

Safety Through Engineering

STE designs possibilities everyday for clients located nearby or around the world—clients who expect advanced engineering and safety knowledge to solve their design challenges and to provide practical ways to apply innovative solutions.

STE Inc. - Sustainable Safety[®] Series: The Hazards of Construction Excavation



DIGGING IN...

The Hazards of Construction Excavation

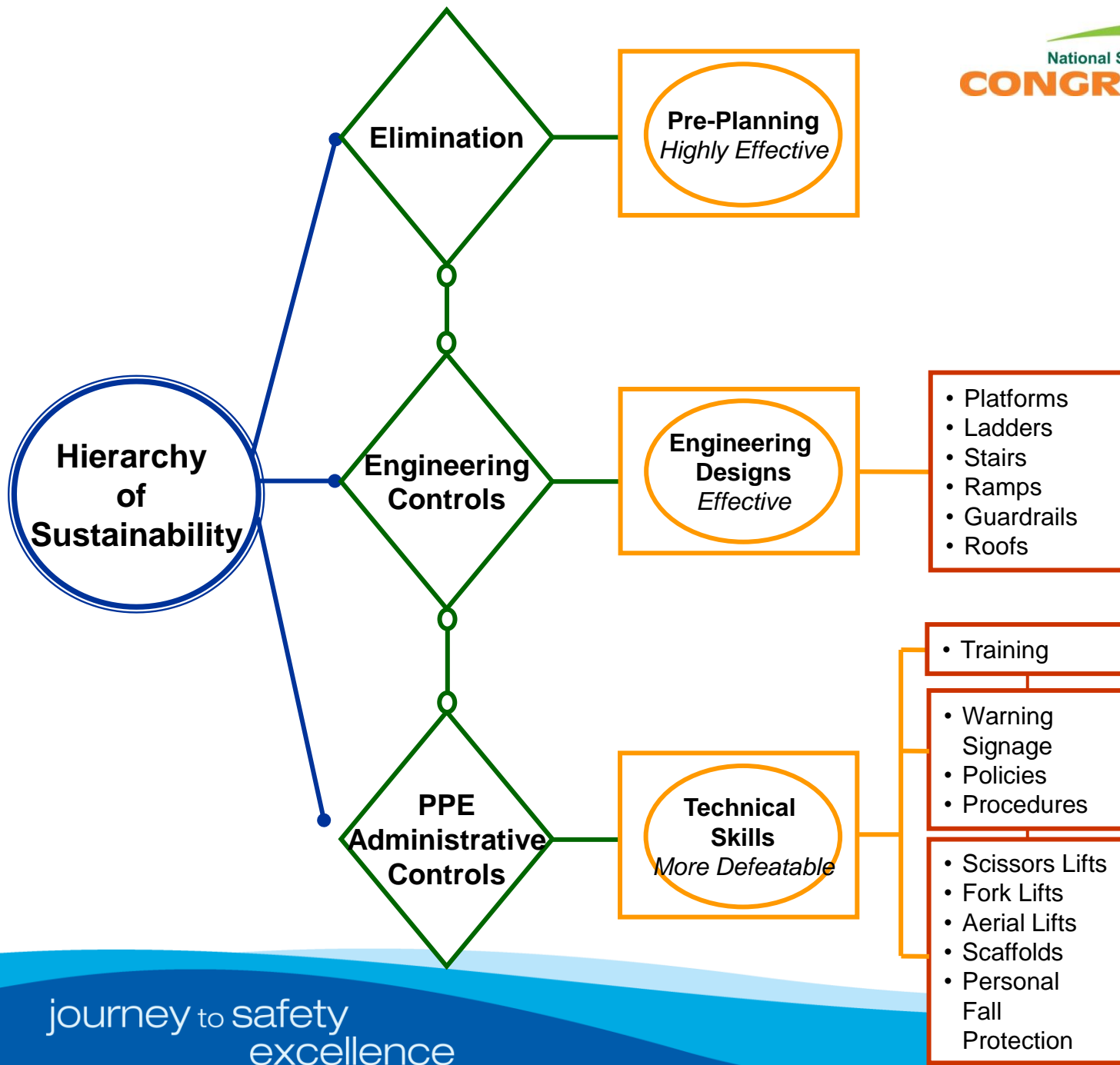


STE Inc. - Sustainable Safety®
Session 109, October 6, 2010

DIGGING IN...

Sustainable Safety®

- The integration of safety methods throughout the life cycle of buildings, machinery, equipment and processes to protect people from workplace hazards.
- Maximizing the economic, environmental and safety performance of buildings, machinery, equipment and processes.



DIGGING IN...

The Hazards of Construction Excavation

- Excavation and Safety Duties
 - OSHA construction compliance
 - Maintain a safe workplace – 5(a)(1)
 - Safety Program
 - Lockout/Tagout
 - Access and egress
 - Suspended Loads
 - Hazardous Atmospheres
 - Fall Protection
 - Rescue
 - Site inspections

DIGGING IN...

Safety Duties

- Excavation Competent Person
 - OSHA [1926.650](#)
 - One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them

DIGGING IN...

Safety Duties

- Excavation Competent Person
 - ANSI [A10.12](#)
 - One who has received training and can demonstrate knowledge, skills and abilities to fulfill the duties required by this standards and who is capable...

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Safety Duties – ANSI A10.12

- Contractor's or subcontractor's responsibilities
 - Designate an excavation competent person
 - Have an excavation safety and health plan
- Excavation Competent Person's Responsibilities
 - Ensure that the soils are classified
 - Ensure that a worker protection system is selected and installed in the safest possible manner
 - Warn workers of impending danger and direct the workers to leave the excavation in the case of hazardous conditions

DIGGING IN...

Safety Duties – ANSI A10.12

- **Excavation safety and health plan**
 - The written safety and health plan developed by the contractor for the excavation work that describes the requirements and procedures to be implemented
 - See section 2.2 of general Requirements

DIGGING IN...

Underground Installations – ANSI A10.12

- Pre-planning of all existing underground sewer, telephone, fuel, electric, water lines, etc...before you excavate
- Notify all utility companies and owners prior to the excavation
- the exact location of the existing underground utilities must be determined by safe and acceptable means.
- When equipment being operated adjacent or near an excavation, a physical warning system shall be used (barricades, hand or mechanical signals, or stop logs and the grade should be away from the excavation).

DIGGING IN...

Lockout/Tagout

- Safety-related work practices are contained in [1926.416](#) and [1926.417](#)
 - In addition to covering the hazards arising from the use of electricity at jobsites, these regulations also cover the hazards arising from the accidental contact, direct or indirect, by employees with all energized lines, above or below ground, passing through or near the jobsite.

DIGGING IN...

Lockout/Tagout

- 1926.416(a)(1)
 - No employer shall permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by deenergizing the circuit and grounding it or by guarding it effectively by insulation or other means.

DIGGING IN...

Lockout/Tagout

- 1926.417(a)
 - Controls that are to be deactivated during the course of work on energized or deenergized equipment or circuits shall be tagged.
- 1926.417(b)
 - Equipment or circuits that are deenergized shall be rendered inoperative and shall have tags attached at all points where such equipment or circuits can be energized.

DIGGING IN...

Exposure to Power Lines

- 1926.550(a)(15)
 - Except where electrical distribution and transmission lines have been deenergized and visibly grounded at the point of work or where insulating barriers, not a part of or an attachment to the equipment or machinery, have been erected to prevent physical contact with the lines, equipment or machines shall be operated proximate to power lines only in accordance with the following...

DIGGING IN...

Exposure to Power Lines

- 1926.550(a)(15)(iv)
 - A person shall be designated to observe clearance of the equipment and give timely warning for all operations where it is difficult for the operator to maintain the desired clearance by visual means.
- 1926.600(a)(6)
 - All equipment covered by this subpart shall comply with the requirements of 1926.550(a)(15) when working or being moved in the vicinity of power lines or energized transmitters.

DIGGING IN...

Access and Egress

- The excavation sides must be protected, supported or soil removed to safeguard employees.
- Equipment structural ramps used for access or egress of equipment designed by Competent Person in structural design (engineer)
- Employee structural ramps as a means of access or egress designed by Competent Person

DIGGING IN...

