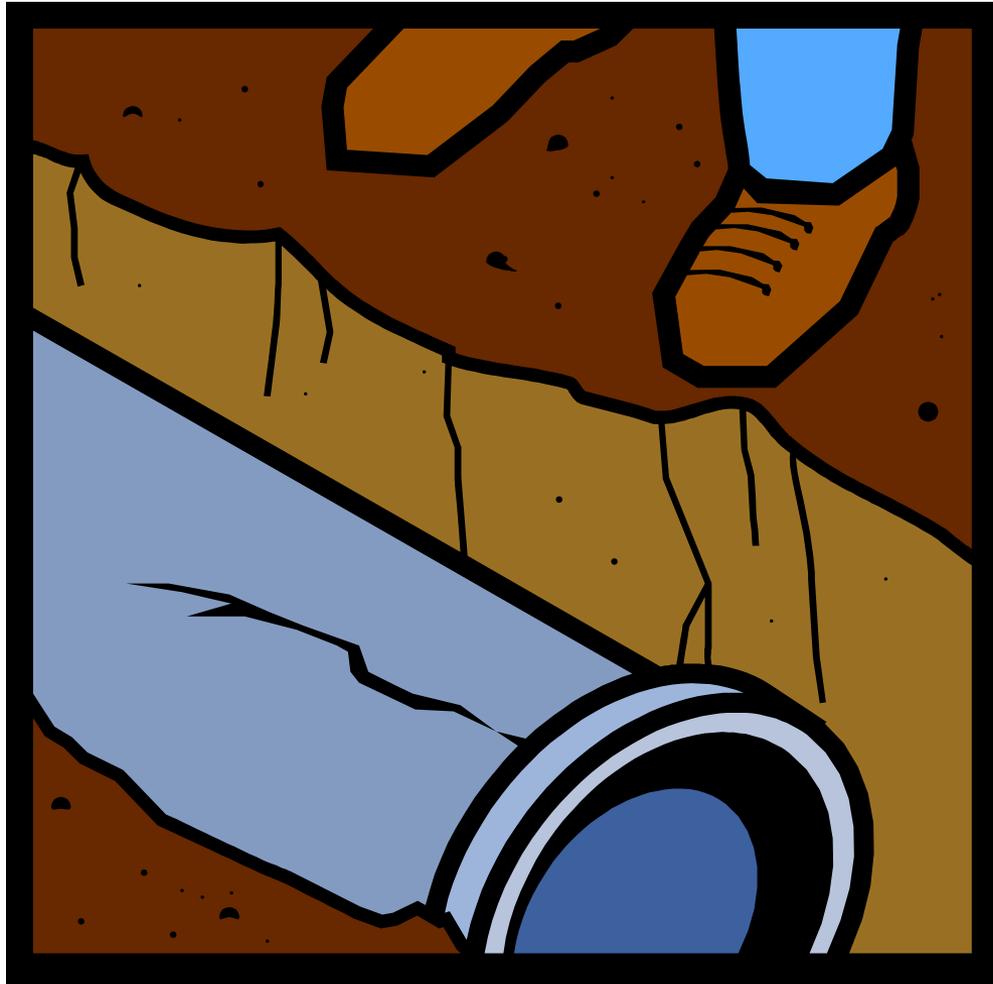


Trenching



Trenching

- **29 CFR 1926.651 “Excavation Requirements”**
 - Controls the trenching and excavation requirements for construction (excluding tunnels)
 - Provides requirements for employee entrance, working environment, and egress to/from open surface trenches and excavations



Trenching

- Pre-excavation requirements

- The estimated location of utility installations such as sewer, telephone, fuel, electric, water lines, or other underground installations that reasonably may be encountered during excavation work shall be determined prior to opening an excavation
- Utility companies or utility locator should be contacted to precisely locate such utilities
- Excavation may proceed with **CAUTION** if
 - >> Utility Company/Locator can not be located or contacted >>
 - Utility Company/Locator can not locate utility



Trenching

- Excavation opening requirements

- When excavating operations approach the location of underground utilities, the exact location shall be determined by safe and acceptable means
- While excavation is open, underground installations shall be protected, supported, or removed as necessary to safeguard employees



Trenching

-Excavation access/egress

- Structural ramps/runways used for access/egress
 - If constructed of two or more members, shall have members connected together
 - if constructed of two or more members, shall have members of uniform thickness
 - Cleats or other connections shall be attached to bottom of runways/ramps
 - Runways/ramps shall be anchored to prevent movement or slipping
- Ladders
 - Shall be of proper design
 - Shall be secured from movement or slippage
 - Shall extend 3' above top of excavation



Trenching

– Employee protection

- Employees exposed to public vehicular traffic shall be provided with and wear vest or other suitable garments marked with high visibility materials
- No employee shall be permitted underneath loads handled by digging or lifting equipment
- When mobile equipment is operated near excavation; barricades, hand and mechanical signals, or stop logs shall be used to protect employees in excavations



Trenching

–Hazardous atmospheres

- Excavations of greater than 4' depth that are located in or near hazardous materials, liquids, or gases shall be tested for the presence of hazardous atmospheres prior to employee entry
 - >> An atmosphere shall be considered hazardous if the level of atmospheric contaminants exceeds 20% of the PEL
- Excavation of greater 4' depth shall be regularly tested for oxygen deficiency (less than 19.5% oxygen)
- Ventilation and respiratory protection shall be provided where hazardous atmospheres are encountered



Trenching

– Emergency rescue equipment

- Where hazardous atmospheres exist or may be expected to occur, the following rescue equipment shall be readily available for use
 - >> Safety Harnesses and lines
 - >> Basket stretcher
 - >> Breathing apparatus equipment
- Employees entering bell-bottomed holes shall wear harness and life line protection
- Employees shall not work in excavations where there is accumulated water unless adequate safety precautions (shoring, ect.) have been taken



Trenching

– Stability of adjacent structures

- Excavations near structures or buildings shall be protected by shoring or other means to assure stability of the affected structure
- Diversion ditches, dikes, or other suitable means shall be provided to prevent surface water intrusion where natural drainage has been interrupted
- Excavations near foundation footings, sidewalks, pavement, or other appurtenant structures shall be protected by underpinning or other suitable means to maintain stability



