Green Building Roundtable:

Current Construction Techniques and Deep Energy Retro-Fits

January 8, 2010

ECOSTAR

Roundtable Discussion Framework:

8:00 AM **Welcome and Introductions**

8:15 AM **Efficient Foundation Construction Practices – Troy Gonyon**
Geotechnical engineering techniques for dry and stable foundations

Discussion

9:00 AM **Break**

9:15 AM **Deep Energy Retro-fits** - new and existing buildings

Discussion

9:45 AM **Resources**
-Federal Funding Programs for Efficiencies and Deep Energy Retrofits
-Others?

9:50 AM **Upcoming Roundtable topics/ideas?**

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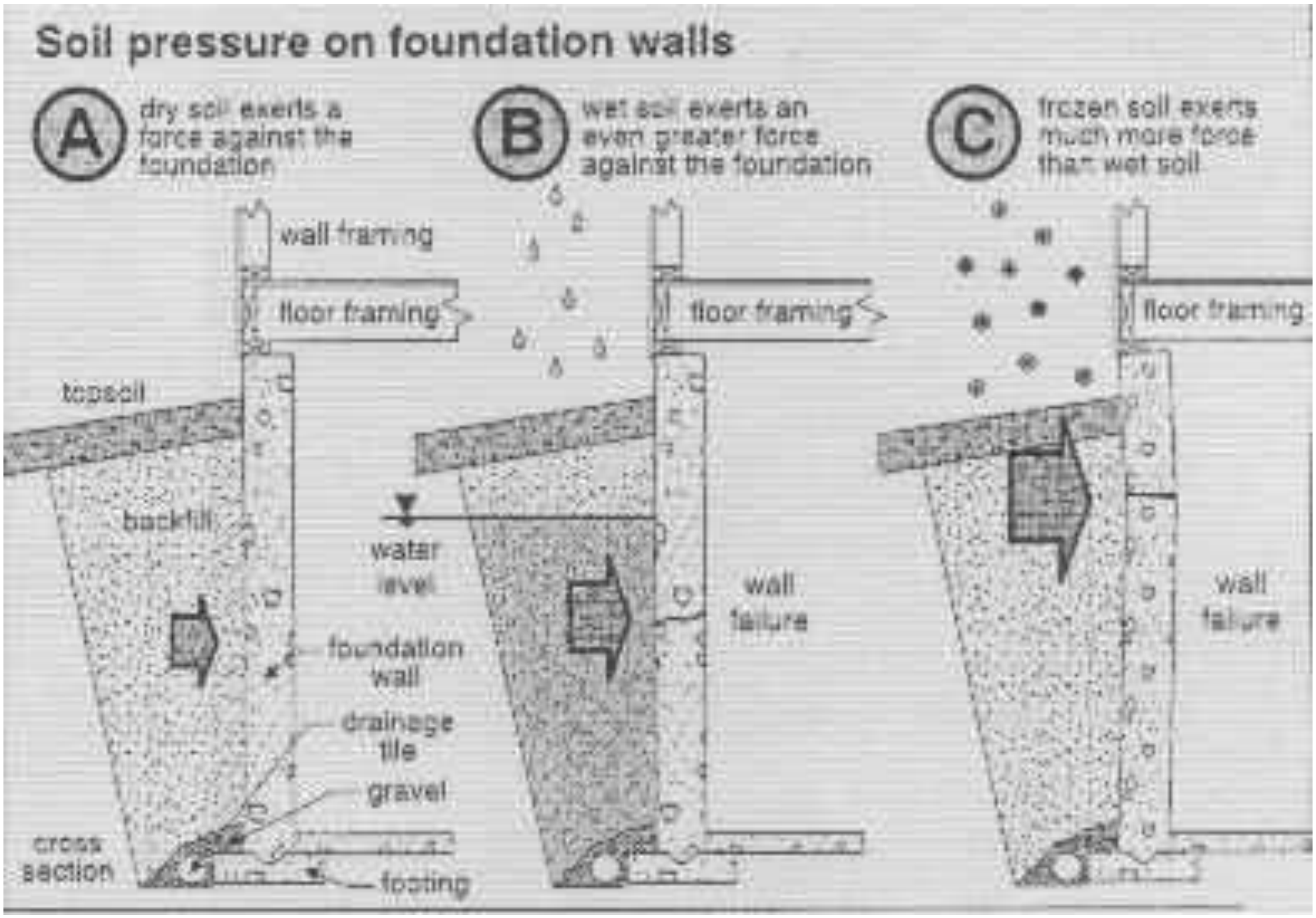
Foundation Repair Industry

Who Are They? What Do They Do? Do we Need Them?

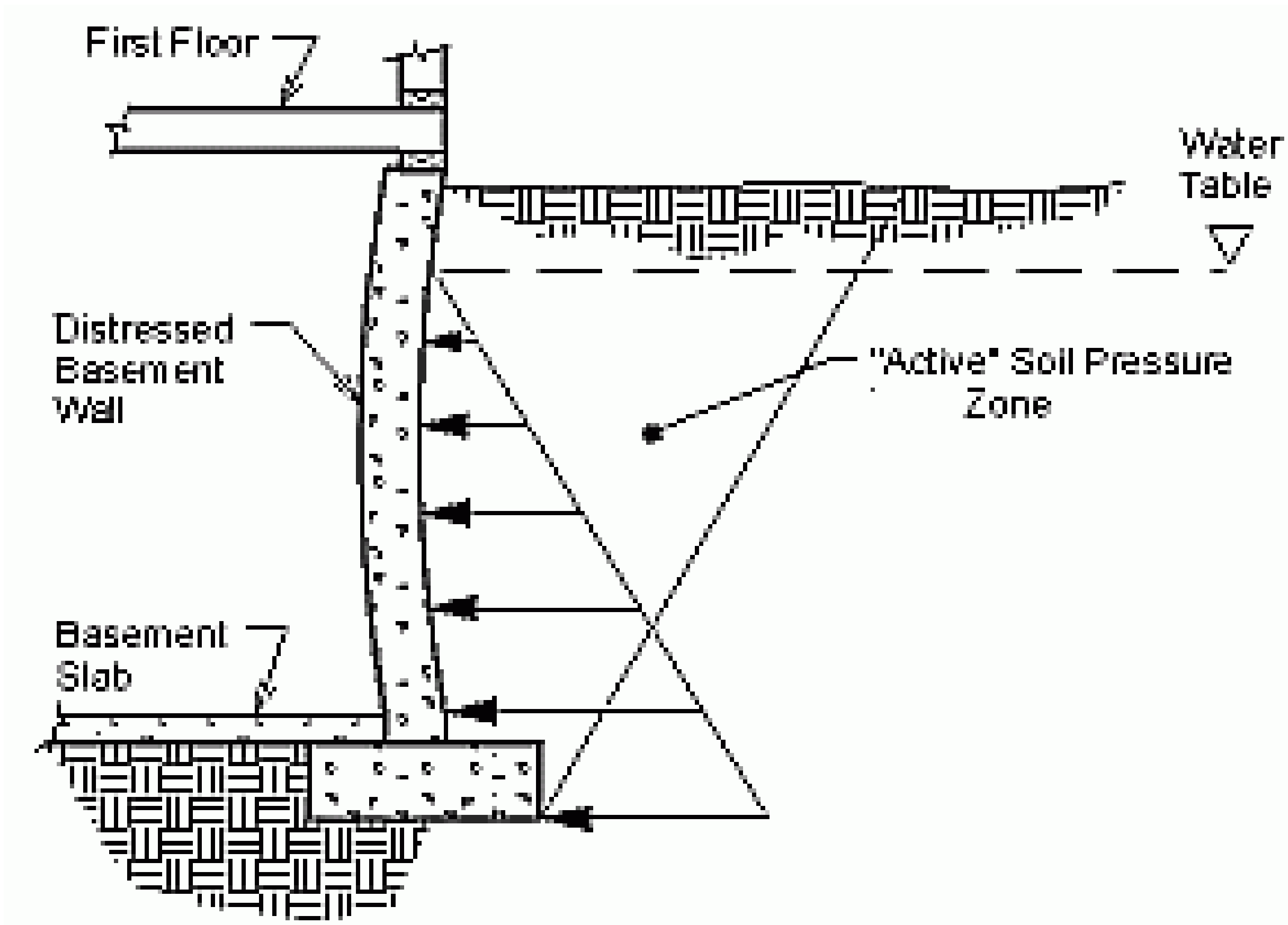
Troy J Gonyon
EHS Manager

Northrop Grumman Corporation
Aerospace Systems
Xinetics
115/53 Jackson Road
Devens, MA 01434

Anchoring


Soil pressure on foundation walls
A
dry soil exerts a force against the foundation
B
wet soil exerts an even greater force against the foundation
C
frozen soil exerts much more force than wet soil
wall framing
floor framing
floor framing
floor framing
topsoil
backfill
water level
wall failure
wall failure
foundation wall
drainage tile
gravel
cross section
footing

Anchoring



First Floor
Water
Table
Distressed
Basement
Wall
"Active" Soil Pressure
Zone
Basement
Slab

Anchoring

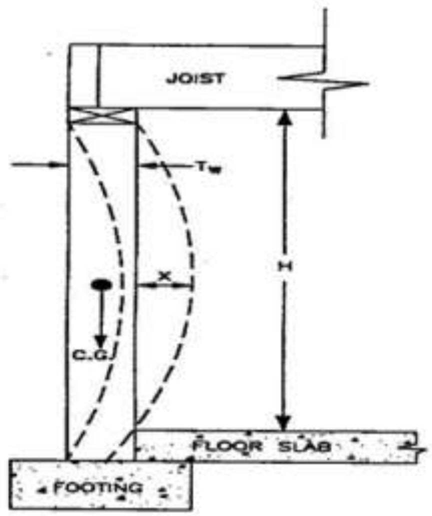
"1/3 RULE FOR WALL STABILITY"

PROJECT: ____________________

JOB#: ____________________

DATE: ____________________

ENGR: ____________________



1. DETERMINE WALL THICKNESS, (T_w), INCHES.
2. DETERMINE WALL HEIGHT, (H), INCHES.
3. DETERMINE WALL DISPLACEMENT [OUTWARD MOVEMENT], (X), INCHES. MEASURE FROM POINT EQUAL TO 1/2 (H), RELATIVE TO POINT AT FLOOR/WALL INTERFACE.
4. CALCULATIONS:
   - $Y = 0.5\ (T_w/3)$
   - IF X>Y, WALL IS UNSTABLE
   - IF $X \leq 0.5\ (T_w/3)$, WALL IS STABLE

CALCULATIONS

EXAMPLE 1:

H = 7 FT. = 84 IN.