Access and Egress

- Ramps and runways constructed shall be of uniform thickness, attached in a manner to prevent tripping, top surface to prevent slipping and connected together to prevent displacement.
- Stairway, ladder, ramp or other safe means of egress must be used in excavations that are 4 feet or more in depth and located not more than 25 feet apart.

DIGGING IN...

Access and Egress

- 1926.1053(a)(1)(i)
 - Self-supporting portable ladders must sustain at least four times the maximum intended load and extra-heavy-duty, type 1A, ladders shall sustain at least 3.3 times the maximum intended load. The ability of a ladder to sustain the loads indicated in this paragraph shall be determined by applying or transmitting the requisite load to the ladder in a downward vertical direction. Ladders built and tested in conformance with the applicable provisions of appendix A of this subpart will be deemed to meet this requirement.

DIGGING IN...

Access and Egress

- 1926.1053(b)(1)
 - When portable ladders are used for access to an upper landing surface, the ladder side rails shall extend at least 3 feet (.9 m) above the upper landing surface to which the ladder is used to gain access
 - when such an extension is not possible because of the ladder's length, the ladder shall be secured at its top to a rigid support that will not deflect, and a grasping device, such as a grab rail, shall be provided to assist employees in mounting and dismounting the ladder.



DIGGING IN...

Access and Egress

- 1926.1060(a)
 - The employer shall provide a training program for each employee using ladders and stairways, as necessary. The program shall enable each employee to recognize hazards related to ladders and stairways, and shall train each employee in the procedures to be followed to minimize these hazards.
- 1926.1060(a)(1)
 - The employer shall ensure that each employee has been trained by a competent person

DIGGING IN...

Exposure to Vehicular Traffic

- Employees must wear high-visibility warning vests or other suitable garments
- 1926.600(a)(1)
 - All equipment left unattended at night, adjacent to a highway in normal use, or adjacent to construction areas where work is in progress, shall have appropriate lights or reflectors, or barricades equipped with appropriate lights or reflectors, to identify the location of the equipment.

DIGGING IN...

Exposure to Falling Loads

Employees shall not be underneath loads (suspended loads).



DIGGING IN...

Exposure to Falling Loads

- [1926.753\(d\)\(1\)](#)
 - Routes for suspended loads shall be pre-planned to ensure that no employee is required to work directly below a suspended load
- Employees shall be protected from spillage or falling materials as the vehicle are being loaded or unloaded.
- Operators loading or unloading vehicles must being protected in accordance with [1926.601\(b\)\(6\)](#)

DIGGING IN...

Hazardous Atmospheres

- Prevent employee exposure to harmful levels of atmospheric contaminants

DIGGING IN...

Hazardous Atmospheres – Confined Space

- Prevent employee exposure to harmful levels of atmospheric contaminants
- 1926.21(b)(6)(i)
 - All employees required to enter into confined or enclosed spaces shall be instructed as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. The employer shall comply with any specific regulations that apply to work in dangerous or potentially dangerous areas.

DIGGING IN...

Hazardous Atmospheres – Confined Space

- 1926.21(b)(6)(ii)
 - ... "confined or enclosed space" means any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels

DIGGING IN...

Hazardous Atmospheres – Confined Space

- **1926.353(b)(1)** (Welding in Confined Space)
 - Except as provided in paragraph (b)(2) of this section, and paragraph (c)(2) of this section, either general mechanical or local exhaust ventilation meeting the requirements of paragraph (a) of this section shall be provided whenever welding, cutting, or heating is performed in a confined space.

DIGGING IN...

Hazardous Atmospheres – Confined Space

- 1926.353(b)(2)
 - When sufficient ventilation cannot be obtained without blocking the means of access, employees in the confined space shall be protected by air line respirators in accordance with the requirements of Subpart E of this part, and an employee on the outside of such a confined space shall be assigned to maintain communication with those working within it and to aid them in an emergency.

DIGGING IN...

Hazardous Atmospheres – Confined Space

- 1926.353(b)(3)
 - "Lifelines." Where a welder must enter a confined space through a manhole or other small opening, means shall be provided for quickly removing him in case of emergency. When safety belts and lifelines are used for this purpose they shall be so attached to the welder's body that his body cannot be jammed in a small exit opening. An attendant with a pre-planned rescue procedure shall be stationed outside to observe the welder at all times and be capable of putting rescue operations into effect.

DIGGING IN...

Hazardous Atmospheres – Confined Space

- Prior to any employees enter excavations greater than 4 feet, the atmosphere shall be tested to determine if the atmospheres containing less than 19.5 percent oxygen.
 - Examples—excavations in landfill areas or excavations in areas where hazardous substances are stored nearby

DIGGING IN...

Hazardous Atmospheres – Confined Space

- Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres.
 - Respiratory protection (Subpart D)
 - Ventilation (Subpart E)
 - Atmosphere with a flammable gas in excess of 20 percent of the lower flammable limit of the gas.
 - Continuous testing shall be conducted to ensure the atmosphere remains safe.

DIGGING IN...

Emergency Rescue Equipment

- Breathing apparatus, safety harness and line, basket stretcher and other emergency rescue equipment shall be readily available
- [1926.502\(d\)\(20\)](#)
 - The employer shall provide for prompt rescue of employees in the event of a fall or shall assure that employees are able to rescue themselves
- Abate hazards such as described in [1926.353](#) of the welder in a confined space becoming jammed in a small exit opening during a rescue attempt

DIGGING IN...

Fall Protection

- Employees accessing into caissons, drilled piers or other similar deep and confined footing excavations, shall use fall protection equipment (including lifelines) **1926.500** thru **1926.503**
- **1926.501(a)(2)**
 - The employer shall determine if the walking/working surfaces on which its employees are to work have the strength and structural integrity to support employees safely. Employees shall be allowed to work on those surfaces only when the surfaces have the requisite strength and structural integrity.

DIGGING IN...

Fall Protection

- Cross over and walkways shall be provided where employees are directed to cross over excavations.
 - Where walkways are 6 feet or more above lower level
 - Guardrails are required and must comply with [1926.502\(b\)](#)
- ANSI [A10.12](#) – Walkways shall be provided where employees or equipment are required or permitted to cross over excavations

DIGGING IN...

Fall Protection

- 1926.501(b)(7)(i)
 - Each employee at the edge of an excavation 6 feet (1.8 m) or more in depth shall be protected from falling by guardrail systems, fences, or barricades when the excavations are not readily seen because of plant growth or other visual barrier;
- ANSI A10.12 – 2.15.2
 - Adequate barrier or physical protection in the form of an obstruction that will deter the passage of persons or vehicles shall be provided...
 - ...Traffic cones are not satisfactory



DIGGING IN...

Fall Protection

- 1926.501(b)(7)(ii)
 - Each employee at the edge of a well, pit, shaft, and similar excavation 6 feet (1.8 m) or more in depth shall be protected from falling by guardrail systems, fences, barricades, or covers
- ANSI A10.12 – 2.15.3
 - (*Adds to OSHA*)...or personal fall protection device.
 - Traffic cones are not satisfactory
 - Upon completion of exploration and similar operations, temporary wells, pits, shafts, ect., shall be backfilled

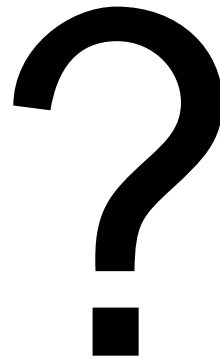
DIGGING IN...

Fall Protection

- 1926.503(a)(1)
 - The employer shall provide a training program for each employee who might be exposed to fall hazards. The program shall enable each employee to recognize the hazards of falling and shall train each employee in the procedures to be followed in order to minimize these hazards.
- 1926.503(a)(2)
 - The employer shall assure that each employee has been trained, as necessary, by a competent person...

DIGGING IN...

Fall Protection



So is the definition of a Competent Person clear

DIGGING IN...

Fall Protection – Qualified Person

- One with a recognized degree or professional certificate and extensive knowledge and experience in the subject field who is capable of design, analysis, evaluation and specifications in the subject work, project, or product.
- 1910.66 App C

DIGGING IN...

Fall Protection – Qualified Person

- One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.
- 1926.32(m)
- ANSI A10.32

DIGGING IN...

Fall Protection – Competent Person

- A person who is capable of identifying hazardous or dangerous conditions in the personal fall arrest system or any component thereof, as well as in their application and use with related equipment.
- 1910.66 App C

DIGGING IN...