Trenching

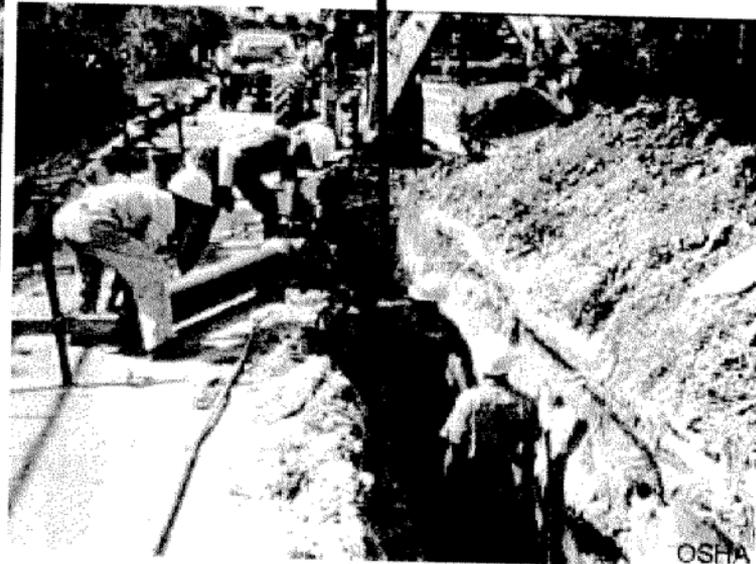
- Stability of excavated materials and excavation walls
 - Excavated materials shall be kept a minimum of 2' from the edge of excavations or by the use of retaining devices
 - Excavated materials may require further clearance from excavations in accordance with soil types (see table)
 - Excavation wall slopes or other wall protection shall be used in accordance with soil type, moisture levels, and other criteria as specified in the soil tables (see table)



Trenching



ARE THESE WORKERS SAFE?

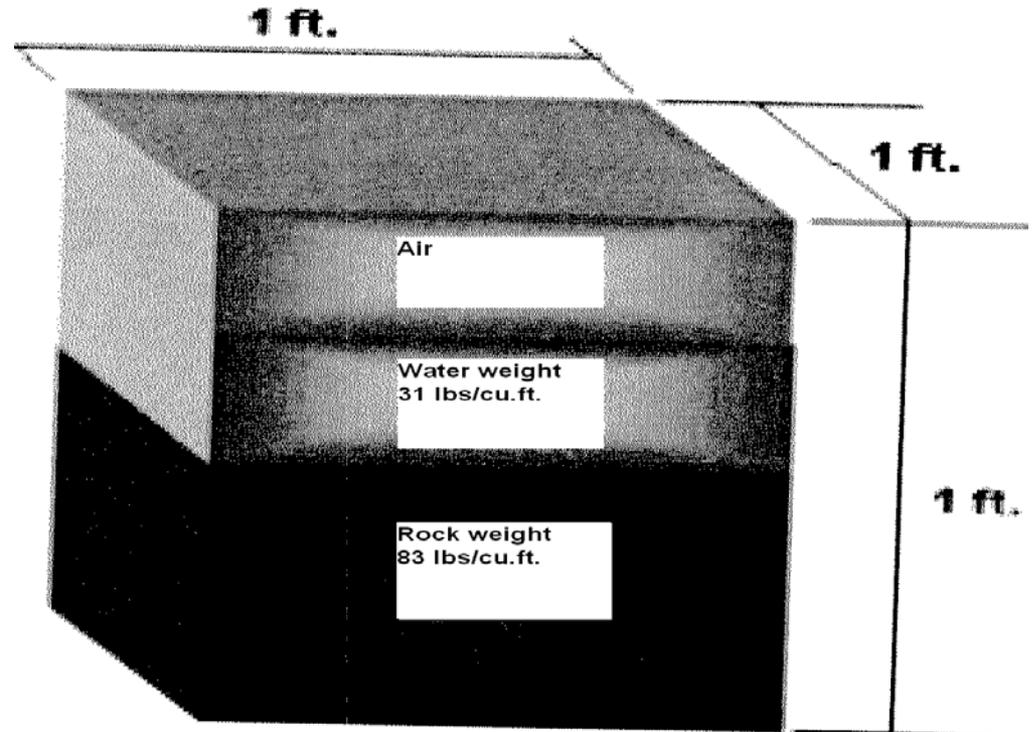


Trenching

- Employee protection in excavations
 - Any excavation or trench >4' depth shall have its walls protected from cave-in or “sluffing”
 - By sloping walls of excavation
 - By shoring excavation
 - By shielding

Trenching

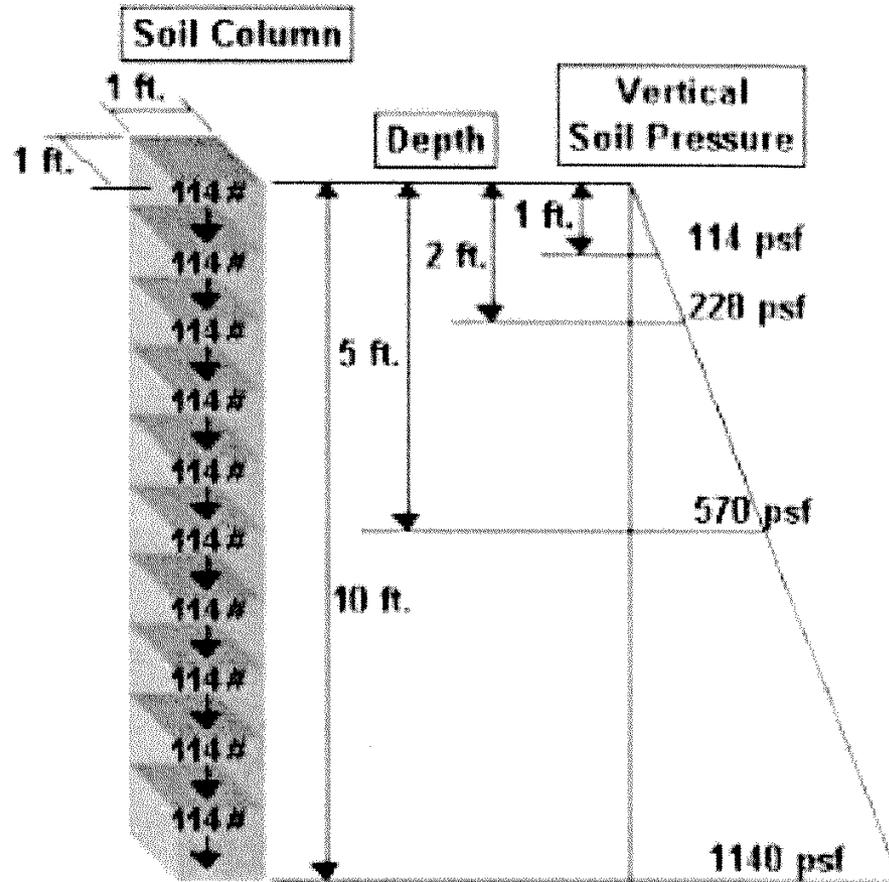
Soil density
makes it
Extremely
Dangerous