T_w = 8 IN., Y = 0.5(8/3) = 1.33 IN.

X = 0.75 IN.

$X \leq Y$, THEREFORE WALL IS STABLE

EXAMPLE 2:

H = 7 FT = 84 IN.

T_w = 8 IN., Y = 0.5(8/3) = 1.33 IN.

X = 1.5 IN.

$X \geq Y$, THEREFORE WALL IS UNSTABLE

FIELD NOTES

CALCULATION 1

H = ________

T_w = ________, Y = ________

X = ________

IF X > Y, WALL IS UNSTABLE

IF $X \leq Y$, WALL IS STABLE

CALCULATION 2

H = ________

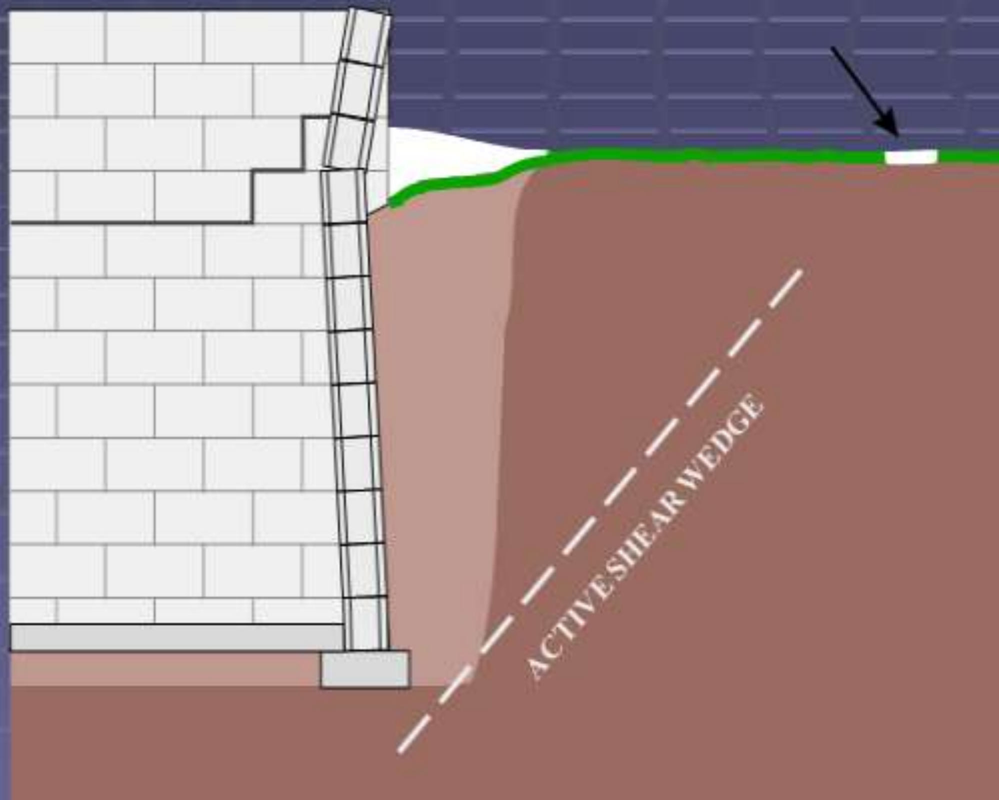
T_w = ________, Y = ________

X = ________

IF X > Y, WALL IS UNSTABLE

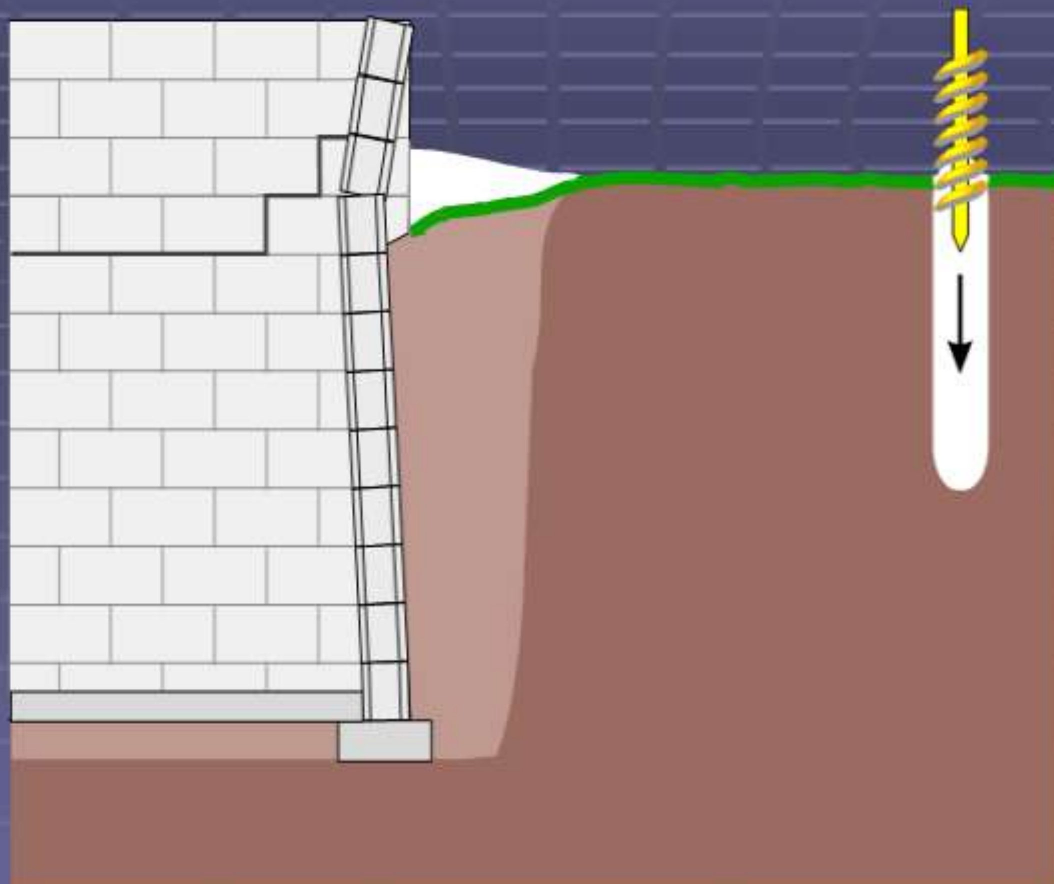
IF $X \leq Y$, WALL IS STABLE

How Does It Work?



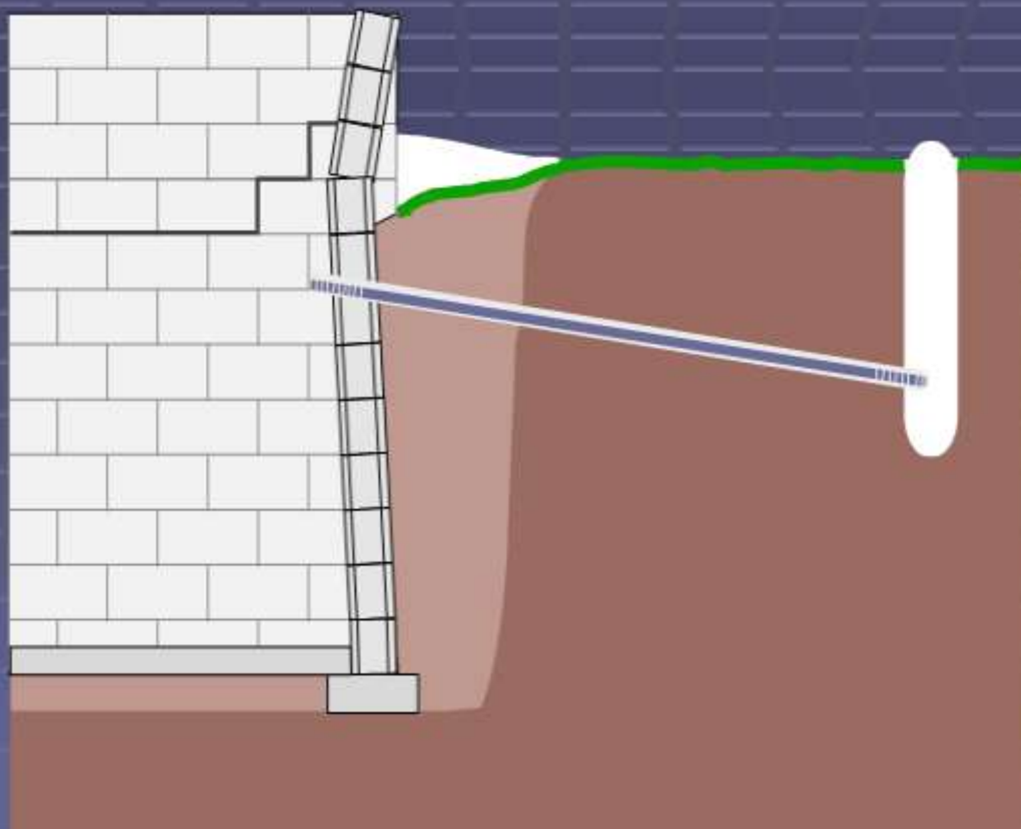
First, distances are measured, then the sod is carefully removed and saved

How Does It Work?