Fall Protection – Competent Person

- One who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
- 1926.32(f)
- ANSI A10.32

DIGGING IN...

Fall Protection – LOI 10/14/1999

- “...a scaffold should never be used as an anchorage point for a fall arrest system unless it has been properly evaluated by a **competent person.**”
- “... a **competent person** is able to correctly determine that it can be so used. “

DIGGING IN...

Fall Protection – LOI 10/14/1999

- “... a ‘competent person’....must have had specific training in and be knowledgeable about the structural integrity”
- “The competent person must also be able to evaluate the effects of occurrences such as a dropped load, or a truck backing into a support leg that could damage a scaffold.”

DIGGING IN...

Fall Protection – LOI 10/14/1999

- “Manufacturers normally use engineering calculations, testing results and other considerations in preparing their guidelines on procedures and limitations. “
- “[The Competent] person would need to have a very high level of knowledge — a level that would enable him or her to understand the concerns the guidelines are meant to address and to determine that the deviation would not result in a hazardous condition. “

DIGGING IN...

Fall Protection – LOI 10/14/1999

- “Mere "experience" that the scaffold had previously been used in a way that deviates from the guidelines with no apparent failure is not a basis on which a competent person (or an employer) could proceed; such "experience" could be purely a product of luck.
“

DIGGING IN...

Fall Protection – LOI 8/28/1995

- “However, if an employer wishes to use a scissor lift as an anchorage for a personal fall arrest system, such as a safety belt and a lanyard or a body harness and a lanyard, they should not do so unless the manufacturer indicates that it can be used as an anchorage or such a usage is approved by a registered engineer.”

DIGGING IN...

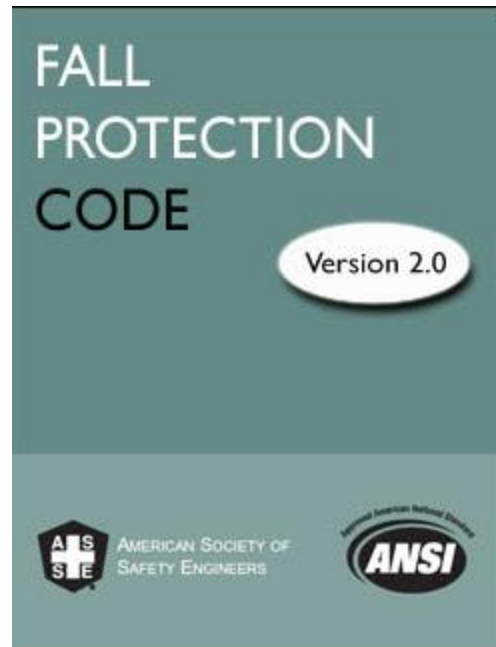
Fall Protection – LOI 02/08/2007

- *The employer must:
(i) Provide a qualified competent person, as specified in paragraphs (f) and (m) of [1926.32](#), who is responsible for ensuring that the **design**, maintenance, and inspection of the hoist system comply with the conditions of this policy and with the appropriate requirements*
- *The employer must use a qualified competent person to **design** and maintain*

DIGGING IN...

Fall Protection

Clarification Needed



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Fall Protection

Standardized, Systematic Approach

- Connects existing fall protection standards
- Information contained in one document
- Addresses topics not previously covered
- ANSI format
- Easier to understand and implement



DIGGING IN...

Fall Protection

- Emphasis on incorporating safety in project preplanning
 - Comprehensive Approach
 - Managed Process of Safety
- Reduced reliance on fall protection equipment



DIGGING IN...

Fall Protection

Competent Person

NOT LISTED BEFORE IN ANSI DOCUMENTS. HAS MORE TEETH THAN EXISTING OSHA REGULATIONS.



DIGGING IN...

Fall Protection

Competent Person

- An individual designated by the employer to be responsible for the immediate supervision, implementation, and monitoring of the employer's managed fall protection program who, through training and knowledge, is capable of identifying, evaluating, and addressing existing and potential fall hazards, and who has the employer's authority to take prompt corrective action with regard to such hazards.

DIGGING IN...

Fall Protection

Competent Person

- Designated by the employer
- Responsible
 - Immediate supervision
 - Implementation
 - Monitoring of the employer's MFPP
- Trained & Knowledgeable
- Capable of identifying, evaluating, and addressing existing and potential fall hazards
- Has employer's authority to take prompt corrective action

DIGGING IN...

Fall Protection

Knowledge & Training

- Provided in various sections of the ANSI/ASSE Z359 standards.
- An individual who does not possess training and knowledge in the areas required by this standard is not considered to be capable of identifying, evaluating, and addressing existing and potential fall hazards nor capable of taking the necessary corrective measures.

DIGGING IN...

Fall Protection

Qualified Person



**NOT LISTED
BEFORE IN ANSI
DOCUMENTS. HAS
MORE TEETH THAN
EXISTING OSHA
REGULATIONS.**

DIGGING IN...

Fall Protection

Qualified Person

- A person with a recognized degree or professional certificate **and** with extensive knowledge, training, **and** experience in the fall protection and rescue field who is capable of designing, analyzing, evaluating and specifying fall protection and rescue systems to the extent required by this standard.

DIGGING IN...

Fall Protection

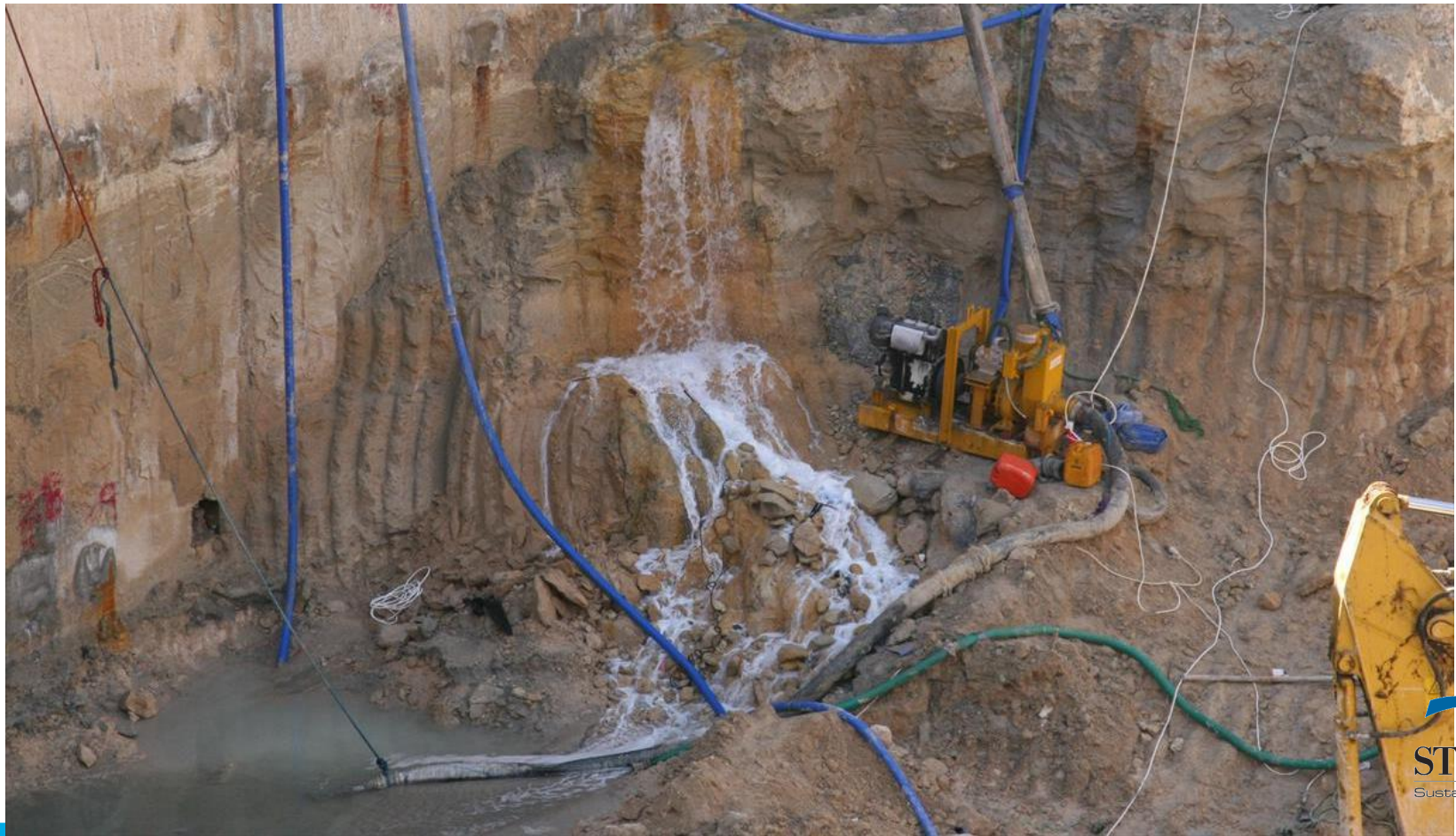
Importance

It is necessary to assure that a fall would be arrested **BEFORE** the person strikes the floor or *obstacle!*

OSHA requires that the “Free Fall” is not more than 6 feet

DIGGING IN...