Soil weight
114 lbs/cu.ft.

Average soil density

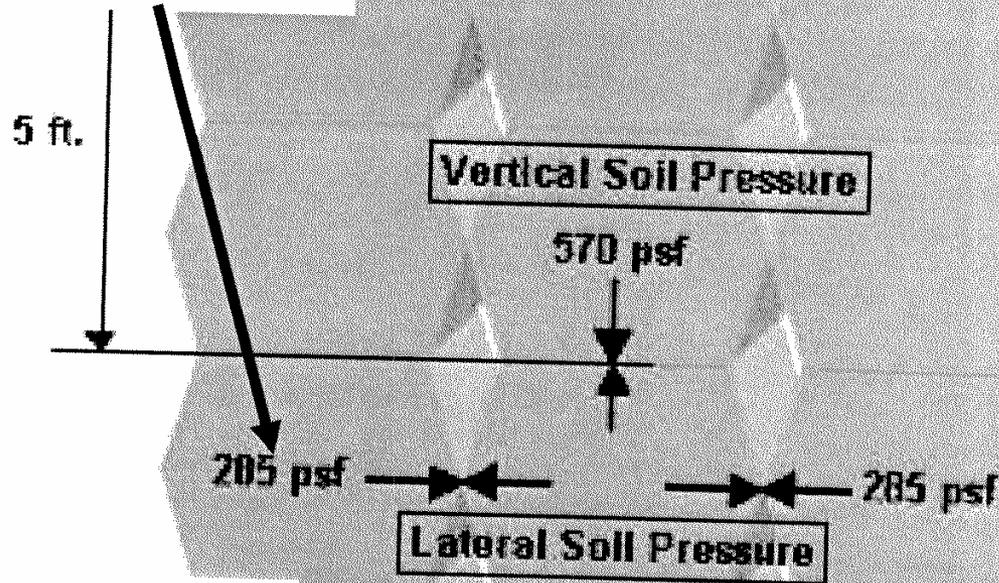
Trenching



SOIL COLUMN PRESSURE

Trenching

LATERAL PRESSURE ~ =
50% VERTICAL PRESSURE

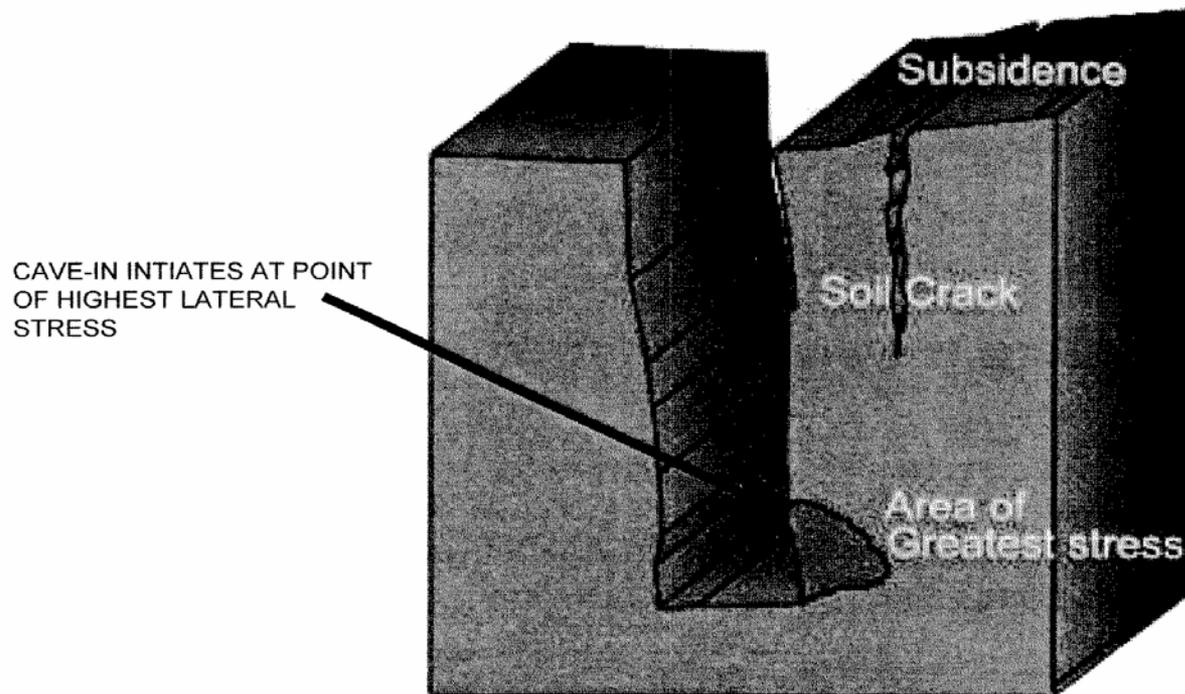


THAT'S WHY MOST TRENCH
COLLAPSE INITIATES AT THE
BOTTOM OF THE TRENCH

SOIL LATERAL COLUMN PRESSURE



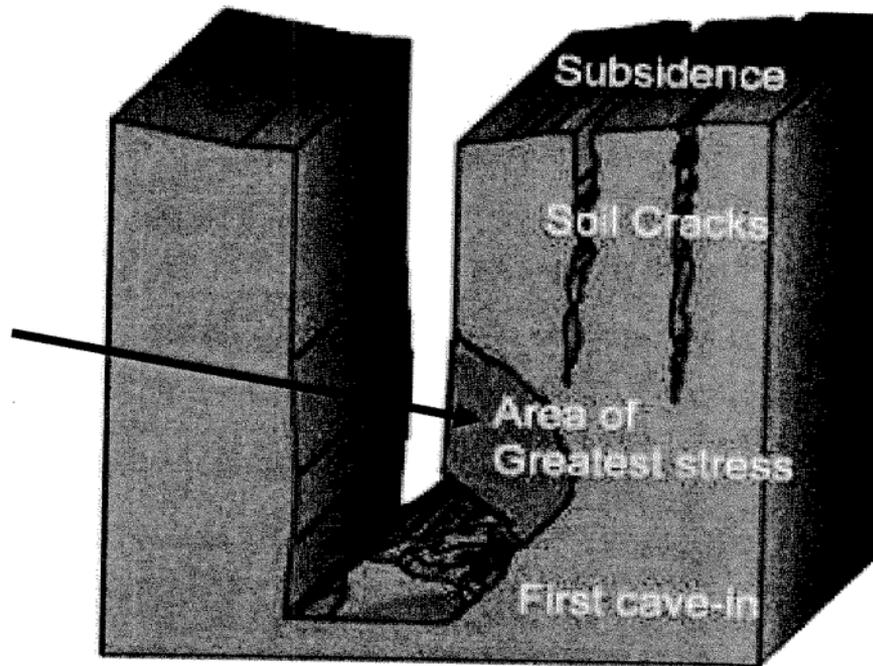
Trenching



ANATOMY OF A CAVEIN - ONSET

Trenching

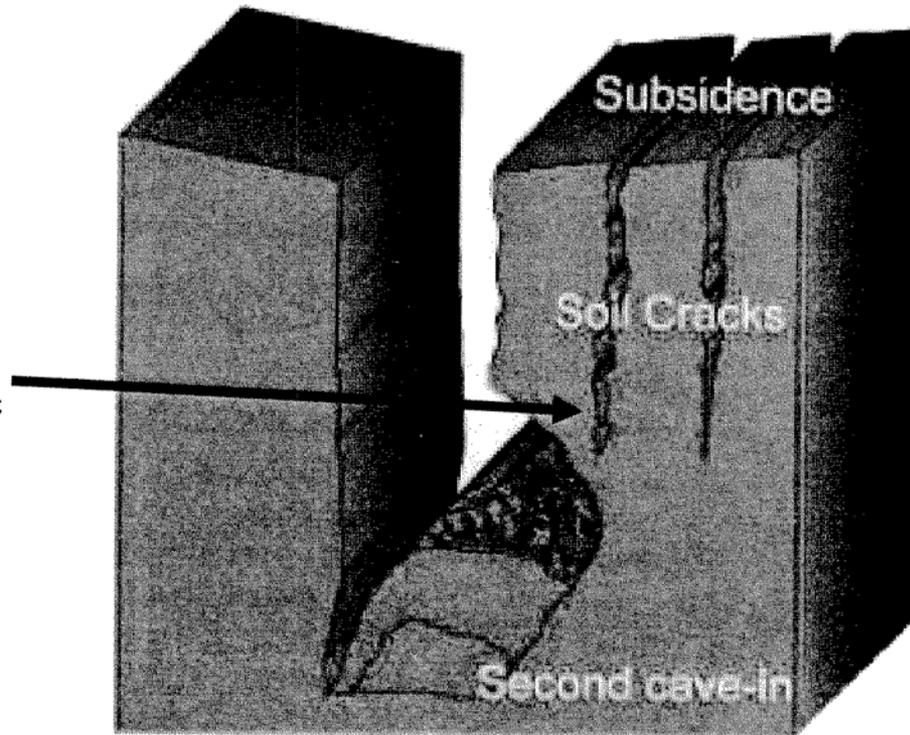
REMAINING COLUMN OF SOIL CANNOT SUPPORT ITSELF VERTICALLY AND SEPARATES AT POINT OF HIGHEST STRESS