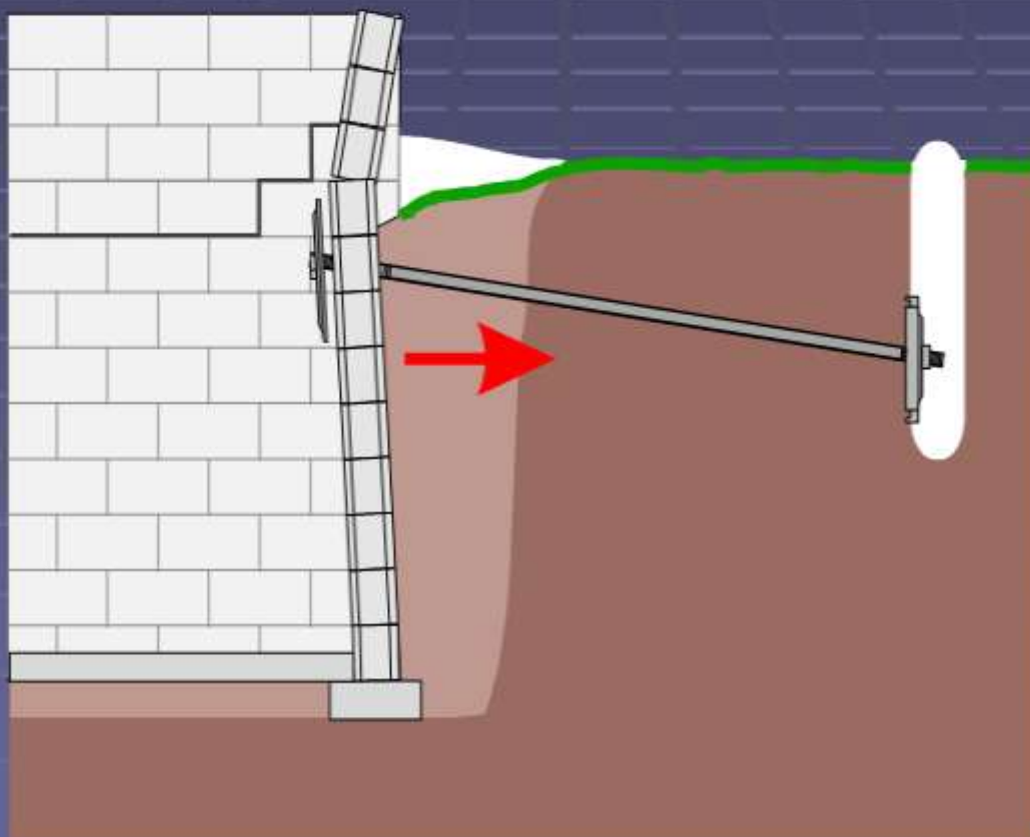
Outside hole are augered about 9 feet from home. What about decks? Extension can be added.

How Does It Work?



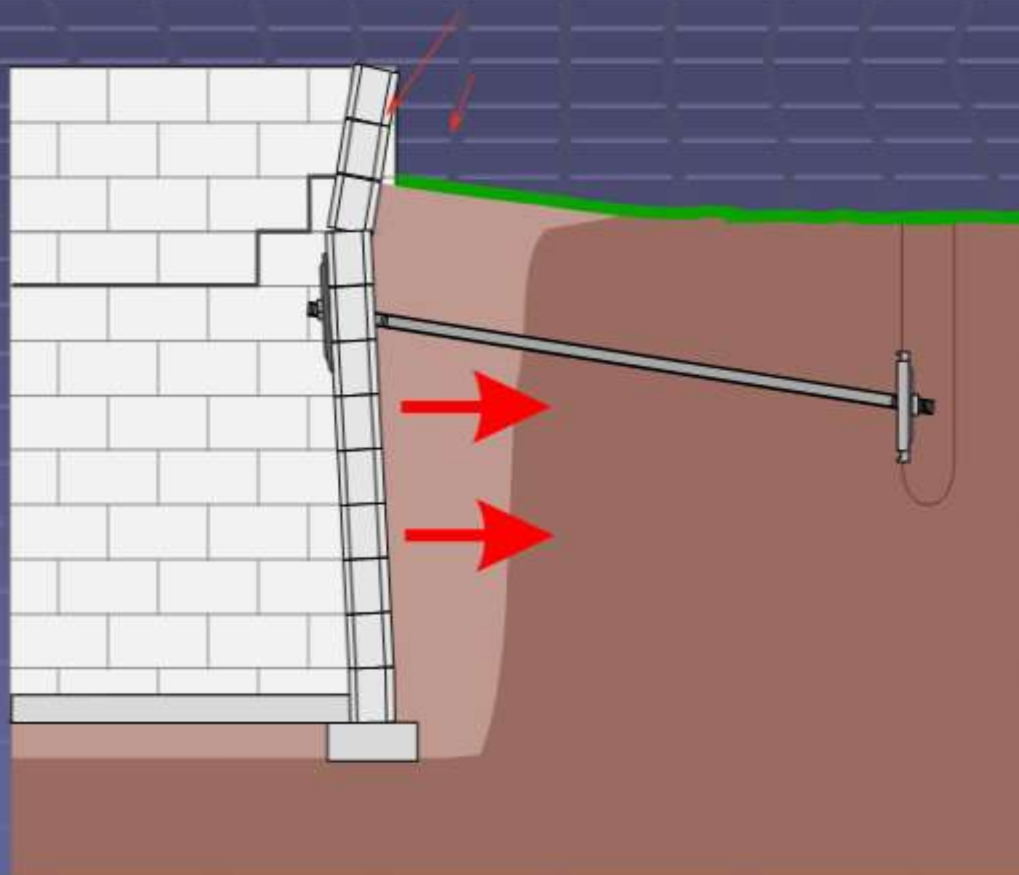
The initial hole is drilled in the basement wall and the anchor rod shot to augered hole.

How Does It Work?



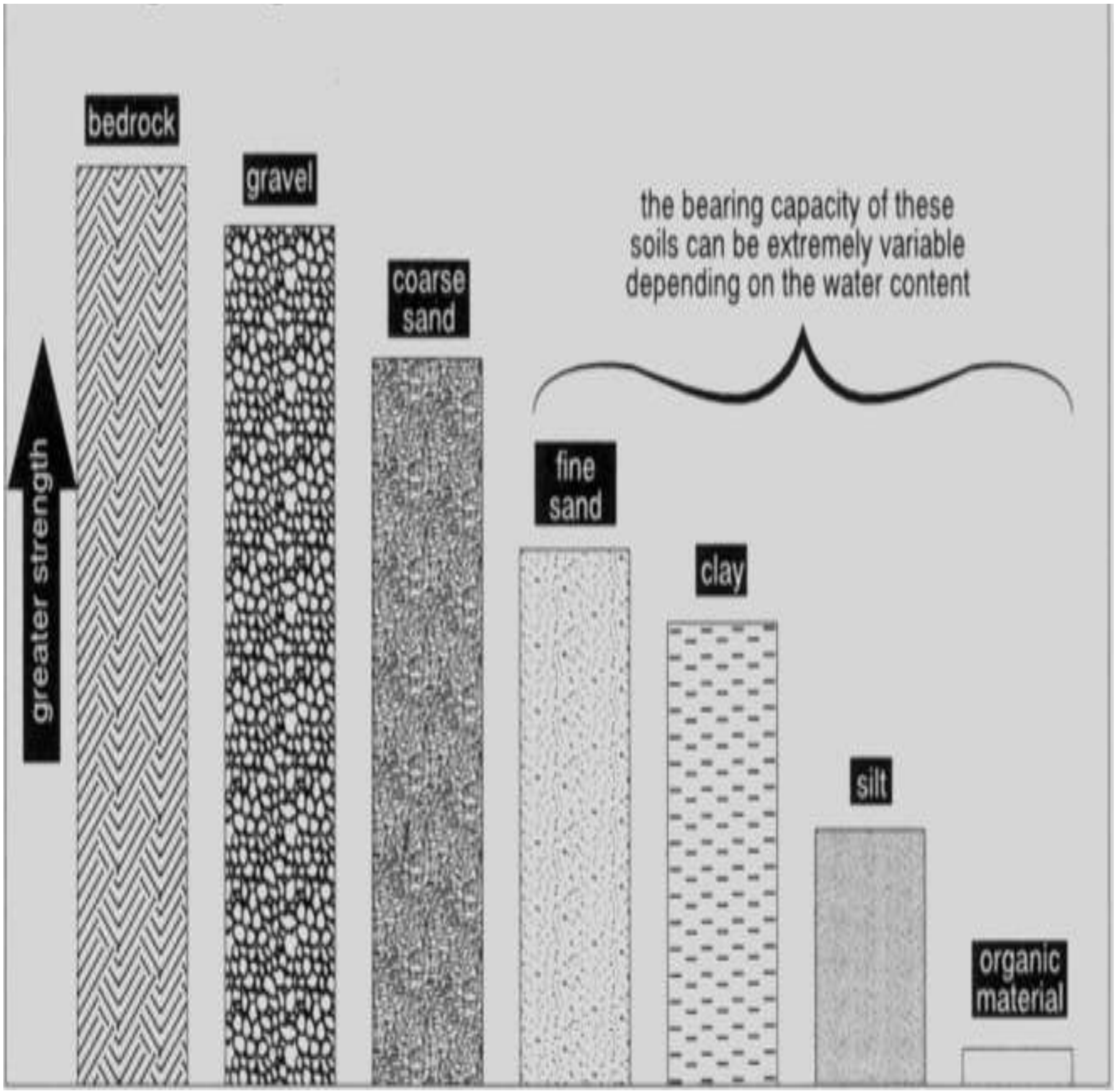
The Wall Plate is installed and tightened

How Does It Work?