Water Accumulation



DIGGING IN...

Water Accumulation

- Employees shall be protected from the water accumulating
- The precautions necessary to protect employees will vary with each situation
 - May include special support to protect from cave-ins
 - May include shield systems to protect from cave-ins
 - May include water removal to control the level of accumulating water
 - The water removal equipment and operations shall be monitored by a competent person to ensure proper operation.
 - May include the use of fall protection equipment (including lifelines)

DIGGING IN...

Water Accumulation

- Surface water shall be prevented from entering the excavation
- Surface runoff from heavy rains resulting in the excavation must be inspection by a competent person
 - Compliance with paragraphs (h)(1) and (h)(2) of [1926.651](#)

DIGGING IN...

Water Accumulation



DIGGING IN...

Water Accumulation



DIGGING IN...

Stability of Adjacent Structures

- Nearby buildings, property walls, or other structures must be structurally supported by engineered methods if they are endangered as a result of the excavation
 - Shoring, bracing, or underpinning shall be use to ensure the stability of such structures for the protection of employees.
- Excavation below the footing of any foundation or retaining wall shall be structurally support by engineered methods
 - Unless the excavation is in stable rock
 - Unless a PE determines no hazard will be created

DIGGING IN...

Stability of Adjacent Structures

- Don't undermine any Sidewalks, pavements and appurtenant structures
 - Unless a structural support system by engineered methods is provided to prevent possible collapse.



DIGGING IN...

Stability of Loose Rock or Soil

- Adequate protection shall be provided from loose rock or soil
 - Scaling to remove loose material
 - Installation of protective barricades to stop and contain falling material
 - Or other adequate means that provide equivalent protection.

DIGGING IN...

Daily Inspections of Excavations

- Excavations shall be inspected by a Competent Person
 - Prior to the start of work and throughout the day
 - After every rainstorm
- The Competent Person shall inspect for evidence of possible hazardous situation in the excavation that could result in:
 - Possible cave-ins
 - Indications of failure of protective systems
 - Hazardous atmospheres
 - Or other hazardous conditions

DIGGING IN...

Daily Inspections of Excavations

- The Competent Person shall remove all exposed employees from the excavation until the hazard is abated



DIGGING IN...

Protection of Employees in Excavations

- Employees shall be protected from cave-ins by engineered protection methods unless
 - Excavation is entirely in stable rock
 - Excavation is less than 5 feet
 - Examination of the excavation by a competent person provides no indication of a potential cave-in.
- The engineered protection methods shall resist all foreseeable applied loads

DIGGING IN...

Classification of Soils

- 1926 Subpart P App A
 - This method of classifying soil and rock deposits is based on site and environmental conditions, and on the structure and composition of the earth deposits
 - "Soil classification system" means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability

DIGGING IN...

Design of Sloping and Benching Systems

- 1926 Subpart P App B
 - Appendix B contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins
 - **Actual slope** means the slope to which an excavation face is excavated
 - **Distress** means that the soil is in a condition where a cave-in is imminent or is likely to occur
 - The development of fissures in the face of or adjacent to an open excavation

Continued...

DIGGING IN...

Design of Sloping and Benching Systems

- The subsidence of the edge of an excavation
- The slumping of material from the face or the bulging or heaving of material from the bottom of an excavation
- The spalling of material from the face of an excavation
- The ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

DIGGING IN...

Design of Sloping and Benching Systems

- **Maximum allowable slope** means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V)
 - The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1
- The actual slope shall not be steeper than the maximum allowable slope

DIGGING IN...

Design of Sloping and Benching Systems

- When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope

DIGGING IN...

Design of Sloping and Benching Systems

- Configurations of sloping and benching systems shall be in accordance with [1926 Subpart P App B](#)

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V)(1) FOR EXCAVATIONS LESS THAN 20 FEET DEEP(3)
STABLE ROCK	VERTICAL (90°)
TYPE A (2)	3/4:1 (53°)
TYPE B	1:1 (45°)
TYPE C	1 1/2:1 (34°)

DIGGING IN...

Design of Sloping and Benching Systems

- Type A soil



DIGGING IN...

Design of Sloping and Benching Systems

- Type B soil



DIGGING IN...

Design of Sloping and Benching Systems

- Type C soil



DIGGING IN...

Design of Sloping and Benching Systems

- The slopes and configurations of sloping and benching systems shall be selected and constructed in compliance
 - **Option (1) - Allowable configurations and slopes**
 - Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical or
 - Unless the employer uses one of the other options
 - Slopes are excavated to form configurations shown for Type C soil in Appendix B.

DIGGING IN...

Design of Sloping and Benching Systems

- **Option (2) - Determination of slopes and configurations using Appendices A and B**
 - Maximum allowable slopes, and allowable configurations for sloping and benching systems
 - Slopes shall be in compliance with the conditions and requirements in appendices A and B
- **Option (3) - Designs using other tabulated data.**
 - A copy of the tabulated data approved by the registered professional engineer
 - A copy of the design shall be maintained at the jobsite while the slope is being constructed

DIGGING IN...

Design of Sloping and Benching Systems

- **Option (3) - Designs using other tabulated data**
 - After the completion of the project, a copy of the tabulated data approved by the registered professional engineer shall be made available to the OSHA upon request
 - Designs of sloping or benching systems shall be in compliance with engineered methods.
 - Such as written tabulated data in design tables and charts and shall include all of the following:

DIGGING IN...

Design of Sloping and Benching Systems

- » Identification of the parameters that affect the selection of a sloping or benching system selected
- » Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe
- » Explanatory information to aid the employer or operator in the selection of the proper protective system

DIGGING IN...

Design of Sloping and Benching Systems

- **Option (4) - Design by a registered professional engineer.**
 - Sloping and benching systems outside the scope of Option (1) or Option (2) or Option (3) shall have written approval from the identified registered professional engineer
 - The magnitude of the slopes (i.e. limits) that were determined to be safe for the particular project
 - The configurations (soil profiles) that were determined to be safe for the particular project

DIGGING IN...

Design of Sloping and Benching Systems

– Option (4) - Design by a registered professional engineer.

- A copy of the design shall be maintained at the jobsite while the slope is being constructed
- After the completion of the project, a copy of the design approved by the registered professional engineer shall be made available to the OSHA upon request

DIGGING IN...

Design of Protective Systems

- Designs of support systems, shield systems, and other protective systems shall be selected and constructed and shall be in compliance
 - **Option (1) - Designs using appendices A, C and D.**
 - Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C
 - Designs for aluminum hydraulic shoring shall be in compliance with this subpart.
 - Unless the manufacturer's tabulated data cannot be utilized, then designs shall be in accordance with appendix D.

DIGGING IN...

Design of Protective Systems

- **Option (2) - Designs Using Manufacturer's Tabulated Data.**
 - Design of support systems, shield systems, or other protective systems that are selected from manufacturer's tabulated data shall be in compliance with all specifications, recommendations, and limitations issued or made by the manufacturer.
 - No changes may be made unless the manufacturer issues specific written approval

DIGGING IN...