ANATOMY OF A CAVEIN – GROWTH STAGE

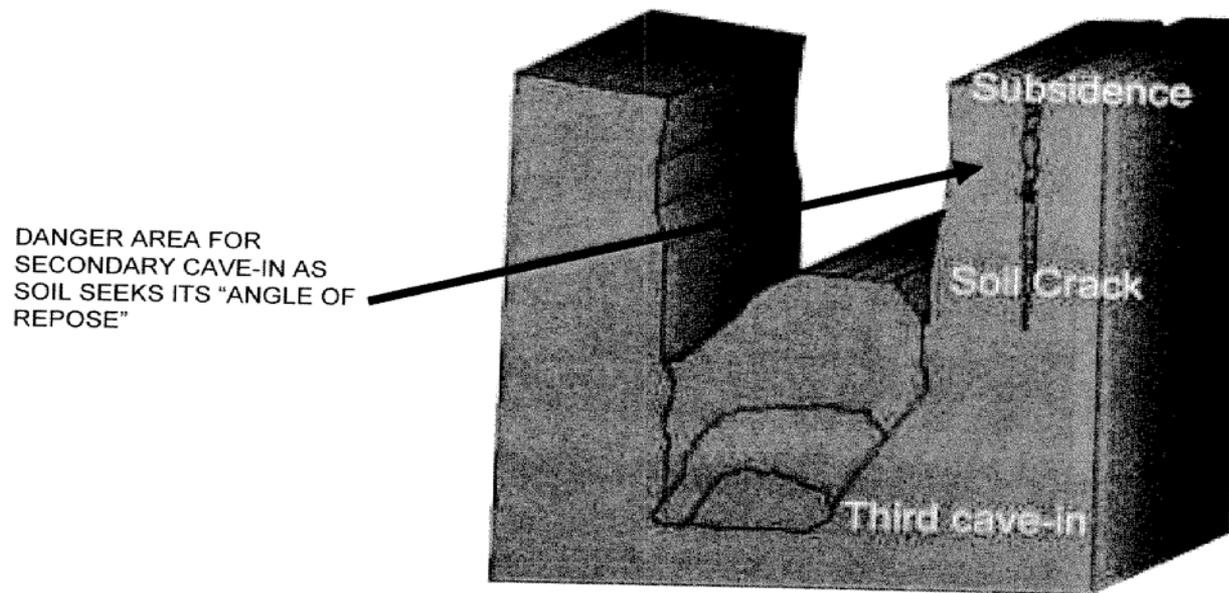
Trenching

CAVE-IN SPEED IS
INFLUENCED BY SOIL
CRACKS, FISSURES,
MOISTURE, POROSITY, ETC



ANATOMY OF A CAVEIN – FULLY DEVELOPED

Trenching



ANATOMY OF A CAVEIN – COMPLETION

Trenching

- There is a "natural angle of repose" for soil. It means that over time the soil will go to a certain slope (usually its natural angle).



Trenching

- Excavation protection is a function of soil type

OSHA categorizes soil and rock deposits into four types as follows:

- A. STABLE ROCK is a natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. Most of the time it is identified by a rock name such as granite or sandstone.
- B. TYPE 'A' SOILS are cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater. These types of soils are often clay, silt clay, sandy clay, clay loam and in certain cases, silty clay loam and sandy clay loam.
- C. TYPE 'B' SOILS are cohesive soils with an unconfined compressive strength greater than 0.5, but less than 1.5 tons per square foot. Examples include angular gravel silt, silt loam, and/or previously disturbed soils
- D. TYPE 'C' SOILS are cohesive soils with an unconfined compression strength of 0.5 tons per square foot or less. Granular soils like gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping, and submerged rock that is not stable fall into the Type 'C' soil category.



Trenching

	Option	Type A	Type B	Type C
	Simple Slope	Yes	Yes	Yes
	Short-term Slope	Yes	No	No
	Simple Bench	Yes	Yes	No
	Multiple Bench	Yes	Yes/No*	No
	Slope with Shoring/Shielding	Yes	Yes	Yes

*Multiple bench allowed only in cohesive Type B soil

TRENCH SLOPES VS. SOIL TYPE

Trenching

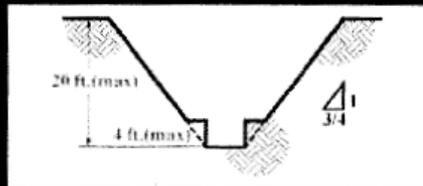
Slope Configurations



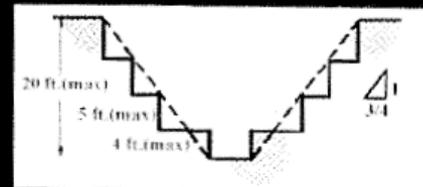
SIMPLE SLOPE - GENERAL
TYPE A SOIL
20 ft. or less in depth
maximum allowable slope of 3/4:1



SIMPLE SLOPE - SHORT TERM*
TYPE A SOIL
12 ft. or less in depth
maximum allowable slope of 1/2:
*open 24 hours or less

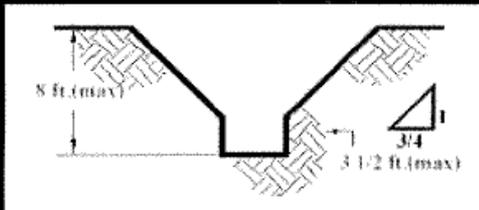


SINGLE BENCH
TYPE A SOIL
20 ft. or less in depth
maximum allowable slope of 3/4:1
maximum bench height 4 ft.

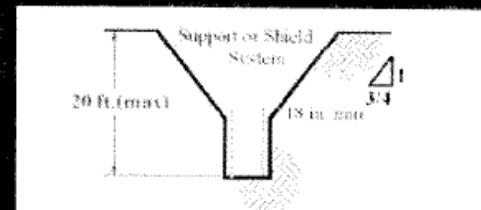


MULTIPLE BENCH
TYPE A SOIL
20 ft. or less in depth
maximum allowable slope of 3/4:1
maximum bench heights shown

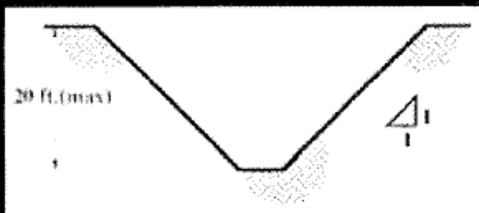
Trenching



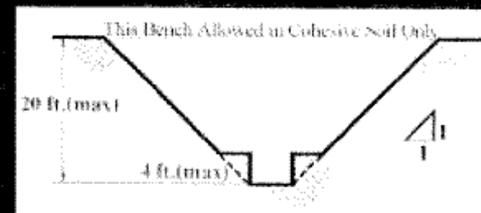
**UNSUPPORTED VERTICALLY SIDED LOWER PORTION
TYPE A SOIL**
8 ft. or less in depth
maximum vertical side of 3-1/2 ft



SUPPORTED/SHIELDED VERTICALLY SIDED LOWER PORTION - TYPE A SOIL
20 ft. or less in depth
maximum allowable slope of 3/4:1
support/shield system must extend at least 18 in. above vertical side

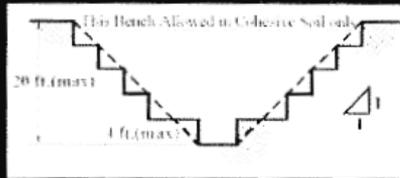


**SIMPLE SLOPE
TYPE B SOIL**
20 ft. or less in depth
maximum allowable slope of 1:1



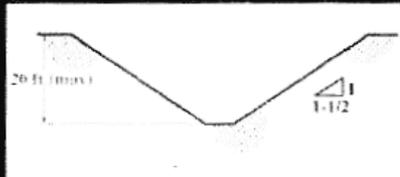
**SINGLE BENCH
TYPE B SOIL**
20 ft. or less in depth
maximum allowable slope of 1:1
maximum bench height 4 ft.