The exterior hole is filled and mechanically compacted and the sod is carefully replaced

Typical Spacing is Determined by Thickness of Wall, and Height of Backfill. Normally Every 4-6 Feet.



greater strength
bedrock
gravel
coarse sand
fine sand
clay
silt
organic material
the bearing capacity of these soils can be extremely variable depending on the water content

TYPICAL BUILDING LOADS

Structure with composition or wood shingles*	Load per linear foot, includes foundation
Single Story	
Frame	1,500 lb.
Brick	2,000 lb.
Full Masonry	2,500 lb.
Two Story	
Frame	2,000 lb.
Brick	2,500 lb.
Full Masonry	3,000 lb.
Three Story	
Frame	2,500 lb.
Brick	3,000 lb.
Full Masonry	4,000 lb.

* **Add 150 lb. per linear foot for slate or tile roofing.**

Examples:

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 (CI, ML, MH, CH)	1,500[b]

For SI: 1 pound per square foot = 0.0479 kN/m^2.

Based on weight & bearing capacity we select size of footing

TABLE R403.1

MINIMUM WIDTH OF CONCRETE OR MASONRY FOOTINGS (Inches)

	LOAD BEARING VALUE OF SOIL (psf)					
	1,500	2,000	2,500	3,000	3,500	4,000
Conventional light-frame construction						
1-story	16	12	10	8	7	6
2-story	19	15	12	10	8	7
3-story	22	17	14	11	10	9
4-inch brick veneer over light frame or 8-inch hollow concrete masonry						
1-story	19	15	12	10	8	7
2-story	25	19	15	13	11	10
3-story	31	23	19	16	13	12
8-inch solid or fully grouted masonry						
1-story	22	17	13	11	10	9
2-story	31	23	19	16	13	12
3-story	40	30	24	20	17	15

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kN/m^2

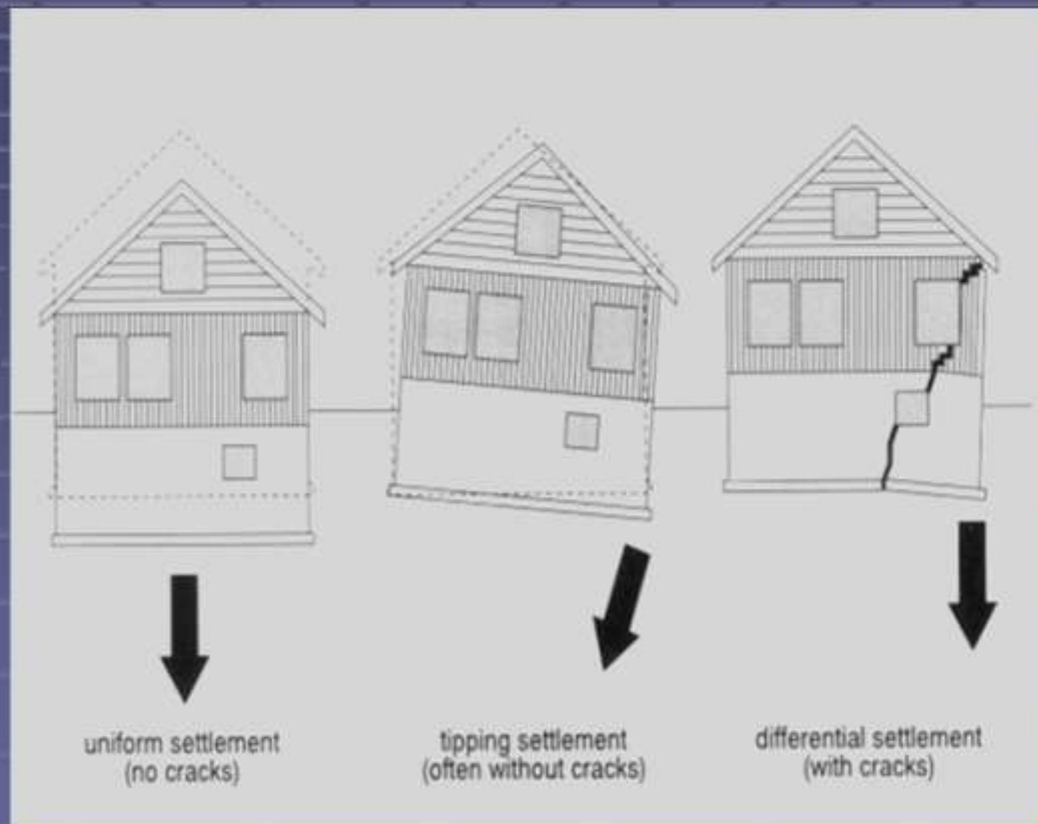
Causes of Foundation Problems

- Very little or no upfront soils study. Expansive clay/ bearing capacities.
- Improper construction techniques
  - Poor Compaction Techniques
  - Building on Organic Fill
  - Improper Drainage
  - Improper Sized Footings for soil
- Soil Creep On Steep Slopes
- Typical designs placed on varying sites (soils)
- Seasonal Changes in Moisture Content (ACTIVE ZONE)

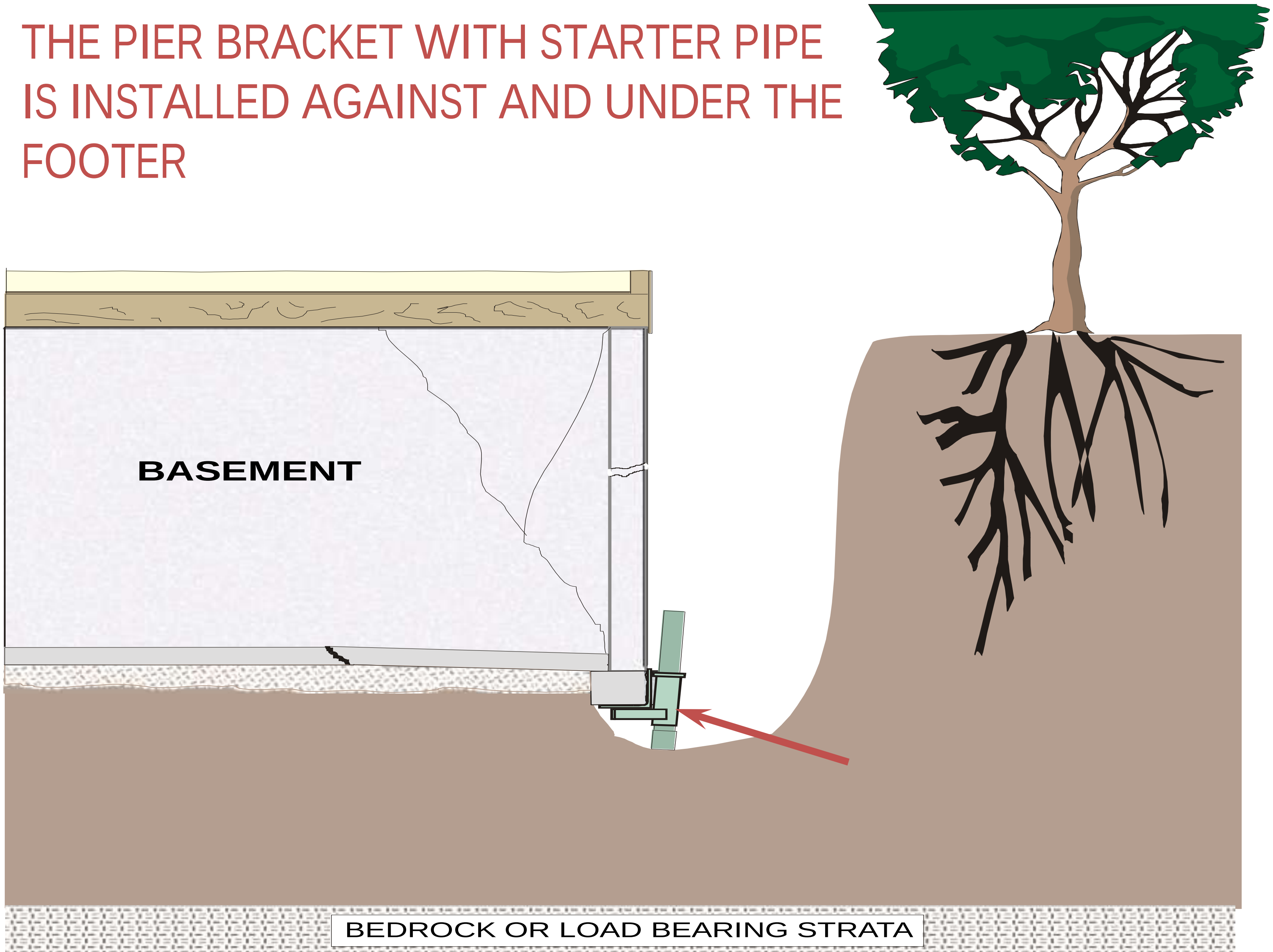
The closer the footing is to the surface, the more it is affected by changes in moisture content.