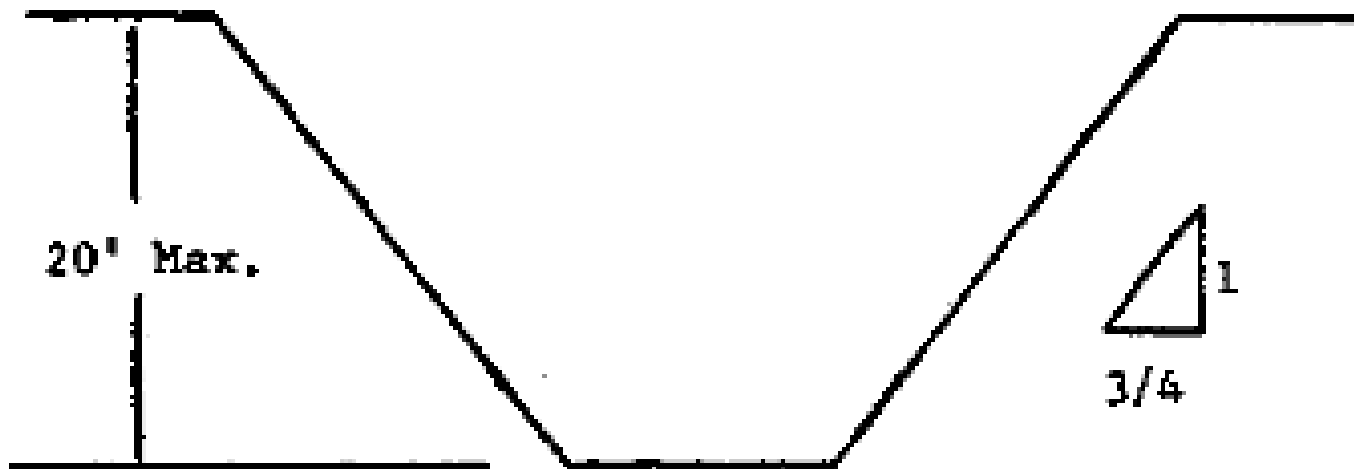
Design of Protective Systems



DIGGING IN...

Excavations Made in Type A Soil

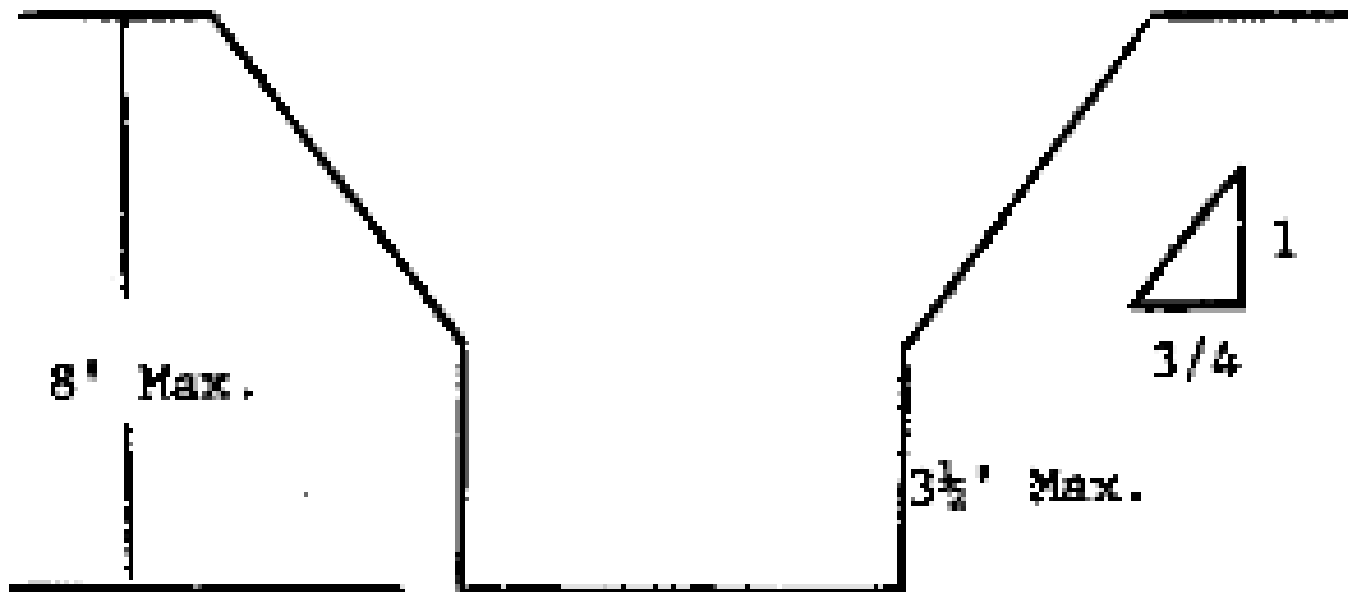
- All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of $\frac{3}{4}:1$



DIGGING IN...

Excavations Made in Type A Soil

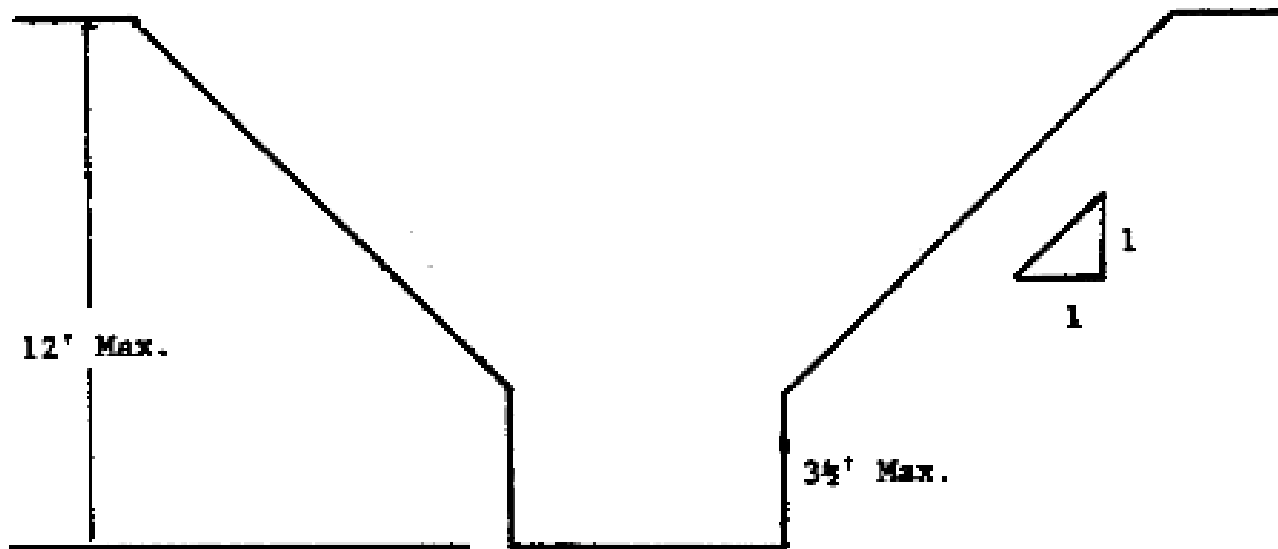
- All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



DIGGING IN...

Excavations Made in Type A Soil

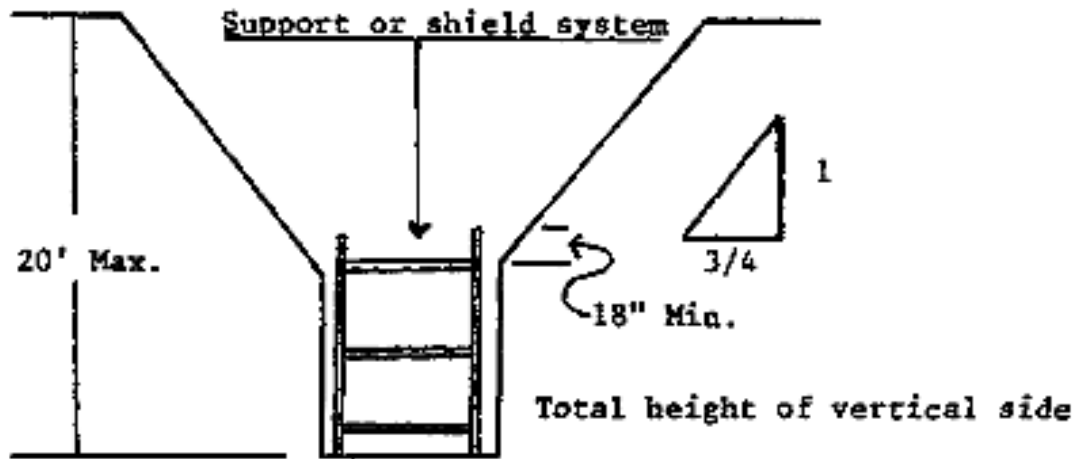
- All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



DIGGING IN...