Trenching



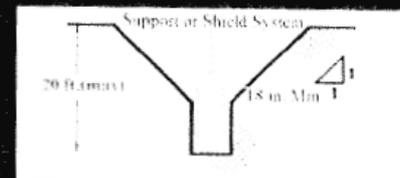
MULTIPLE BENCH TYPE B SOIL

20 ft. or less in depth
maximum allowable slope of 1:1
maximum bench heights shown



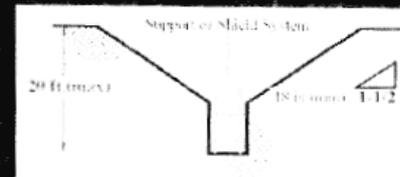
SIMPLE SLOPE TYPE C SOIL

20 ft. or less in depth
maximum allowable slope of 1-1/2:1



SUPPORTED/SHIELDED VERTICALLY SIDED LOWER PORTION - TYPE B SOIL

20 ft. or less in depth
maximum allowable slope of 1:1
support/shield system must extend
at least 18 in. above vertical side

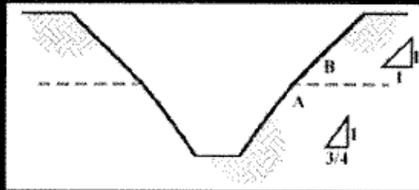


SUPPORTED/SHIELDED VERTICALLY SIDED LOWER PORTION - TYPE C SOIL

20 ft. or less in depth
maximum allowable slope of 1-1/2:1
support/shield system must extend
at least 18 in. above vertical side