Three types of settlement:

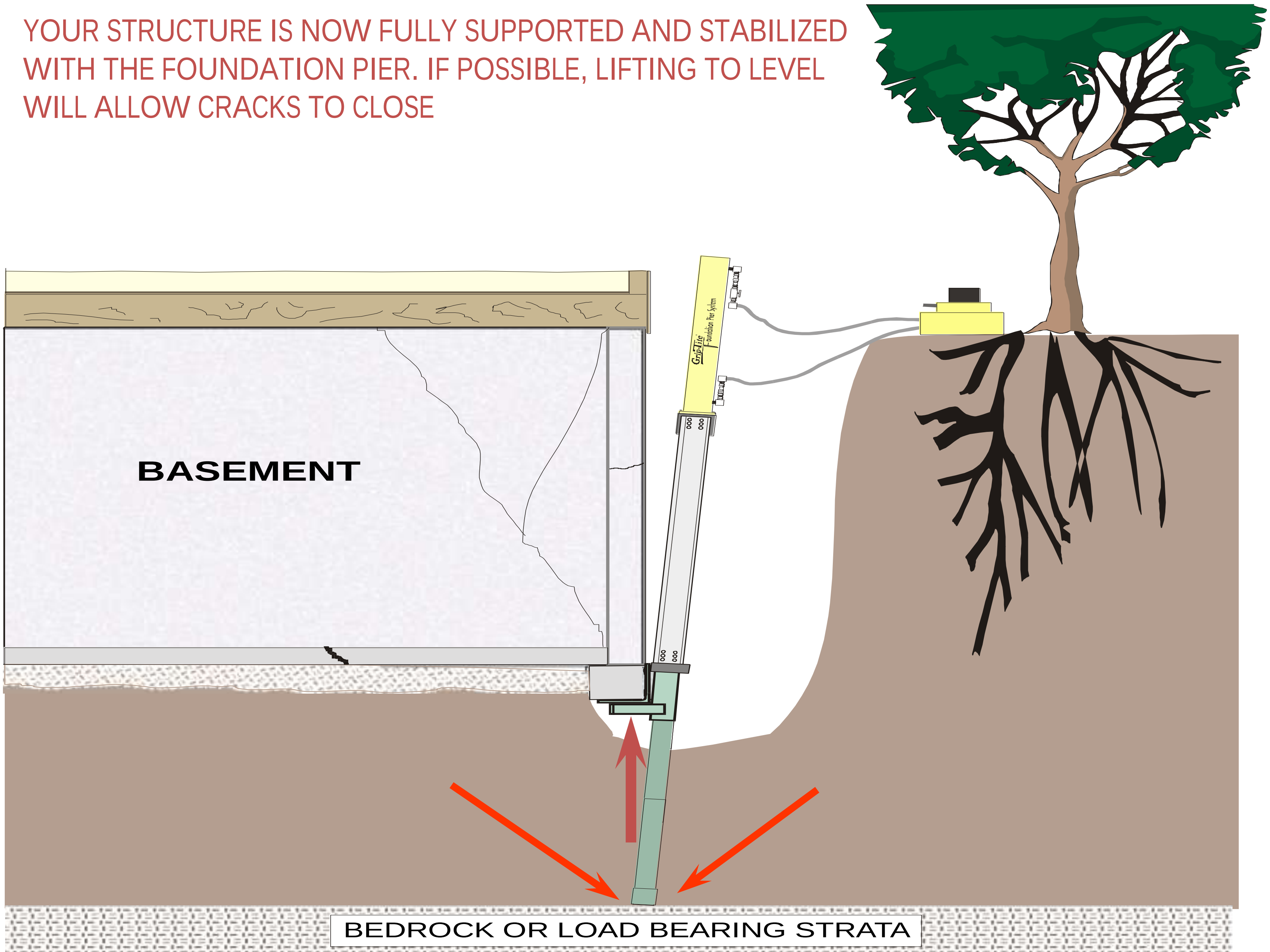
- Uniform
- Tipping
- Differential



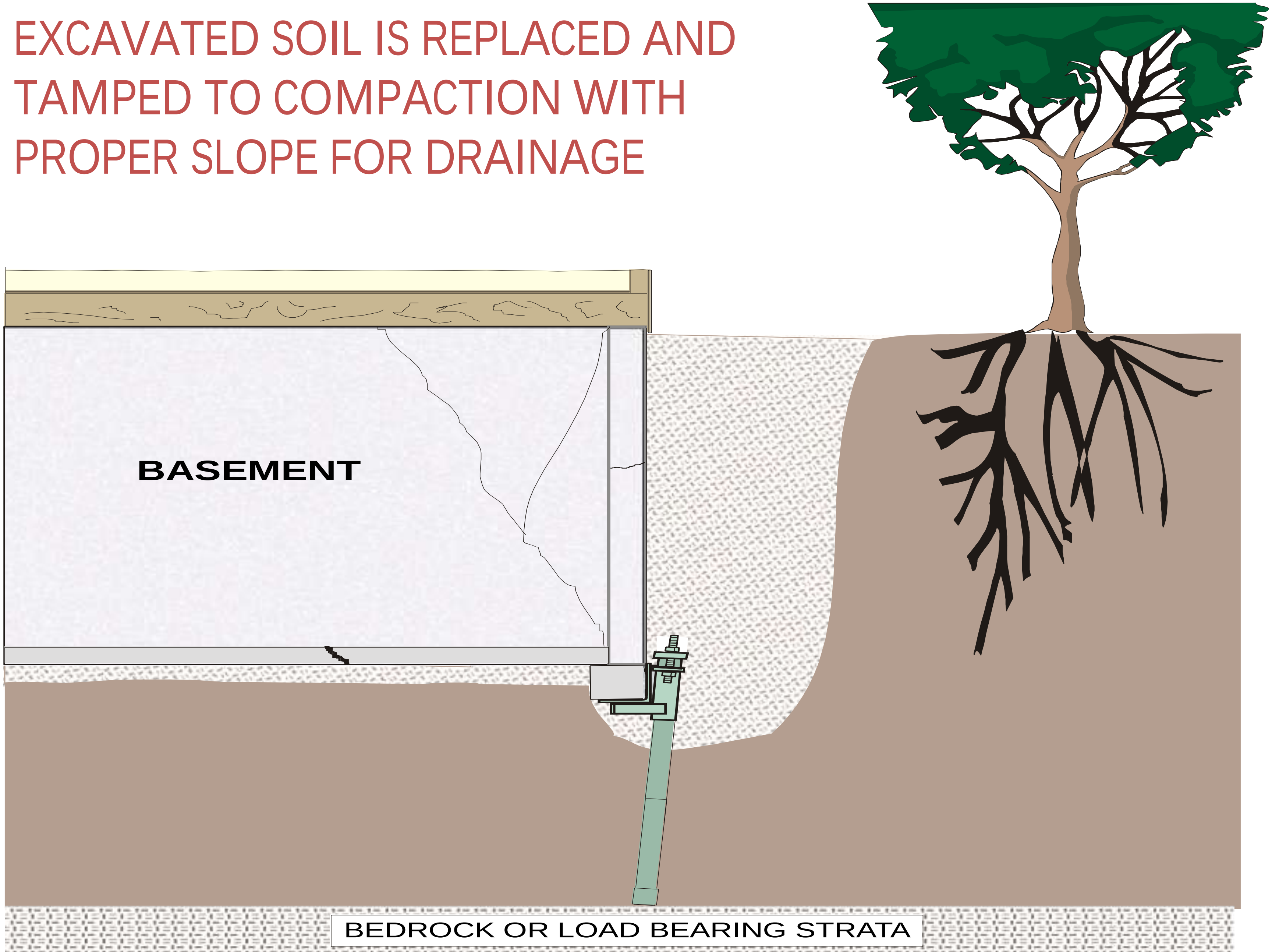
THE PIER BRACKET WITH STARTER PIPE IS INSTALLED AGAINST AND UNDER THE FOOTER



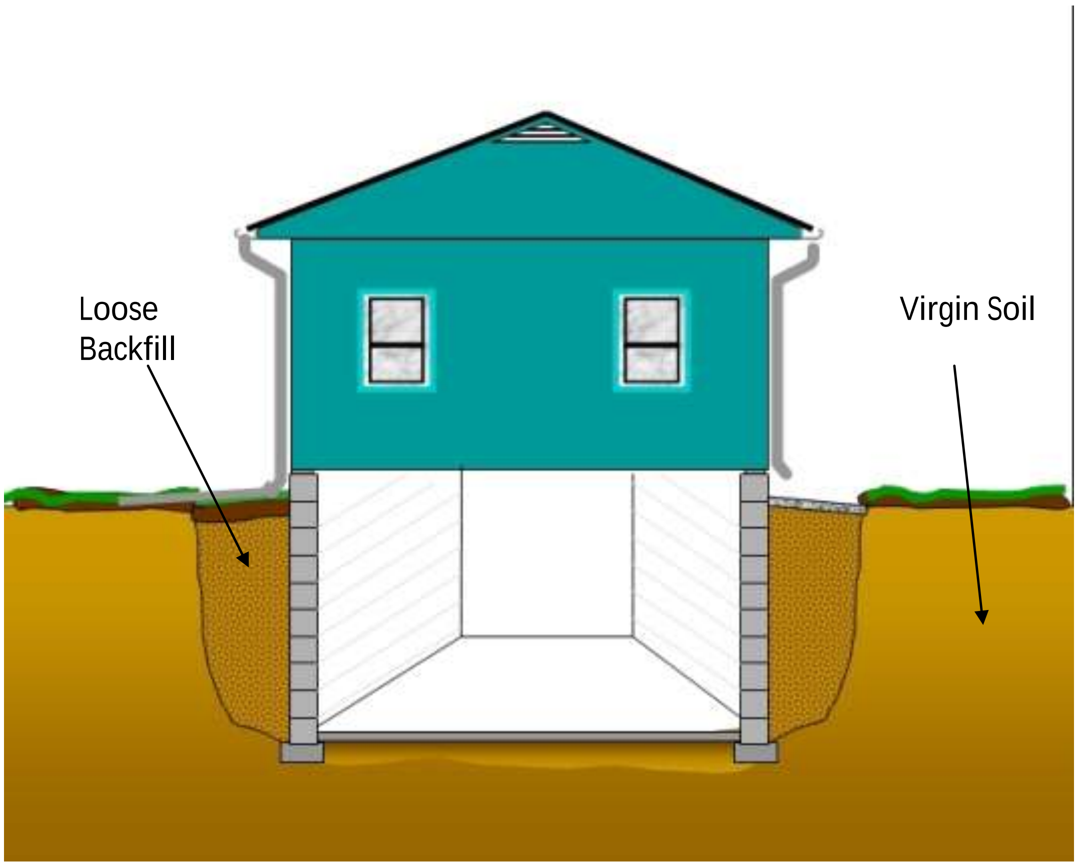
YOUR STRUCTURE IS NOW FULLY SUPPORTED AND STABILIZED WITH THE FOUNDATION PIER. IF POSSIBLE, LIFTING TO LEVEL WILL ALLOW CRACKS TO CLOSE