Excavations Made in Type A Soil

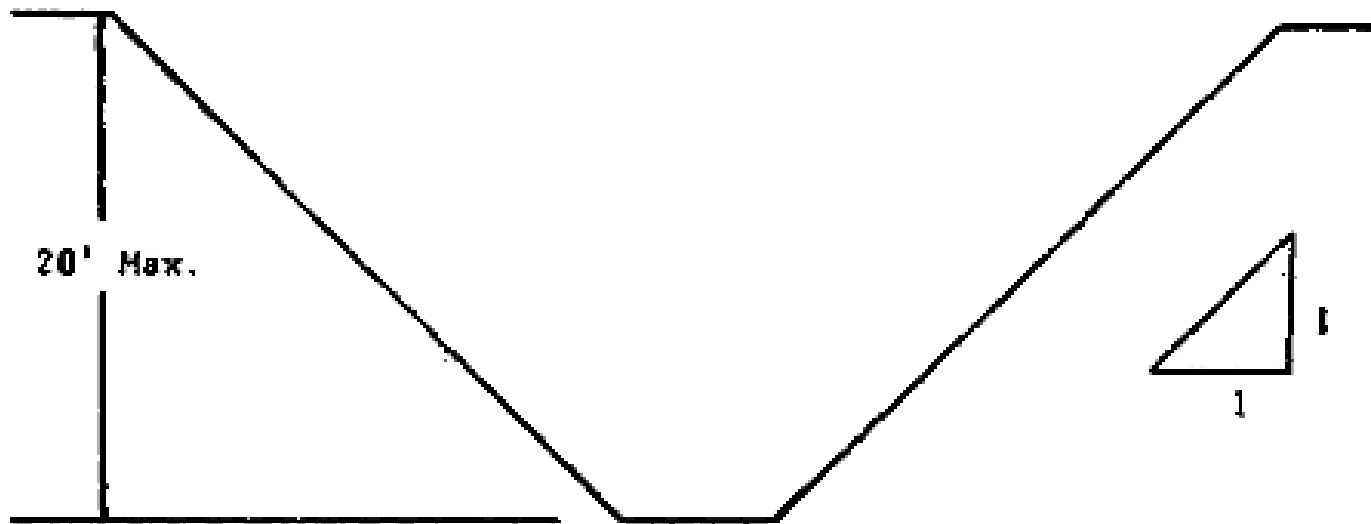
- All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of $\frac{3}{4}$:1. The support or shield system must extend at least 18 inches above the top of the vertical side.



DIGGING IN...

Excavations Made in Type B Soil

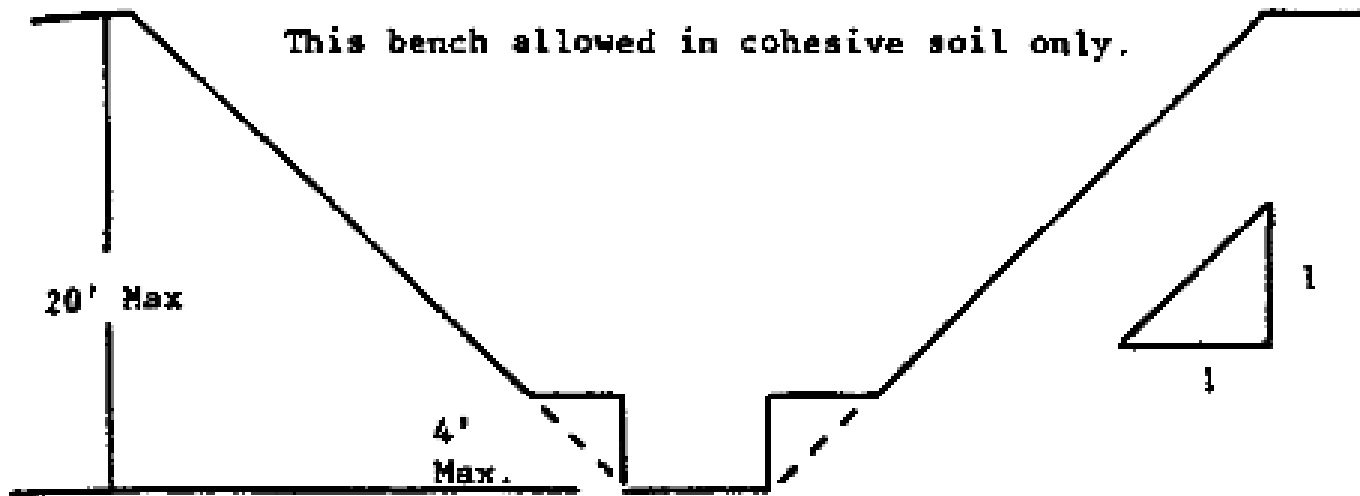
- All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.



DIGGING IN...

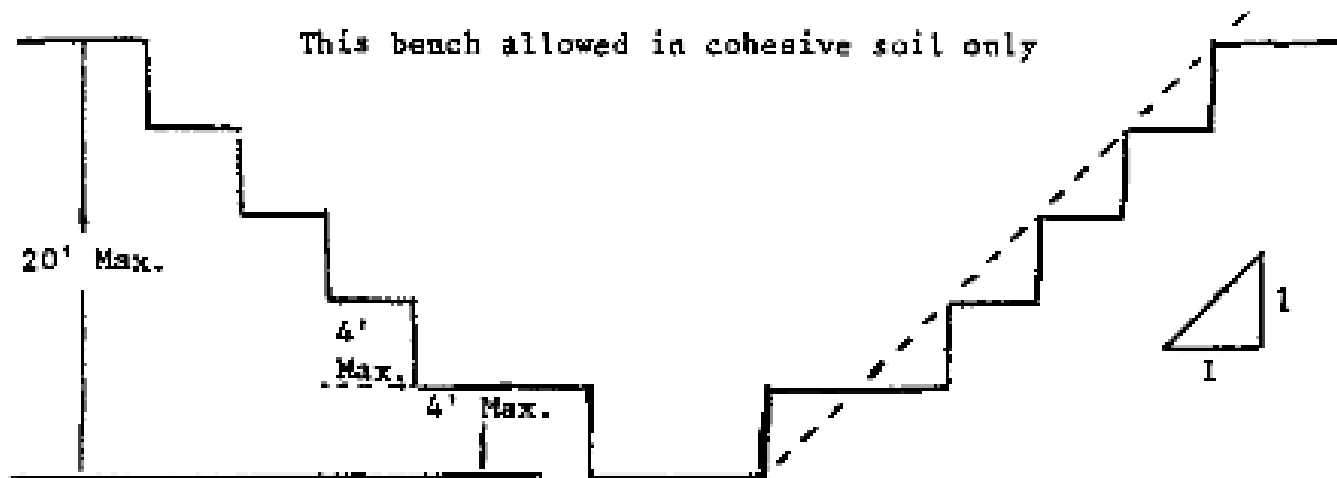
Excavations Made in Type B Soil

- All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:



DIGGING IN...

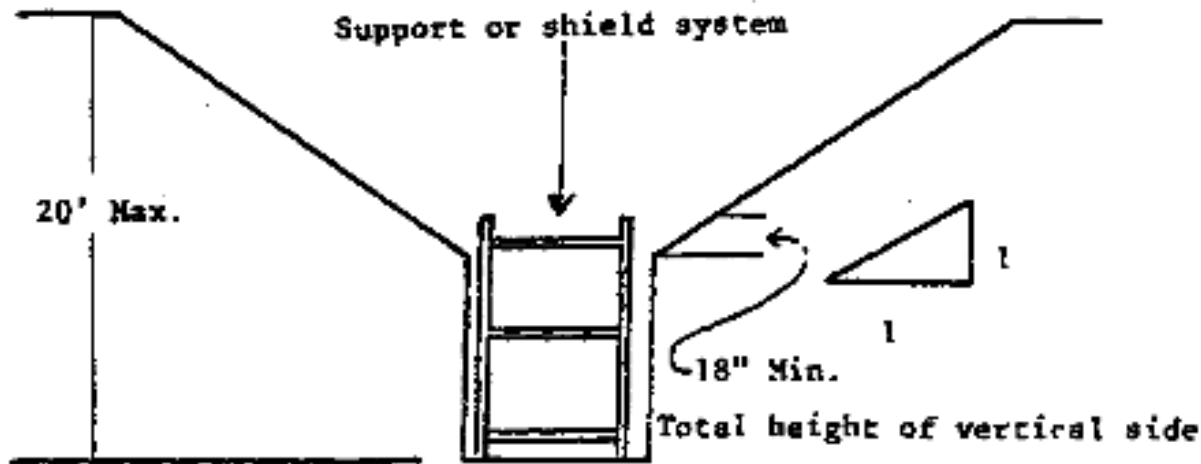
Excavations Made in Type B Soil



DIGGING IN...

