

Excavation and Trenching Safety

**Controlling Excavation and
Trenching Related Hazards**

References

- ◆ EM 385-1-1 Section 25
- ◆ 29 CFR 1926.650 ; Subpart P
- ◆ NFGS 1525 (Latest)
- ◆ Manufacturer's Material
- ◆ Accident Abstracts

Potential Contractor Mishap Outcomes

- ◆ Cave-ins
- ◆ Fires, Explosions, Electrocutions and Engulfments due to utility hits
- ◆ Struck by falling objects
- ◆ Falls and Equipment rollovers
- ◆ Asphyxiation, toxic exposures, and explosions due to hazardous atmospheres
- ◆ **Leading to property damage, injury, death**

Direct Causes of Excavation and Trenching Mishaps

- ◆ Working in trench which is not shored, sloped or shielded
- ◆ Not having ladder within 25 ft of workers
- ◆ Digging without utility identification
- ◆ Failure to keep tools, materials and equipment at least 2 ft from excavation's edge
- ◆ Failure to barricade
- ◆ Failure to test and monitor atmosphere

Indirect Causes of Excavation and Trenching Mishaps

- ◆ Lack of training
- ◆ No SOP for operation
- ◆ Lack of supervision
- ◆ Failure to apply AHA by site superintendent
- ◆ Inadequate site-specific safety training prior to phase of work

Indirect Causes of Excavation and Trenching Mishaps (continued)

- ◆ Approved safety plan not implemented
- ◆ Proper tools, materials & protective system not provided
- ◆ Daily inspections of excavation, protective system and surrounding area not performed
- ◆ Lack of management leadership

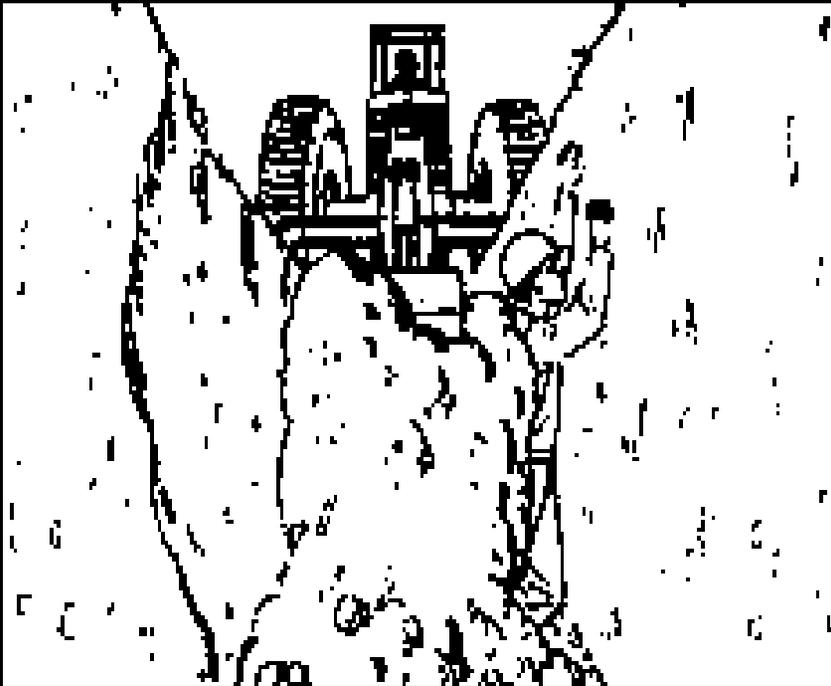
Excavation Safety Facts

- ◆ Each year as many as 400 workers die and another 4000 are injured from cave-ins.
- ◆ Most are 20-30 years old with no training.
- ◆ Most deaths are in trenches 5-14 ft deep.
- ◆ Cave-ins cause deaths by; Suffocation, Crushing, Loss of Circulation and Falling Objects.
- ◆ One cubic foot of soil can weigh up to 140lbs
- ◆ One cubic yard can weigh 3000 lbs.

Excavation Mishap Myths

- ◆ Work can be completed and back-filled so fast that it will not have time to cave-in.
- ◆ Dirt smells peculiar just before it caves in.
- ◆ It is possible to out-run a collapsing wall.
- ◆ A rope tied to a worker will help rescuers find them if the trench caves in.. (it might but they'll be dead).
- ◆ Cave-in victims can be dug out easily with a backhoe... (victims are usually disemboweled or decapitated).

Fatal Mishap



- ◆ Trench was 4 ft. deep and 7 ft. wide.
- ◆ Backhoe was 30 ft. away straddling trench.
- ◆ The operator the saw collapse.
- ◆ No protective system
- ◆ Worker died.