EXCAVATED SOIL IS REPLACED AND TAMPED TO COMPACTION WITH PROPER SLOPE FOR DRAINAGE

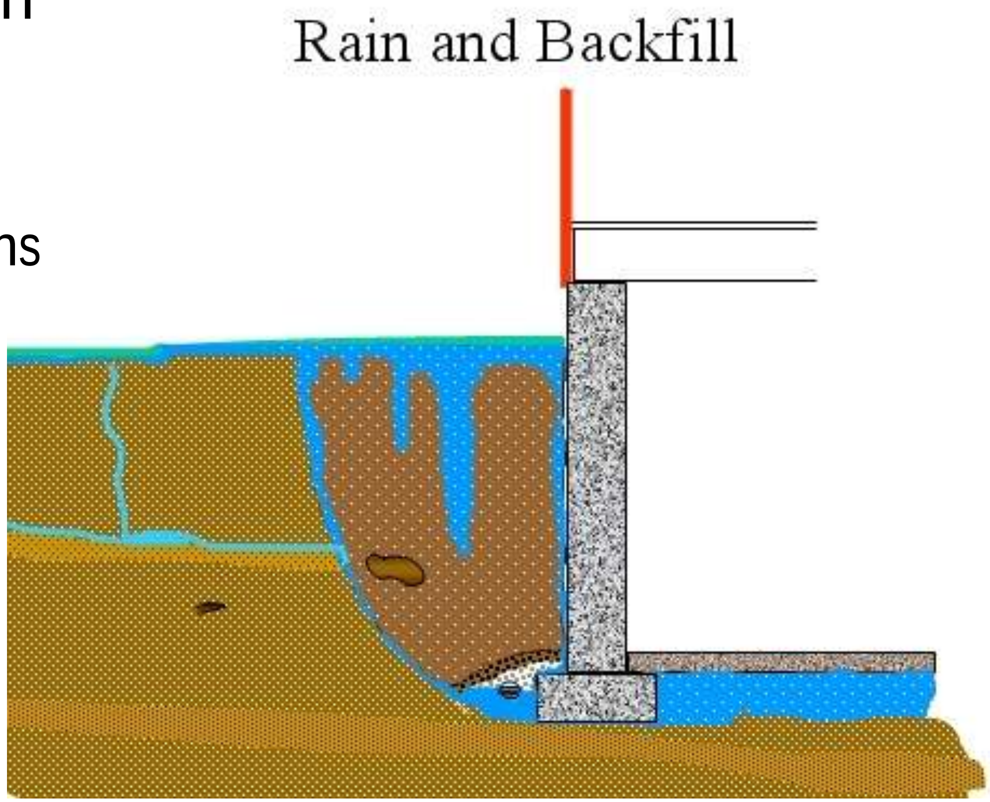


Second, we build the house in the big hole

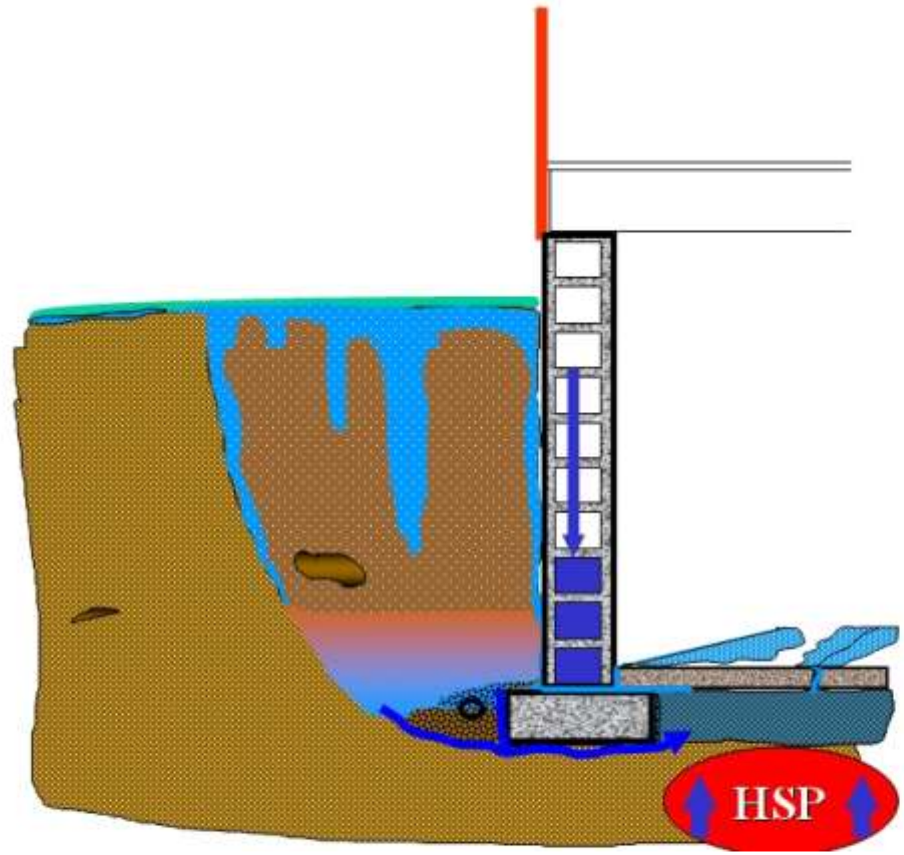


Third,

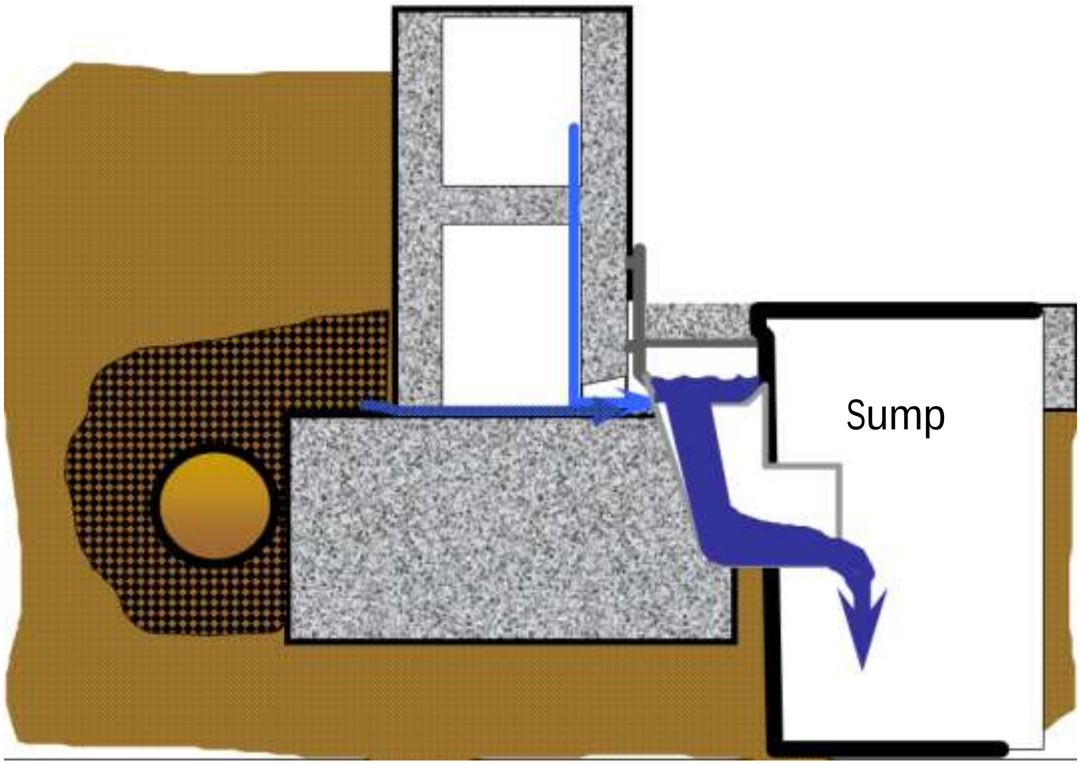
- Three Ways water can get into basements:
  - Above Grade Problems
  - Capillary Action
  - Hydrostatic Pressure