Excavations Made in Type B Soil

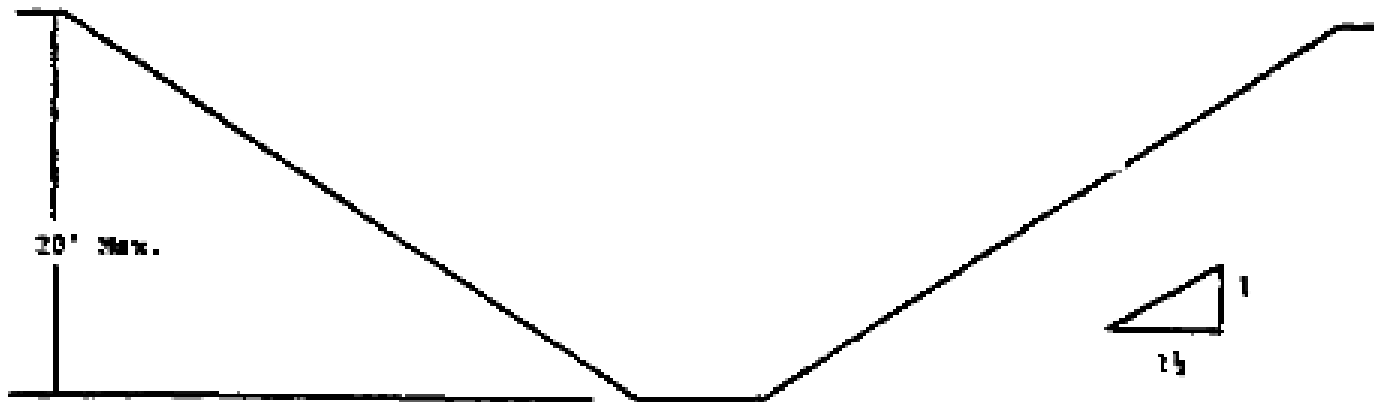
- All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.



DIGGING IN...

Excavations Made in Type C Soil

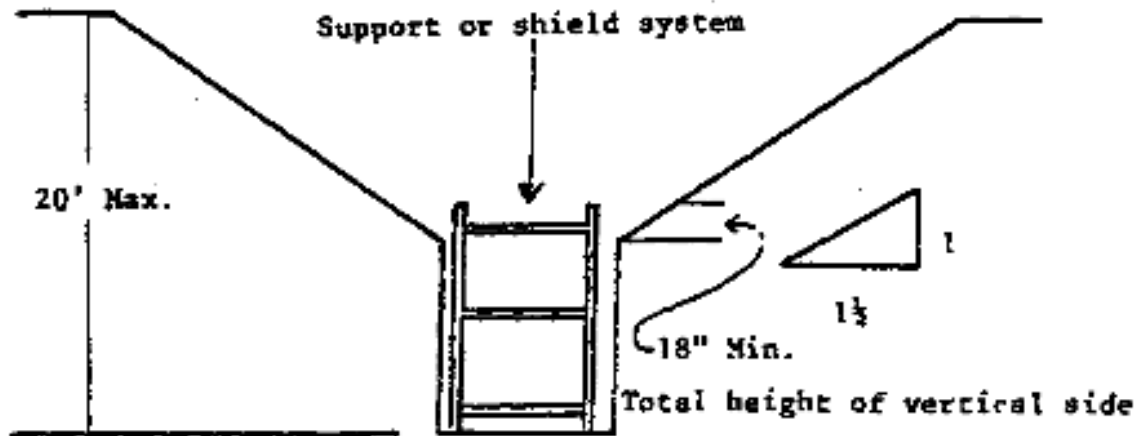
- All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



DIGGING IN...

Excavations Made in Type C Soil

- All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.



DIGGING IN...

Excavations Made in Layered Soil

- All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth in [1926 Subpart P App B, B-1.4](#)
- All other sloped excavations shall be in accordance with the other options permitted in [1926.652\(b\)](#)

DIGGING IN...

Building Collapse Case Study

- (1) An underground garage was being dug on the south side of a 13 story building, to a depth of 4.6 meters
- (2) The excavated dirt was being piled up on the north side, to a height of 10 meters
- (3) The building experienced uneven lateral pressure from south and north
- (4) This resulted in a lateral pressure of 3,000 tonnes, which was greater than what the pilings could tolerate. Unless a structural support system by engineered methods is provided to prevent possible collapse

DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study

First the building was constructed

美丽的
莲花河畔景苑大楼
是怎样倒塌的

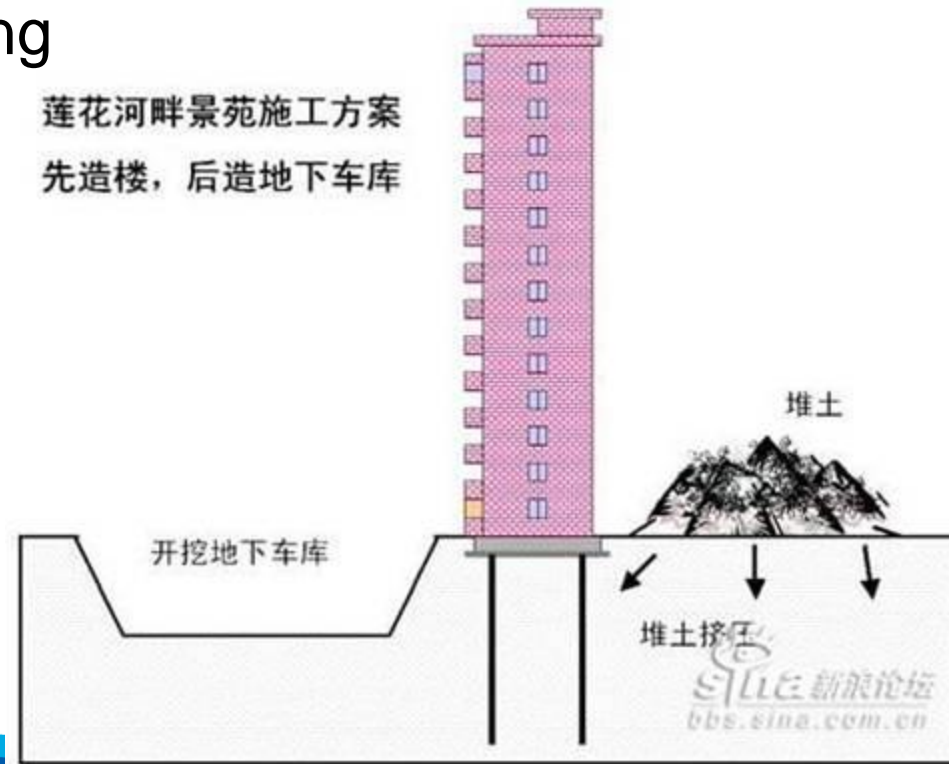


DIGGING IN...