Cave-in Contributory Factors

- ◆ Soil Type
- ◆ Soil Moisture Content
- ◆ Vibration
- ◆ Surface Loads
- ◆ Previously Disturbed Soil
- ◆ Intersecting Trenches
- ◆ Freezing/Thawing
- ◆ Traffic
- ◆ Equipment
- ◆ Adjacent Structures
- ◆ Ground Water

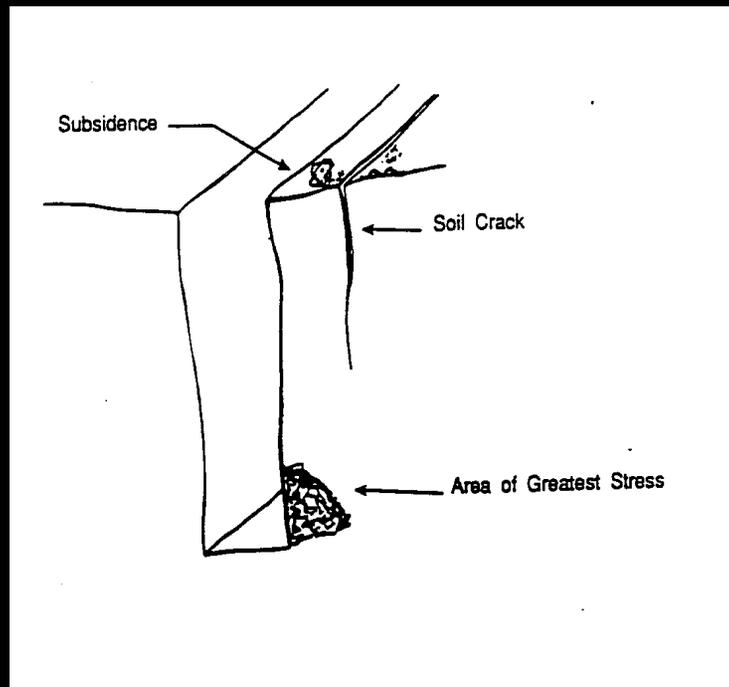
Mechanics of a Cave-in

- ◆ An excavation is an unnatural situation.
- ◆ One cubic foot weighs about 100 lbs.
- ◆ Consider a one foot by one foot column which is ten feet high.
- ◆ At ten feet the vertical stress (compression) is 1,000 lbs.
- ◆ Lateral stress (tension) trying to pull the column away (into the trench) from the rest of the remaining soil is half the vertical stress: 500 lbs.

Mechanics of a Cave-in con't

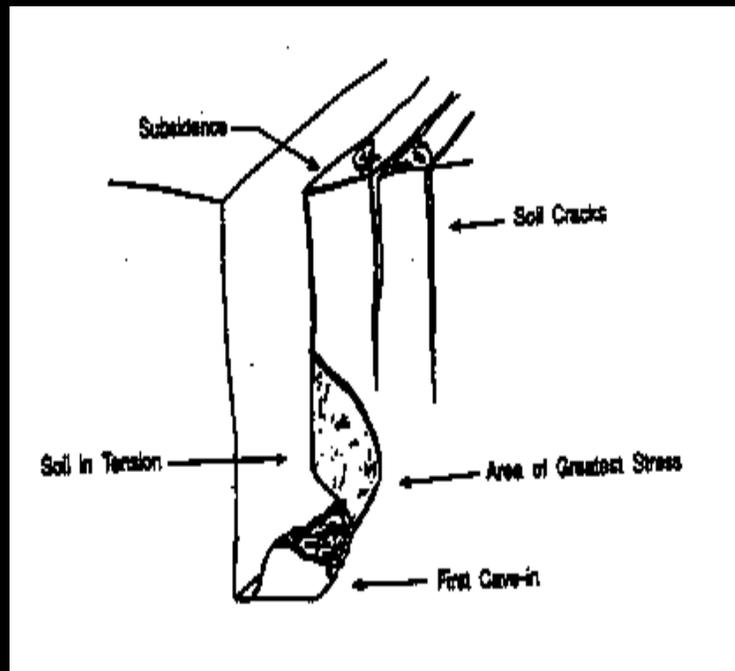
- ◆ Dirt, like concrete, handles compression well but tension poorly.
- ◆ Undisturbed soil may be visualized as an infinite number of columns.
- ◆ When an excavation is cut into these columns, the soil will begin to immediately move, however slowly, into the excavation.