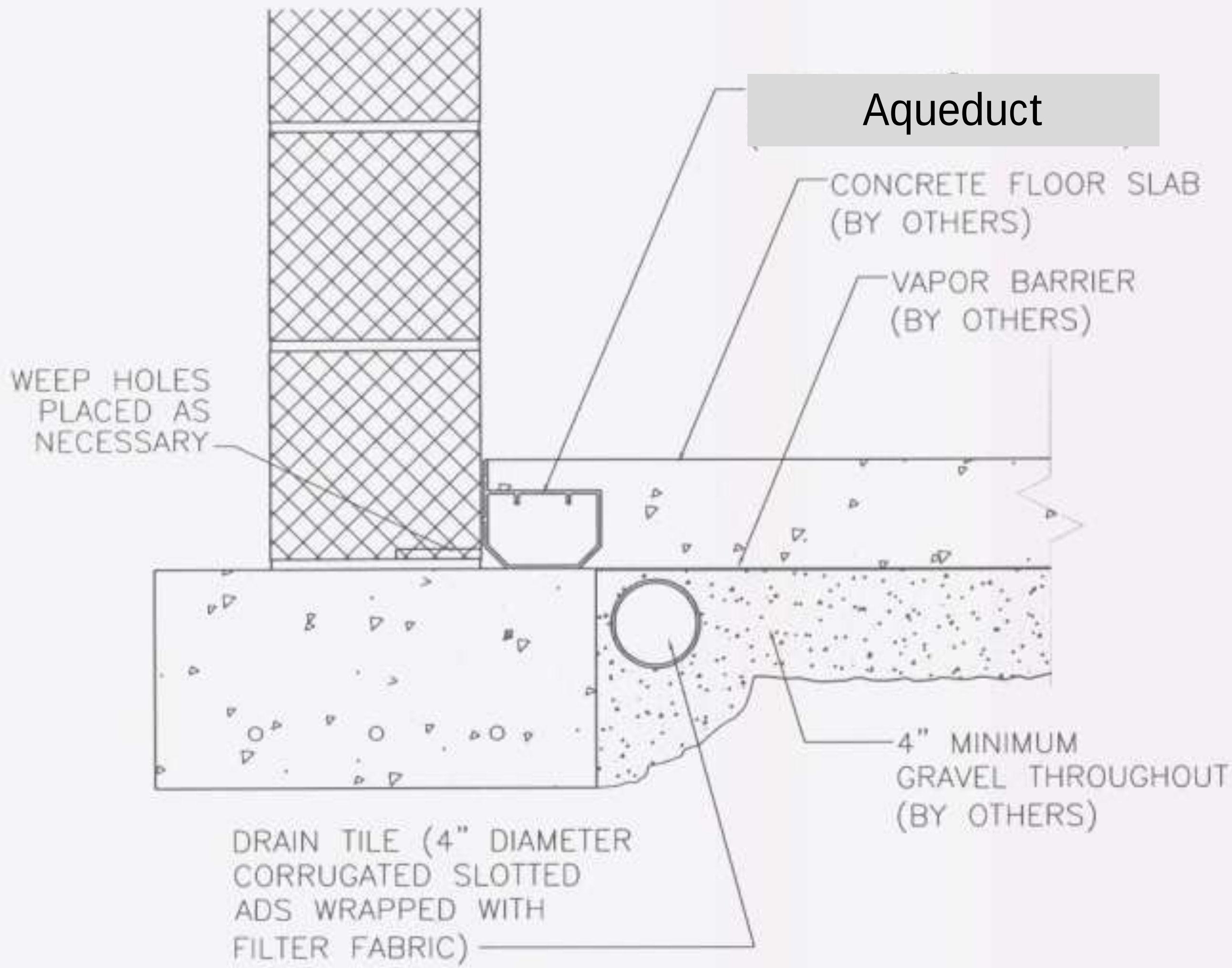


What is Hydrostatic Pressure?



Typical Water Management

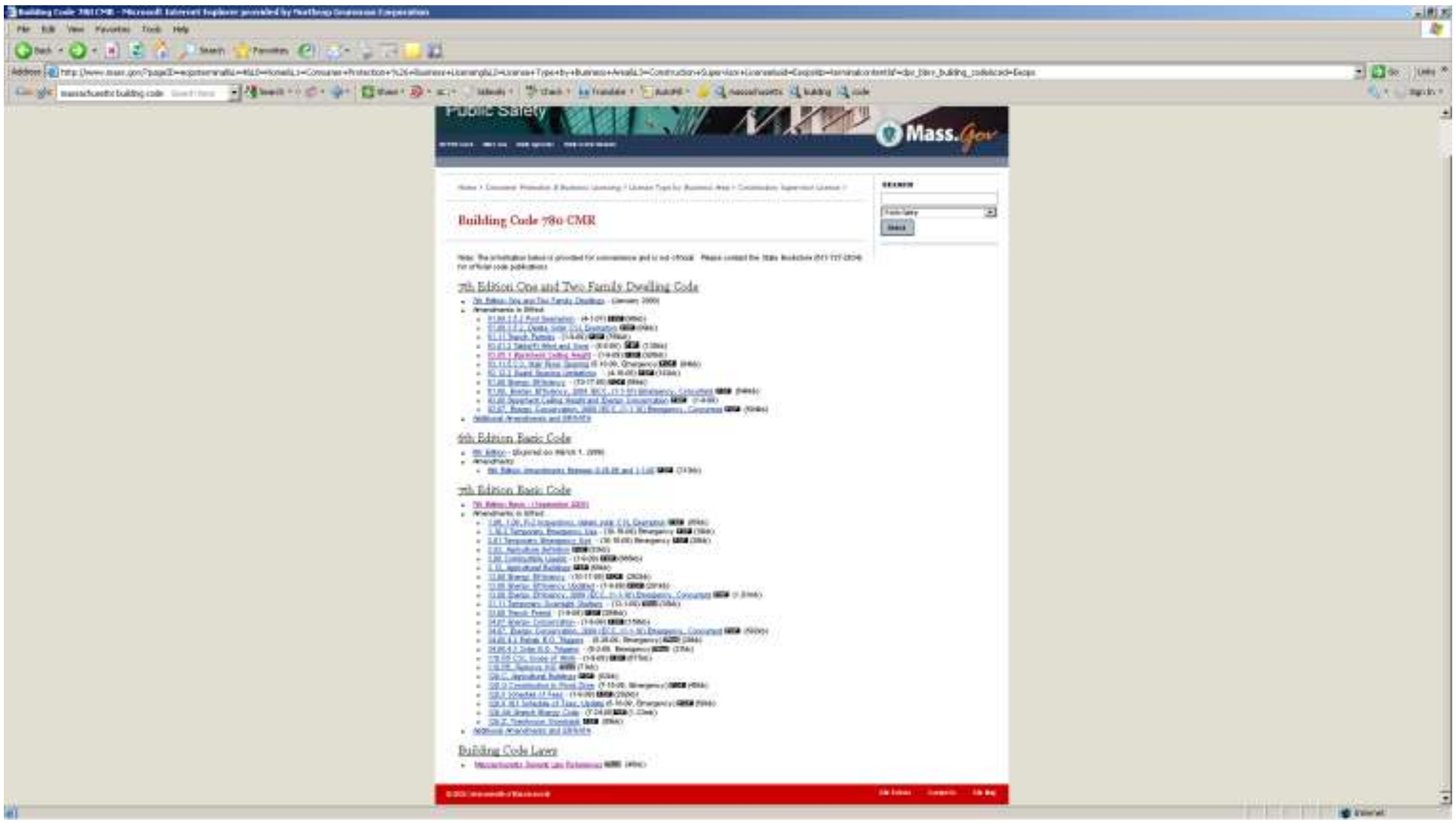



Aqueduct
CONCRETE FLOOR SLAB
(BY OTHERS)
VAPOR BARRIER
(BY OTHERS)
WEEP HOLES
PLACED AS
NECESSARY
4" MINIMUM
GRAVEL THROUGHOUT
(BY OTHERS)
DRAIN TILE (4" DIAMETER
CORRUGATED SLOTTED
ADS WRAPPED WITH
FILTER FABRIC)

Section View

http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

State Building Code



State Building Code

780 CMR 18.00 FOUNDATIONS AND RETAINING WALLS

Section

TABLE OF CONTENTS

State Building Code

780 CMR 1610.0 LATERAL SOIL AND HYDROSTATIC LOADS

780 CMR 1610.0 is unique to Massachusetts

1610.1 General. Basement, foundation, and retaining walls shall be designed to resist lateral loads due to soil and water pressure. Lateral soil pressure on said walls shall be determined in accordance with the principles of soil mechanics and as provided in 780 CMR 18.00. Floors or similar elements below the water table shall be designed to resist the upward pressure of the water.

> **Exception**. Uninhabitable spaces with concrete floors on the ground with an under-slab drainage system, including sump pits and sump pumps, designed to keep the water level a minimum of one foot below the bottom of the floor slab need not be designed to resist water pressure.

State Building Code - Appendix R

780 CMR 120.R

GUIDANCE FOR SELECTION OF FOUNDATION MATERIAL CLASSES

120.R1.1 Purpose. The purpose of 780 CMR 120.R is to provide guidance for the selection of the material class and consistency in place when using Table 1804.3, Allowable Bearing Pressures for Foundation Materials.

120.R1.2 Application. 780 CMR 120.R is provided only as a general guide to engineering judgment. All available data should be evaluated and professional engineering judgment exercised in selection of the appropriate material classification for use with Table 1804.3. The references on soil and rock classification and typical ranges of index properties provided in this appendix should not be considered to be code requirements.

120.R1.3 Classification of Soil. Guidelines for generally accepted engineering practice in the description and classification of soils are provided in ASTM D2488-84 Description and identification of Soils (Visual-Manual Procedure) and ASTM D2487-85 Classification of Soils for Engineering Purposes.

120.R1.4 Classification of Rock. Guidelines for generally accepted engineering practice in the description and classification of rocks are provided in Chapter 1 of Design Manual 7.1 - Soil Mechanics, Naval Facilities Engineering Command, May 1982 (NAVFAC DM-7.1)

120.R1.5 Typical Index Properties. Typical ranges of index properties for the Material Classes listed in Table 120.R1 are provided in Table 120.R2.