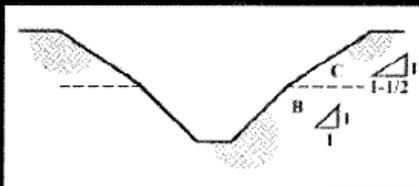
TRENCH SLOPES CONFIGURATIONS – PG 3

Trenching



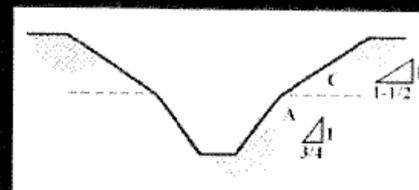
LAYERED SOILS B OVER A

20 ft. or less in depth
maximum allowable slope for each
layer
shown above



LAYERED SOILS C OVER B

20 ft. or less in depth
maximum allowable slope for each
layer
shown above



LAYERED SOILS C OVER A

20 ft. or less in depth
maximum allowable slope for each
layer
shown above



LAYERED SOILS A OVER B

20 ft. or less in depth
maximum allowable slope for each
layer
shown above

TRENCH SLOPES CONFIGURATIONS – PG 4

Trenching



LAYERED SOILS A OVER C

20 ft. or less in depth
maximum allowable slope for each
layer
shown above

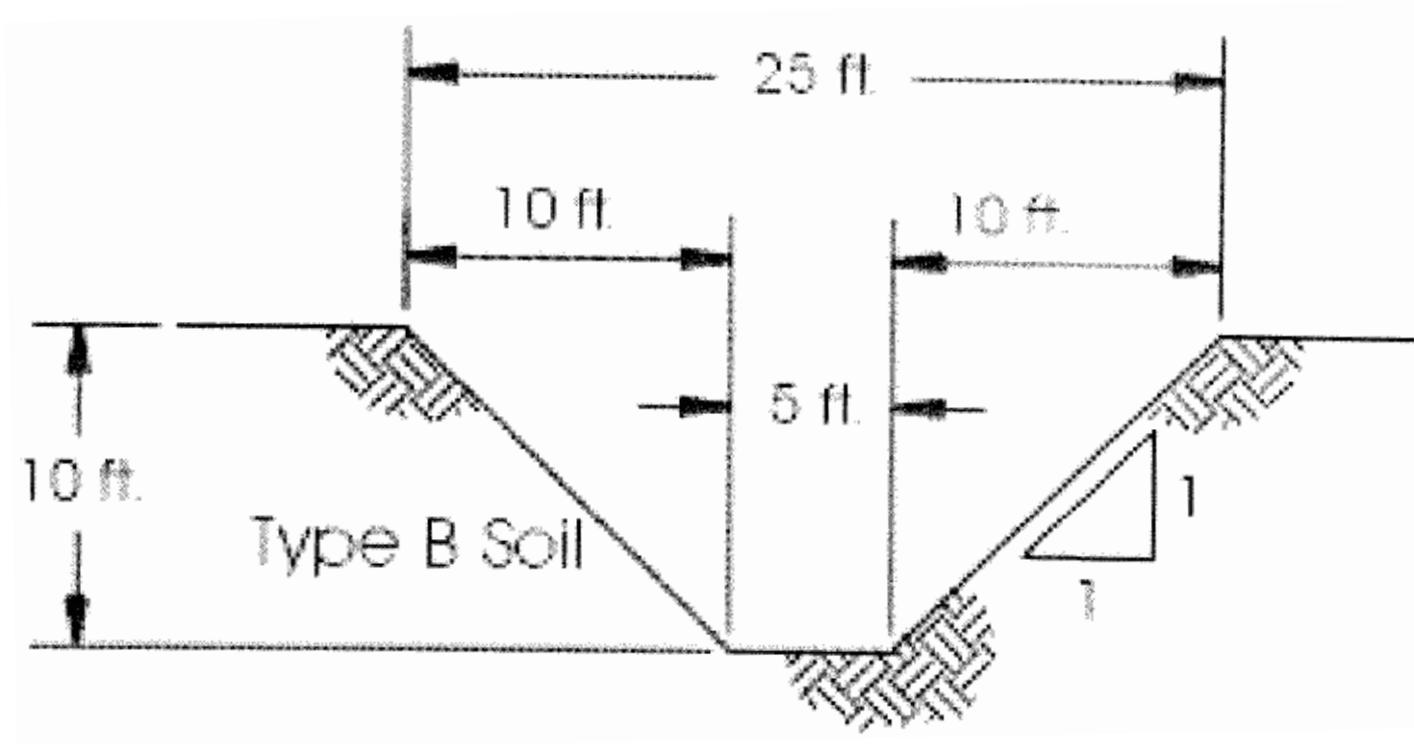


LAYERED SOILS B OVER C

20 ft. or less in depth
maximum allowable slope for each
layer
shown above

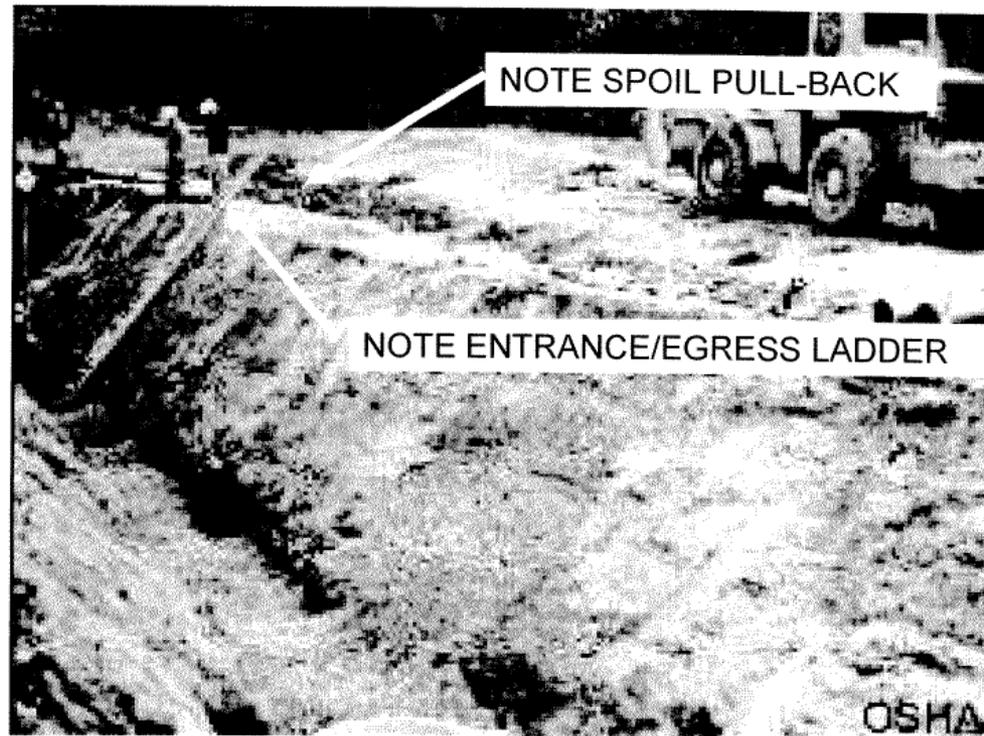
TRENCH SLOPES CONFIGURATIONS –PG 5

Trenching



Trench typical dimensions

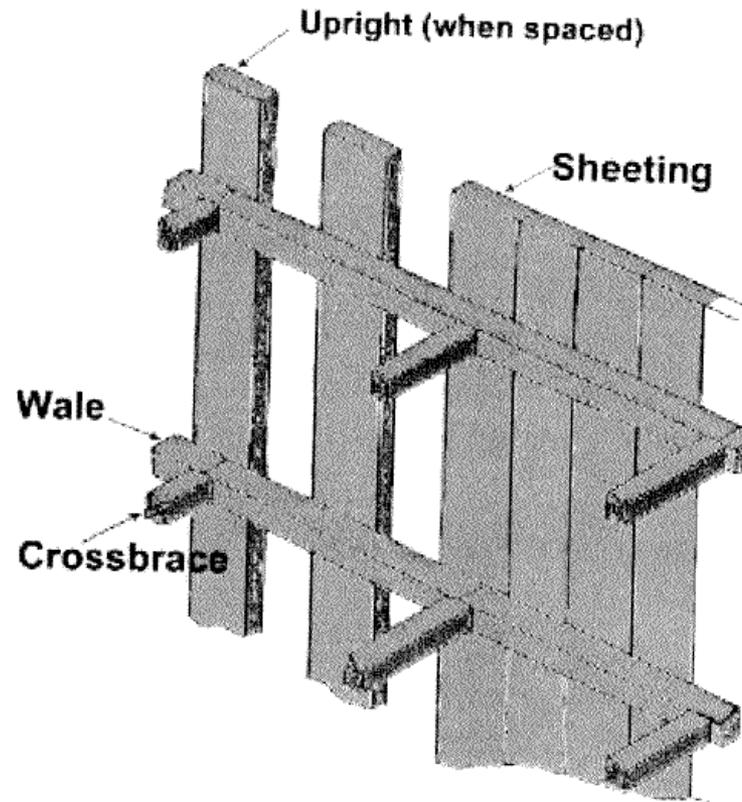
Trenching



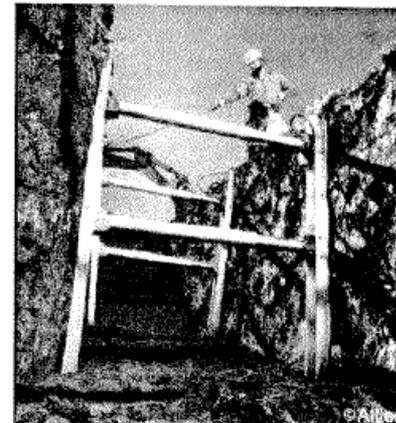
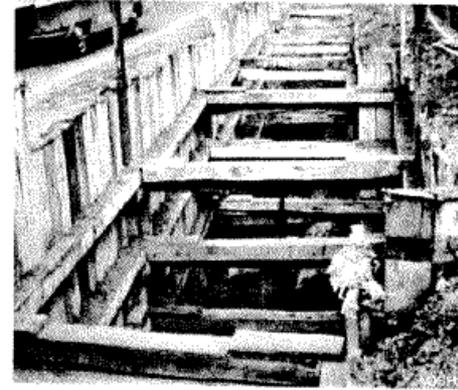
Typical sloped trench