Mechanics of a Cave in



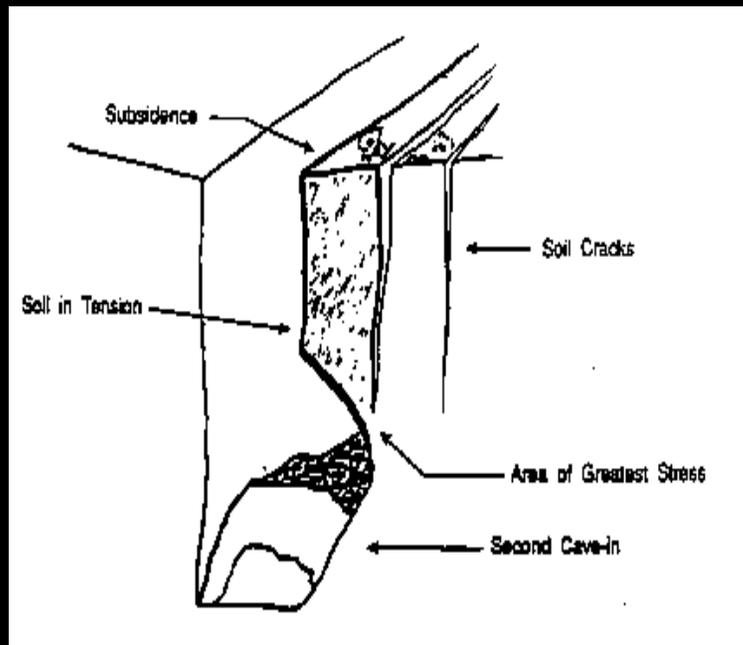
- ◆ Surface cracks will occur $1/3$ to $2/3$ of the excavation depth.
- ◆ Once these cracks appear great pressure is placed on the lower part of the excavation.

Mechanics of a Cave in



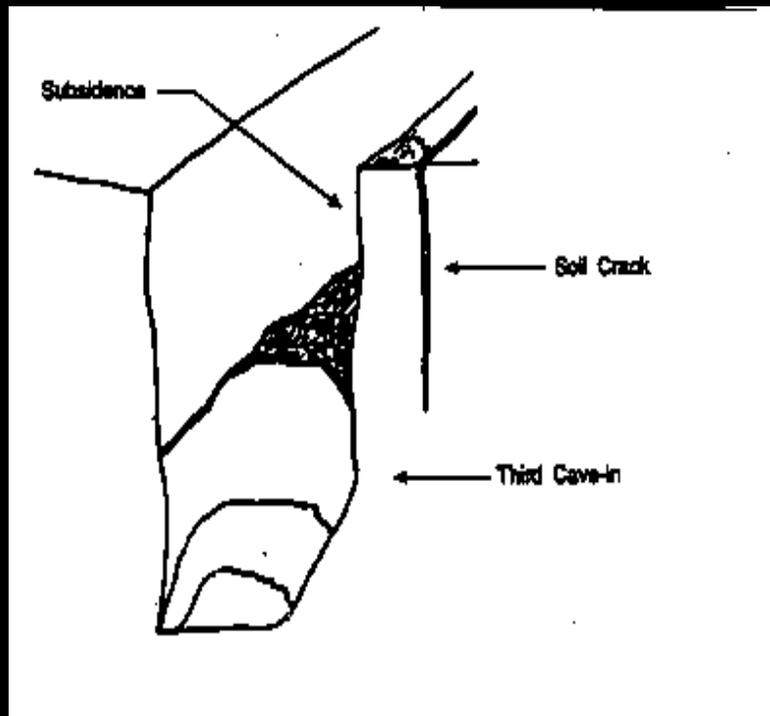
- ◆ The great pressure causes the bottom of the excavation to fail.
- ◆ First cave-in occurs !
- ◆ Excavation wall is now hanging only by tensile forces.
- ◆ Soil can't handle tension.

Mechanics of a Cave in



- ◆ Further subsidence
- ◆ More tension
- ◆ Greater stress
- ◆ Second Cave in occurs
- ◆ Remainder of soil hangs in tension

Mechanics of a Cave in



- ◆ Third and final Cave-in occurs.
- ◆ Remember- soil, like concrete, is normally strong in compression but not at all strong in tension.
- ◆ Break ground and you create tension !

Controlling Excavation and Trenching Hazards

Contractors must use various methods to protect their workers from the hazards associated with excavation and trenching. These include: Following EM-385 Section 25, Most recent Guide Specifications, and Safety Plan/AHA.

Contractor review of associated Accident Abstracts also helpful !