TABLE 120.R1 ALLOWABLE BEARING PRESSURES FOR FOUNDATION MATERIALS

Material Class	Description	Notes	Consistency in Place[1]	Allowable Net Bearing Pressure ($tons/ft^2$)
1a	Massive bedrock: Granite, diorite gabbro, basalt, gneiss	3	Hard, sound rock, minor jointing	100
1b	Quartzite, well cemented conglomerate	3	Hard, sound rock moderate jointing	60
2	Foliated bedrock: slate, schist	3	Medium hard rock, minor jointing	40
3	Sedimentary bedrock: cementation shale, siltstone, sandstone, limestone, dolomite, conglomerate	3, 4	Soft rock, moderate jointing	20
4	Weakly cemented sedimentary bedrock: compaction shale or other similar rock in sound condition	3	Very soft rock	10
5	Weathered bedrock: any of the above except shale.	3, 5	Very soft rock, weathered and/or major jointing and fracturing	8
6	Slightly cemented sand and/or gravel, glacial till (basal or lodgement), hardpan	7,8	Very dense	10
7	Gravel, widely graded sand and gravel; and granular ablation till	6, 7, 8	Very dense Dense Medium dense Loose Very loose	8 6 4 2 Note 11

Your Local Health Department

Local Contact – Leominster, MA

- Chris Kanuth
  - Director of Health
    - Resident Geologist in the area
- 978-534-7533 x249

Deep Energy Retrofits

- Radically improvements in energy performance of the existing buildings (energy reductions of 50% to 90%)
- Super-insulation, air-sealing, windows, efficient systems, passive design
- Key: understanding energy use - assess all the ways that a building uses, doesn't use, saves, and stores energy.
- Need to address all or nearly all energy loads — space conditioning, hot water, lighting, appliances, and plug loads
- Requires intensive and extensive systems approach: Relationships between energy, indoor air quality, durability, and thermal comfort essential.
- Passive solar design and renewable energy systems common

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Key Deep Energy Retrofit Systems

Building envelope
Insulate slab and foundation walls (R-17).
air sealing and moisture management.
Super-insulate existing walls, floors and ceiling or roof with formaldehyde-free insulation (R-28 to R40) (R70 for roof). Eliminate thermal bridging.
Install a durable roof (green roof or high reflectance or combination solar pv/hw.
Energy-efficient Doors and windows (glazing based on solar exposure), thermal massing

HVAC
Provide appropriate controls.
Specify high-efficiency mechanical equipment and heat pumps (heat recovery ventilator systems)
Consider alternatives to conventional air conditioning.
Make sure than combustion appliances are vented properly.

Plumbing
Reconfigure plumbing to distribute hot water efficiently.
Insulate hot water pipes.
Choose a high-efficiency water heater, low/no flow fixtures.

Lighting
Increase natural daylighting
Install energy-efficient lighting (sensors, task lighting)

Appliances/Equipment
Eliminate phantom loads, energy efficient models.

Energy sources
Renewables, GSHP for remaining loads.

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How to Plan for Deep Energy Retrofits

- Current energy use (utility bills, blower door, infrared, blower duct, kill-a-watt)
- Moisture! – where it goes, how building gets wet and dries out and how improvements will impact this.
- Look at site drainage, vegetation and soil conditions (basement perimeter drains, exhaust fans in the kitchen and bathroom, whole-house ventilation system).

CASE STUDY

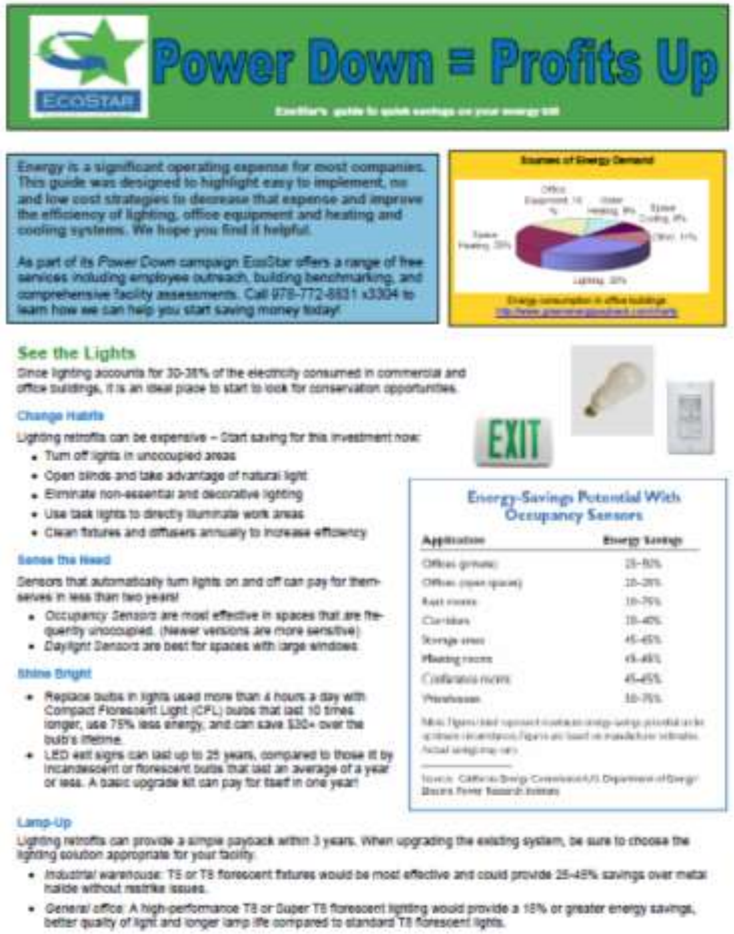
- Empire State Building – 38% energy reduction - $11 million annual energy bill
- Evaluated over 60 measures for EE and carbon reduction
- 8 key improvements – three year payback:
  -reduced cooling and thermal load (super-insulated windows, glazing types dependant on orientation, reusing existing glass, insulation behind radiators)

  -lighting controls

  -tenant energy management system

Devens Eco-Efficiency Center Resources

www.ecostardevens.com



Power Down = Profits Up

EcoStar's guide to quick savings on your energy bill

Energy is a significant operating expense for most companies. This guide was designed to highlight easy to implement, no and low cost strategies to decrease that expense and improve the efficiency of lighting, office equipment and heating and cooling systems. We hope you find it helpful.

As part of its *Power Down* campaign EcoStar offers a range of free services including employee outreach, building benchmarking, and comprehensive facility assessments. Call 978-772-8831 x3304 to learn how we can help you start saving money today!

Sources of Energy Demand

Energy consumption in office buildings
[illegible]

See the Lights

Since lighting accounts for 30-35% of the electricity consumed in commercial and office buildings, it is an ideal place to start to look for conservation opportunities.

Change Habits

Lighting retrofits can be expensive – Start saving for this investment now:

- Turn off lights in unoccupied areas
- Open blinds and take advantage of natural light
- Eliminate non-essential and decorative lighting
- Use task lights to directly illuminate work areas
- Clean fixtures and diffusers annually to increase efficiency

Sense the Need

Sensors that automatically turn lights on and off can pay for themselves in less than two years!

- Occupancy Sensors are most effective in spaces that are frequently unoccupied. (Newer versions are more sensitive)
- Daylight Sensors are best for spaces with large windows

Shine Bright

- Replace bulbs in lights used more than 4 hours a day with Compact Florescent Light (CFL) bulbs that last 10 times longer, use 75% less energy, and can save $30+ over the bulb's lifetime.
- LED exit signs can last up to 25 years, compared to those lit by incandescent or florescent bulbs that last an average of a year or less. A basic upgrade kit can pay for itself in one year!

Energy-Savings Potential With Occupancy Sensors

Application	Energy Savings
Offices (private)	25–50%
Offices (open spaces)	20–25%
Rest rooms	30–75%
Corridors	30–40%
Storage areas	45–65%
Meeting rooms	45–65%
Conference rooms	45–65%
Warehouses	50–75%

[illegible]

Source: [illegible]

Lamp-Up

Lighting retrofits can provide a simple payback within 3 years. When upgrading the existing system, be sure to choose the lighting solution appropriate for your facility:

- *Industrial warehouse:* T5 or T8 florescent fixtures would be most effective and could provide 25-45% savings over metal halide without restrike issues.
- *General office:* A high-performance T8 or Super T8 florescent lighting would provide a 15% or greater energy savings, better quality of light and longer lamp life compared to standard T8 florescent lights.

Deep Energy Retrofit Funding Opps.

Energy Star Rebates for Homeowners (envelope improvements, roofing, HVAC upgrades, boilers, renewable energy systems, fuels cells and more)
http://www.energystar.gov/index.cfm?c=tax_credits.tx_index#c2

Tax deductions for new or existing commercial buildings ($1.80/sq.ft) that achieve 50% energy reductions and meet ASHRAE 90.1-2001. Also partial deductions for Building system improvements (envelope, lighting, HVAC)
http://www.energystar.gov/index.cfm?c=tax_credits.tx_comm_buildings

Industrial Energy Assessment Assistance
http://www1.eere.energy.gov/industry/saveenergynow/

Recovery Act Funding Opportunities for Industrial Efficiency Projects ($256m)
http://www1.eere.energy.gov/industry/financial/

Federal Incentives for Renewables and Efficiencies in Massachusetts
http://www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=MA

MA EOEEA DOER Energy Audit Program for Municipalities
http://www.mass.gov/Eoeea/docs/doer/pub_info/ea-pon-announce-121108.pdf

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Deep Energy Retrofit Funding Opps.

MA State RE Tax Incentives for Residential and Commercial
http://www.mass.gov/?pageID=eoeeaterminal&L=4&L0=Home&L1=Energy%2c+Utilities+%26+Clean+Technologies&L2=Renewable+Energy&L3=Renewable+Energy+Funding+and+Incentives&sid=Eoeea&b=terminalcontent&f=doer_renewables_massachusetts_incentives&csid=Eoeea

National Grid Deep Energy Retrofit Pilot Program
https://www.powerofaction.com/der/

UMASS Lowell – Industrial Assessment Center (EE for small-med sized companies >500 employees, <$100m annual sales, no in-house energy expert, annual energy costs between $100K and $2.5m)
http://www.ceere.org/iac/index.html

CHP for the Northeast – Assessment and Analysis Support
http://www.northeastchp.org/nac/services.htm

National Grid Whole Building Assessment Program
http://www.nationalgridus.com/non_html/WBAMOU_Final_5_22_09.d

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