Building Collapse Case Study

Then the plans called for an underground garage
The excavated soil was piled on the other side of the building

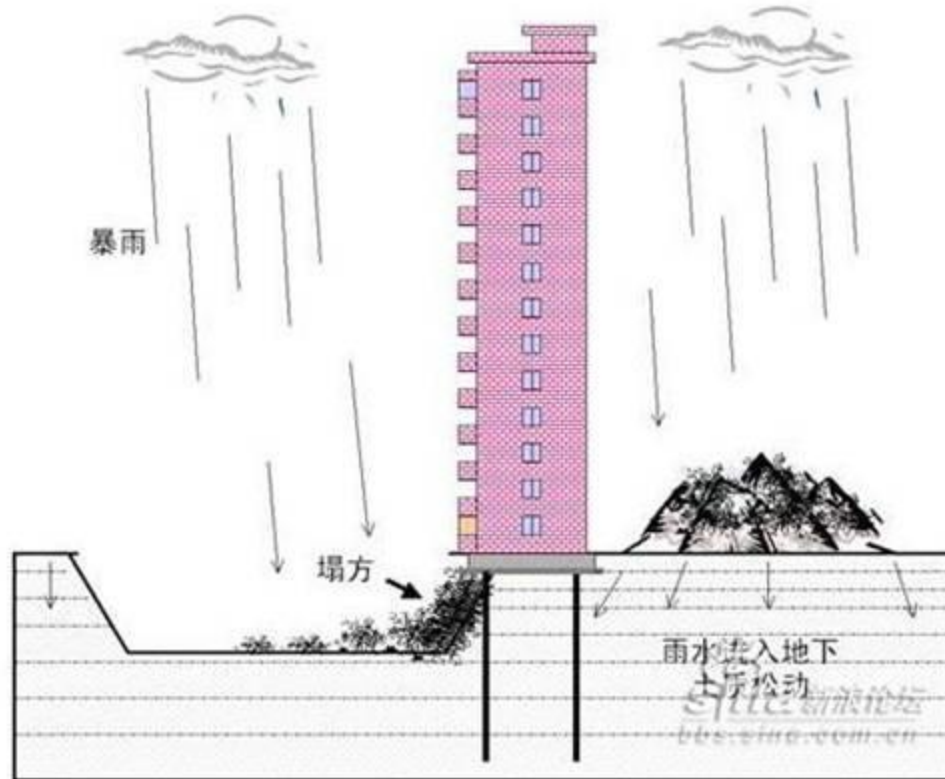
莲花河畔景苑施工方案
先造楼，后造地下车库



DIGGING IN...

Building Collapse Case Study

Heavy rains resulted in water seeping into the ground



DIGGING IN...

Building Collapse Case Study

The building shifted and the pilings snapped from lateral pressure_____

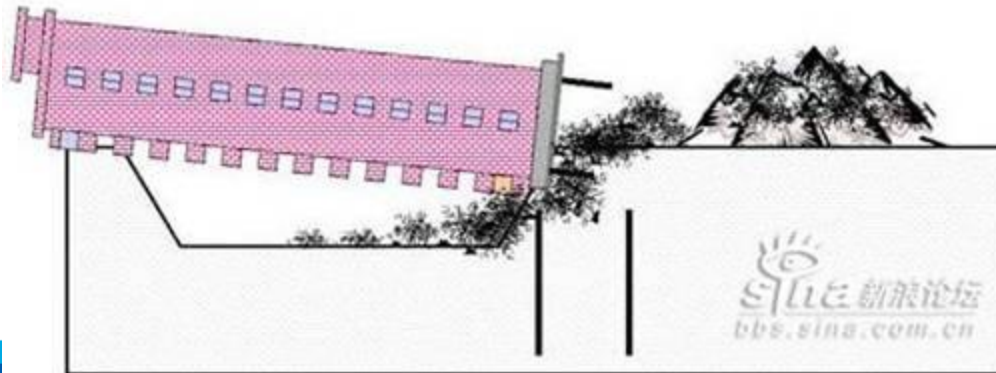


DIGGING IN...

Building Collapse Case Study

The building began to tilt

创造世界房屋倒塌奇迹



DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study



DIGGING IN...

Building Collapse Case Study

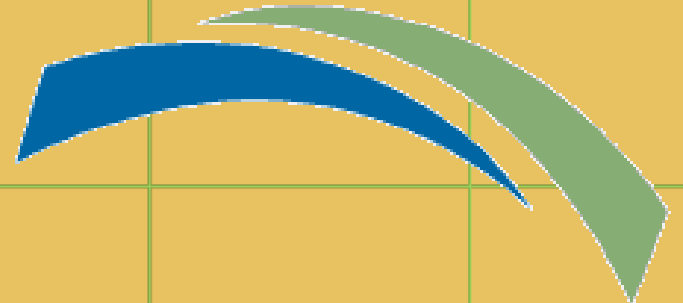
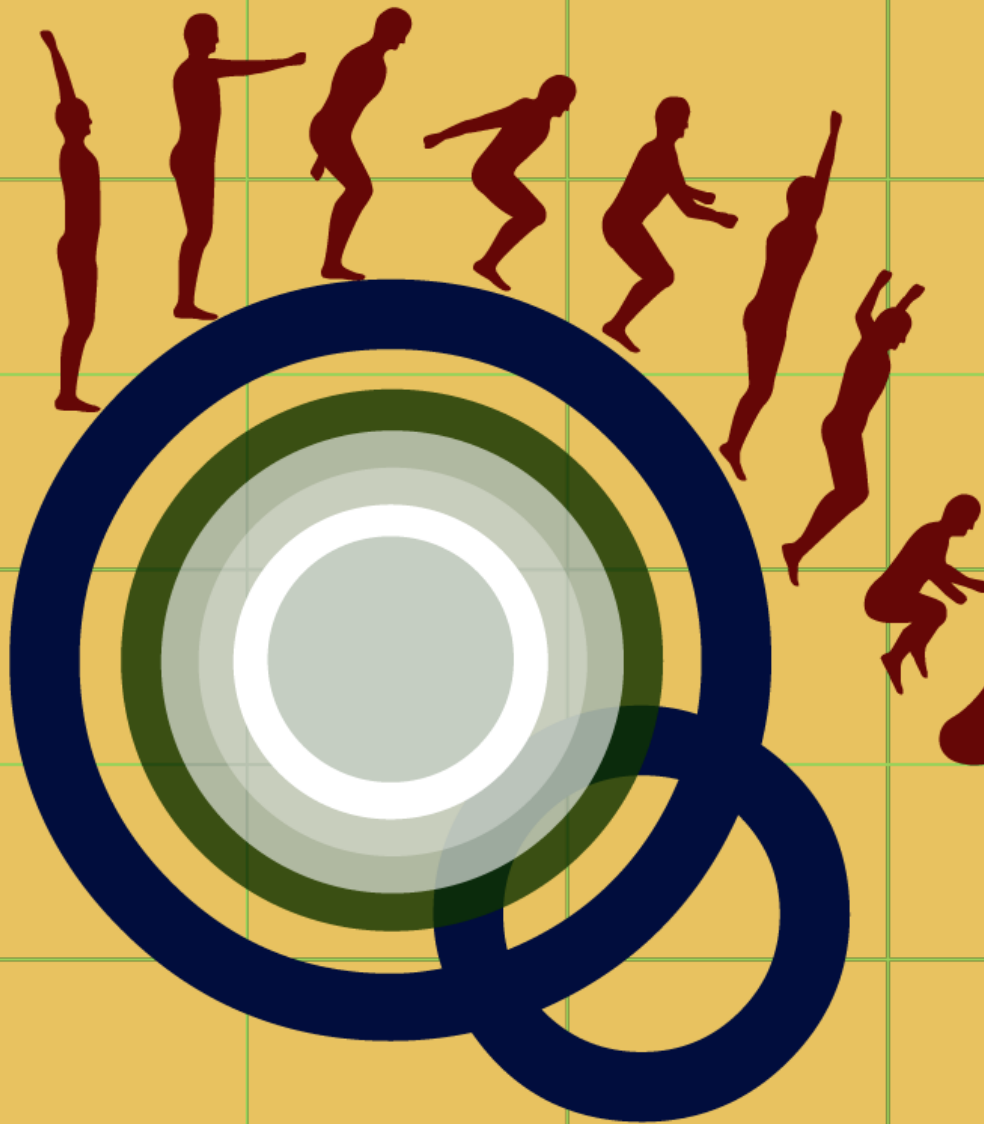
- (1) 13 stories
- (2) On grade
- (3) No basement
- (4) Hollow pilings
- (5) Little or no rebar

DIGGING IN...

WRAP UP

- Sustainable Safety® is more than compliance
- Maintain a safe workplace – 5(a)(1)
- Safety Program is more than just excavation
 - Lockout/Tagout
 - Access and egress
 - Fall Protection
 - Site inspections
 - Hazardous Atmosphere
 - Suspended Loads
 - Rescue

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