Planning-prior to Digging

- ◆ Utility companies and other responsible parties contacted.
- ◆ All underground utilities should be located.
- ◆ Once located, utilities must be protected from damage.
- ◆ Areas known or suspect to explosive contamination, cleared by qualified explosive ordnance disposal (EOD) personnel.

Call Before You Dig



- ◆ Failure to contact and locate utilities can lead to catastrophic events and large repair bills.

Excavation Inspections

- ◆ Done by a competent person.
- ◆ Inspected at least daily.
- ◆ As needed through out shift.
- ◆ After every rainstorm or other hazard- increasing occurrence.
- ◆ If cave-in hazard identified, work stopped, workers removed !

Atmospheric Hazards

- ◆ Many gases and toxic vapors are heavier than air and will lay in excavations.
- ◆ Digging around landfills and Sewage treatment systems, can lead to Hydrogen Sulfide and Methane pockets.
- ◆ Areas known or suspect to atmospheric hazards must be tested prior to the start of each shift or more often if directed by designated authority.
- ◆ Test log must be maintained at work site.

Protective Systems

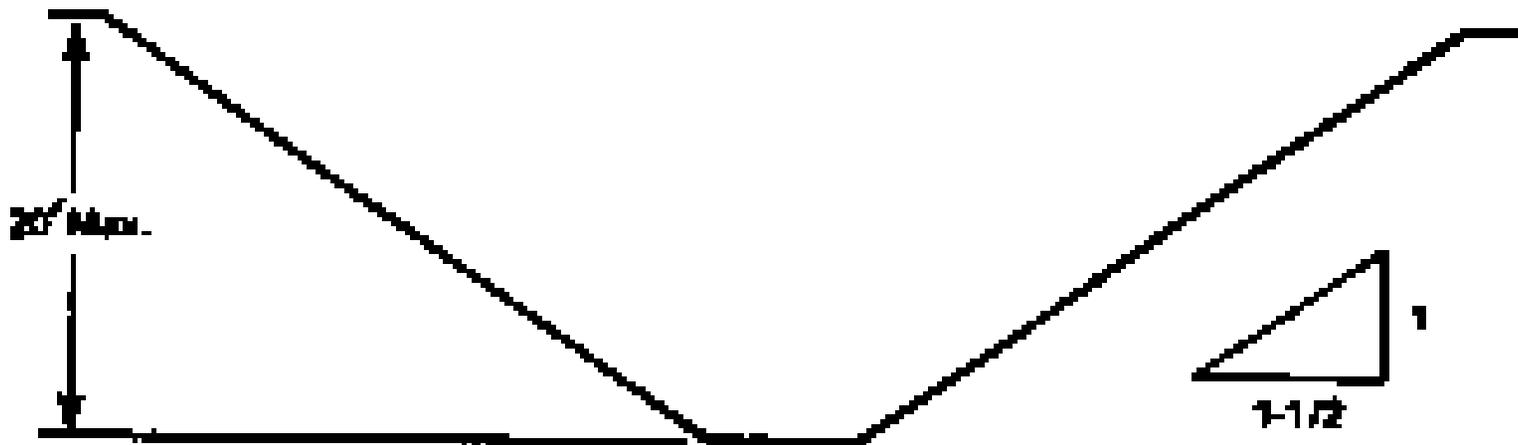
(benching, sloping, shoring, boxes)

- ◆ Required in excavations greater than 5 ft deep or where workers are in danger of moving soil.
- ◆ NOT Required in excavations less than 5 feet deep if competent person says so.
- ◆ Sloping or benching in accordance with 25 C.
- ◆ Support Systems in accordance with 25 D.

Sloping and Benching Options

- ◆ Excavations less than 20 feet deep, maximum slope shall be 34 degrees measured from the horizontal (1 1/2 horizontal to 1 vertical).
- ◆ Design selected from tabulated data (such as OSHA's Standard)
- ◆ Designed by registered engineer.

Maximum allowable slope for any kind of soil



Support System Options

- ◆ Timber, hydraulic and mechanical shoring systems etc..
- ◆ Designs drawn from manufacturer's tabulated data.
- ◆ From tabulated data (such as tables and charts such as OSHA's Standard).
- ◆ Designed by a registered engineer.

Fatal Shoring Related Mishap



- ◆ Good example of a poorly designed system.
- ◆ 8'x15'x3/4" Steel plates leaning at 30 degrees against bank.
- ◆ No supports
- ◆ Not approved, no tabulated data used.

Good, Bad, or Ugly ?