Trenching

Shoring System Components

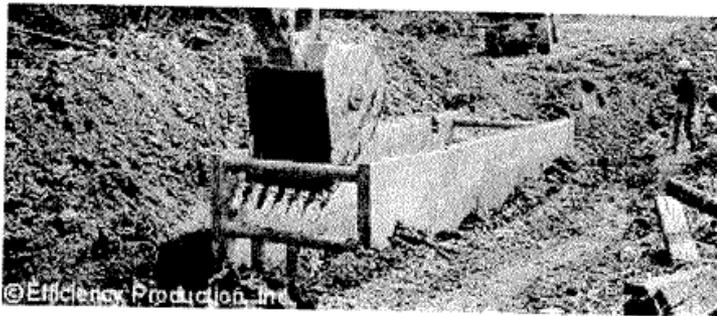
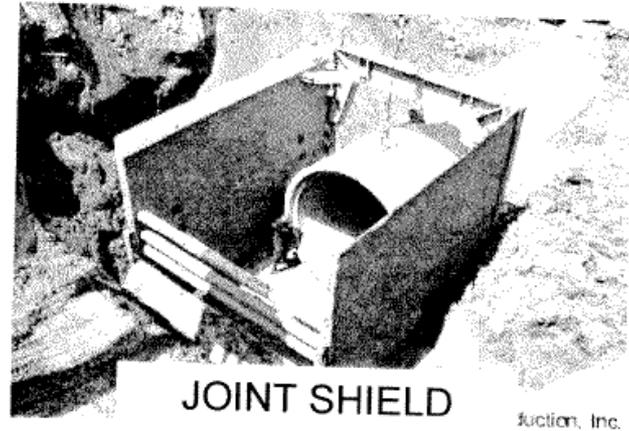
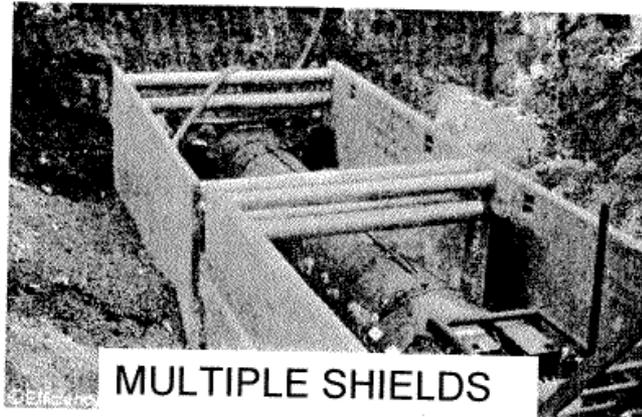


Trenching



TRENCH SHORING EXAMPLES

Trenching



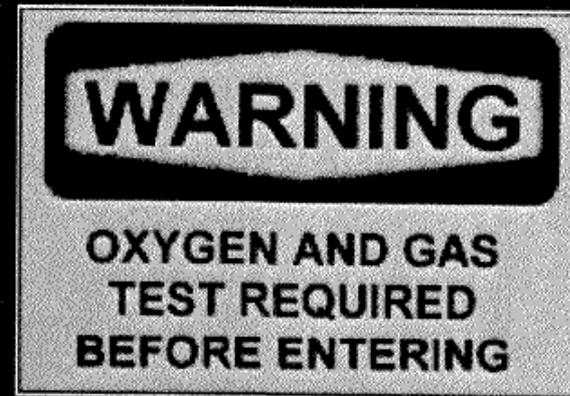
SLIDING SHIELD



Trenching

A hazardous atmosphere is one which is:

- Oxygen deficient
- Toxic
- Explosive
- Flammable
- Corrosive
- Irritating
- Oxidizing
- Poisonous



Trench hazardous atmospheres

Trenching

Oxygen Content and Worker Level								
Activity	Oxygen Content in the Work Space (%)							
Level	21	20	19	18	17	16	15	14
Resting	A	A	A	A	A	A	A	A
Walking	A	A	A	A	A	A	A	
Moderate Work	A	A	A	A	A			
Heavy Work	A	A	A	A				
	A	Blood Oxygen Content Adequate						
		Blood Oxygen Content Likely Inadequate						

RESPIRATORY PROTECTION REQ'D

SAFE WORKING OXYGEN LEVELS IN TRENCHES

Trenching

BEWARE!

**CO & CO2 ARE
HEAVIER THAN AIR
& WILL COLLECT
AT BOTTOM OF
EXCAVATIONS!!!!**



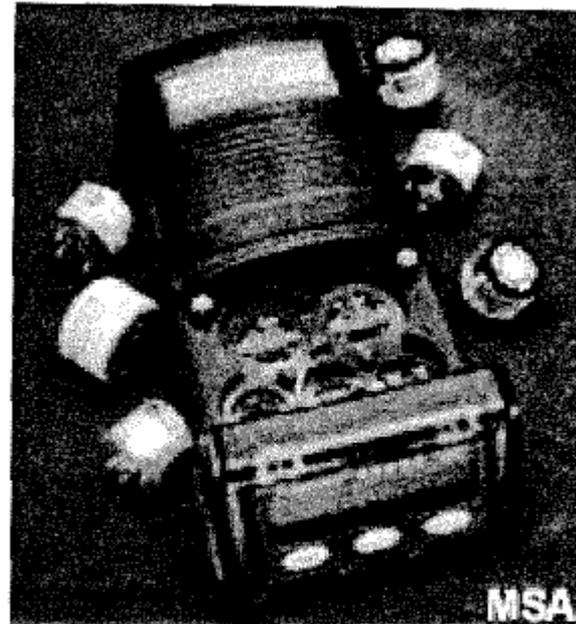
TRENCH MACHINE OPERATIONS



Trenching



ATMOSPHERIC MONITORING PPE



GAS MONITOR WITH GAS SAMPLE
CANISTERS

SAFE WORKING OXYGEN LEVELS IN TRENCHES