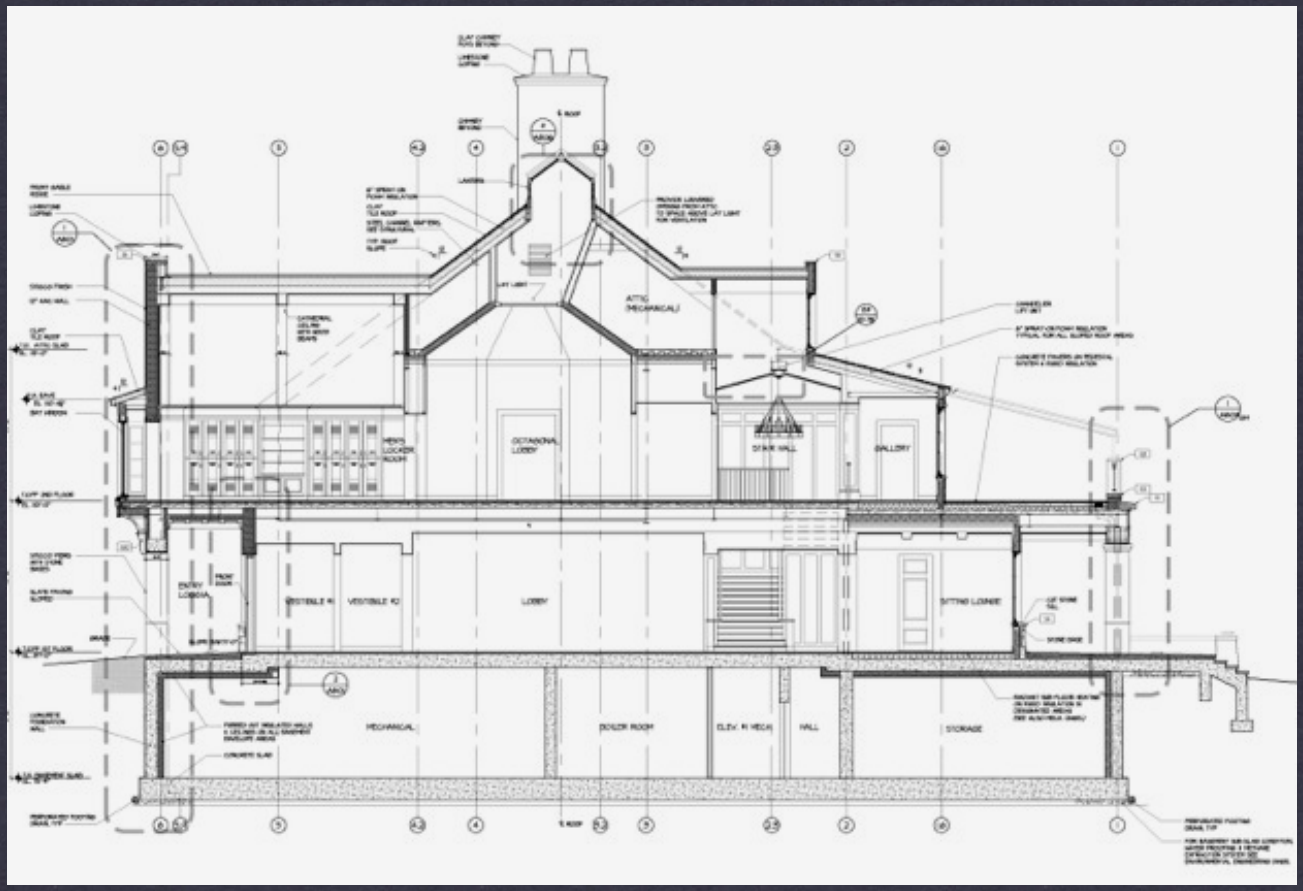
REQUIRED WHEN THE EARTH MATERIAL BELOW THE SITE DOES NOT HAVE ADEQUATE BEARING CAPACITY FOR THE STRUCTURE

A THICK SLAB EQUAL TO THE FULL FOOTPRINT OF THE BUILDING MAXIMIZES THE SPREAD OF THE LOAD. THE BUILDING “FLOATS”.

Floating Foundations

FLOATING FOUNDATION

THE THICK SLAB DISTRIBUTES THE LOAD ACROSS THE FULL FOOTPRINT OF THE STRUCTURE
IT ALSO SERVES TO STRENGTHEN THE STRUCTURE IN CASE THERE IS SETTLEMENT.



wrap up:

FOUNDATIONS ARE THE FIRST CRITICAL ELEMENT OF THE STRUCTURE OF ALL BUILDINGS. ALL BUILDINGS MUST TRANSFER THEIR LOAD SAFELY TO THE EARTH AND RESIST FORCES OVER THE LIFETIME OF THE STRUCTURE.

- all foundation design starts with investigation of the earth under the building site
- the geotechnical engineer write a report on the site conditions and makes recommendations to the architect and structural engineer
- the configuration of foundations reflects the conditions of the earth under the site as well as the structure rising into the sky.