- ◆ What kind of system is this ?
- ◆ What's good about this situation ?
- ◆ What's bad about this situation ?

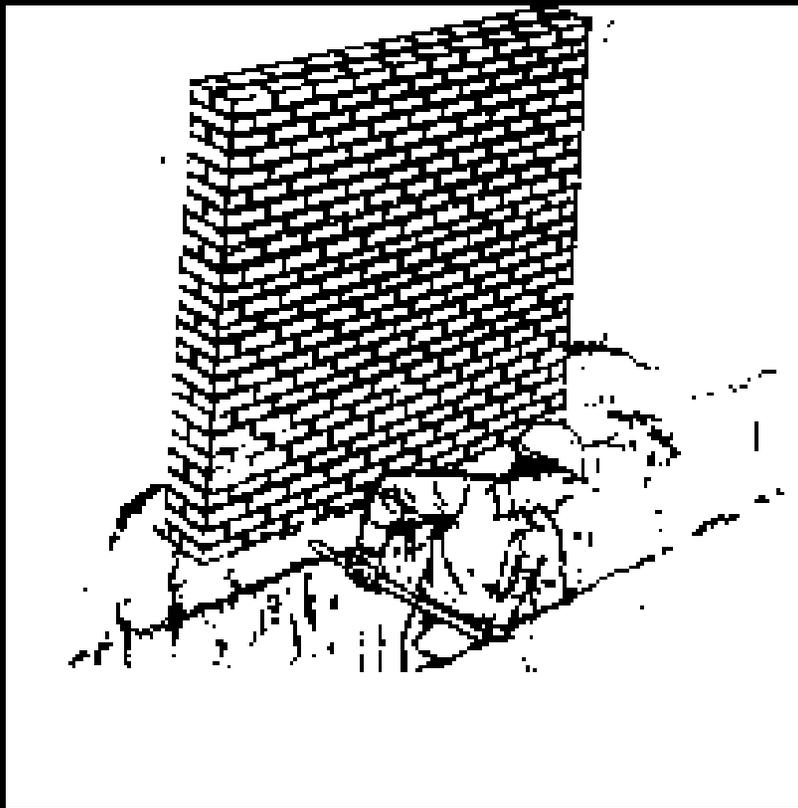
Shield Systems-Trench Boxes

- ◆ Installed to restrict movement in the event of sudden lateral loads (cave-ins).
- ◆ Workers protected from hazards while entering or leaving boxes.
- ◆ Workers not allowed in boxes while installing and moving.

Adjacent Structures and Overhanging Material

- ◆ Can not undermine.
- ◆ A support system, designed by a qualified person, such as underpinning must be used ...or
- ◆ A registered engineer has determined the structure is far enough away and unaffected.

Fatal Undermining Related Mishap



- ◆ Good example of structure not being far enough away.
- ◆ Four foot deep trench
- ◆ Brick wall collapsed on worker
- ◆ Worker died

Protection from Water

- ◆ Water must be prevented from entering excavations... ditches, dikes, etc...
- ◆ Workers can't work in accumulated water.
- ◆ Accumulating water must be controlled.
- ◆ Control measures directed by a registered engineer.

Protection from Falling Materials

- ◆ Excavated material at least 2 feet from edge.
- ◆ If not 2 feet, retained by device.
- ◆ Material placement must prevent excessive loading on the face of the excavation.
- ◆ Anything such as; boulders, stumps, materials etc... that could roll into excavation must be removed or made safe.

Heavy Equipment Precautions

- ◆ Stop logs or barricades must be used.
- ◆ Workers must stay clear of loading/unloading operations to avoid being struck by spillage.
- ◆ No workers under loads.
- ◆ No workers on faces above others unless lower workers protected.

Heavy Equipment Related Fatal Incident



- ◆ No barricades present
- ◆ Ground was snow covered
- ◆ Dozer drove/slide into trench
- ◆ Operator wasn't wearing his belt.
- ◆ Operator was crushed

Safe Access

- ◆ Excavations greater than 4 feet in depth must have access... ladder, ramp, stairs.
- ◆ Access must be within 25 feet of worker.
- ◆ Ladders must extend from the bottom of excavation to 3 feet above surface.
- ◆ Personnel ramps at least 4 feet wide, equipment 12 feet.

Protection from Falling Into

- ◆ Workers, vehicles, equipment and the public must be protected.
- ◆ The public, vehicles or equipment require class I perimeter guarding.
- ◆ Greater than 6 feet or other hazard and worker exposure requires class II guarding.
- ◆ If none of the above, at least class III.
- ◆ See definitions for type I, II, III guarding.