# Trenching and excavation safety

Preventing trench wall cave-in and soil movement is a necessary consideration in the planning of sewer, pipeline and similar sub-surface work by the cut and cover (trench and backfill) method. Either (or both) may result in death or serious injury to workers, plus damage to adjacent structures, utilities and facilities.

2. This data sheet will discuss the hazards associated with trench excavation and what precautions are necessary to avoid them. The use of sliding trench shields also will be covered.

## Hazards

3. The hazards of trench excavation are:

- Death by suffocation or crushing when falling or subsiding soil buries a worker
- Materials falling on workers in the trench, such as equipment, rocks, dirt or tools being kicked into the trench
- Falls when mounting or dismounting equipment
- Handling and placing of frames and covers for manholes or catch basins
- Handling and placing pipe or other materials, including lifting or hoisting overhead
- Being struck by moving equipment
- Falls by workers when climbing into or out of the excavation
- Employees working too close together, and striking one another with tools or equipment
- Stumbling over equipment or excavated material, or falling into a trench
- Encountering toxic, irritating or flammable gases; or an oxygen-deficient atmosphere
- Heavy equipment falling or being driven into the trench

4. Trench excavations are subject to a number of hazardous stresses. A cave-in of sidewalls is the worst hazard. Most accidents of this type occur because of taking a chance by not using shoring, or using inadequate shoring, in an attempt to reduce cost.

5. Common causes of trench failure that proper shoring helps prevent:

- Instability of the bottom of the excavation
- Failure of inadequate shoring due to unexpected or transient loads; these loads are usually superimposed on the shoring structure or ground surface at the edge of the trench
- Failure resulting from vibration due to traffic, adjacent backfill and tamping operations, jack hammering, or rock splitting
- Use of defective shoring material
- Failure to maintain shoring properly after changes caused by operations, or after damage by washouts or heavy rains
- Failure to place removed spoil at a safe distance from the edge of an excavation or failure to retain it by effective barriers
- Undercutting of the trench walls by trenching machines not properly leveled

## Shoring of trenches

6. Proper sheeting and bracing (shoring) will prevent both cave-in and possible soil movement.

7. Proper trench shoring cannot be reduced to a standard formula. Therefore, each job must be treated as an individual problem because of the variable conditions existing on each job. Some important factors to be considered in planning a job are:

a. Nature of soil structure: Soil structure varies from hard rock at one extreme to soil containing sufficient water to produce hydrostatic pressure. Hard rock may contain faults in strata that make it unstable when cut through.

Normal moisture content in soil affects its stability; consequently, possible variations in moisture content must be considered when determining margins of safety (sandy soil, or soil that has been backfilled, is very unstable and usually requires tight sheeting where the trench depth exceeds 4 feet).

b. Fluctuating weather and moisture conditions: Rainfall; freezing; thawing; overflow of adjacent streams, storm drains or sewers; and melting snow all produce changes in soil condition. Water from any source probably will increase the rate of seepage and may reduce the cohesion of the soil or swell the soil, thereby increasing pressure on sheeting and bracing. A trench in frozen ground may be safe with little or no sheeting; thawing, however, may cause the entire bank to cave. Certain soils have high adhesion properties (and thus stability) while wet, but become dangerously loose when allowed to dry, as when a trench is cut and left open.

c. Proximity of other structures or sources of vibration: Shoring not otherwise necessary may be needed to prevent dislocation of foundation soil or damage to adjoining buildings, curb lines, trees or utility poles. Vibration, which may arise from machine operations in nearby buildings (as from punch presses or forging hammers), passing vehicular or railway traffic, or blasting also must be considered. Equipment used on a job, such as material trucks, pile drivers, air spades, power ramrods, tampers, rollers and drills also may produce vibration and should be considered in planning shoring.

d. Trench dimensions: As the width of the trench increases, the cross braces or struts must be increased in cross-section size to maintain the necessary rigidity. Remember that with soil possessing sufficient cohesion to act as a solid, the side pressures reach a maximum at a point slightly higher than one-half the depth of the cut, and with dry granular and saturated soils the side pressures increase in proportion to the depth of the excavation.

8. Where soil is removed by machine, special precautions are necessary. The machine should be kept level to prevent undercutting the trench walls. Shoring should be kept as close as is practical to the machine and should be accessible. If the set-up is improperly arranged, the hoist or bucket may strike the bracing and result in damage. In mechanically excavated trenches, all connections should be bolted.

9. Where personnel are required to enter or work in an excavation, the excavated material should be stored or retained at least 2 feet or more from the edge of the excavation.

10. Wales or shoring timbers should not be used as supports for platforms to carry concrete mixers, wheelbarrows, Georgia buggies or other heavy equipment. If it is necessary for heavy equipment to be used over or across a trench, vertical supporting members should be cut in between the wale and the load should be transmitted to the ground through additional vertical members from the bottom wale. The additional vertical members should be of sufficient size to carry the entire superimposed load.

11. Cross bracing should consist of screw jacks, hydraulic jacks or timbers, cleated and rigidly jacked or wedged.

12. When sheeting is used, sufficient length should be provided to permit at least 18 inches of the sheeting to protrude above ground level.

13. Where the walls of trenches are

sloped to the angle of repose, but the slope does not extend to the bottom of the trench, the timbering required to support the vertical part of the trench should extend not less than 12 inches above the bottom of the slope and, if necessary, toe boards of sufficient height should be placed behind the timbers to prevent material from sliding into the trench. The timber size must meet requirements for the total trench depth from original ground level to the trench bottom.

14. Where trenches are located near buildings, special care must be taken to protect the foundation walls of such buildings. Requirements vary with different types of soil but, in general, shoring is usually necessary when the depth of the trench exceeds the distance from its edge to the wall of an adjoining structure. Also be alert to the building's imposing additional loads on the soil. Competent engineers should be consulted in questionable cases.

15. Frequent inspection by a competent person should be made to make certain shoring, bracing and sheeting are in good condition. Stability of adjoining walls or buildings could be affected; the shoring, bracing or underpinning should be inspected daily or as conditions warrant.

16. Cleats or scabs should be nailed in place over the joints between struts and wales. Where more than one set of braces is required, all connections should be bolted.

17. Braces, except screw jack or hydraulic jack type, should be cut and fitted for a "driving" fit. Wedges may be necessary to make sure the shoring is stable. Hardwood wedges should be used.

18. If an attempt is made to salvage sheeting for reuse, it may leave a void in the ground that is difficult to fill. Where excavation is carried on near buildings or roads, however, the lateral earth pressure may cause some subsequent shifting of soil toward such a void with the possibility of settlement cracks developing in the building walls. In these cases, it is better to leave the sheeting in place after cutting it off flush, or below ground level, and then filling in.

19. When dismantling shoring, cross bracing should be removed cautiously, and backfill kept as close to the dismantling operation as possible. Dismantling should be done systematically from the bottom upward either by having braces pulled out from above with lifting tackle or by introducing screw jacks or hydraulic jacks that will take up the strain of wedged timber cross braces, making removal easy.

20. The strain on the jacks should then be released very slowly, taking into account the condition of the sidewalls. Backfilling should carefully follow the removal of shoring.

21. Where steel sheeting or other types of shoring are to be reused, they should be carefully inspected for defects. Even a minor defect should be cause for rejecting any sheeting, stronger or cross brace.

22. Adequate protection for pedestrian and passing vehicular traffic should be provided. Also, workers should be protected against being struck by objects that are kicked or thrown into a trench.

23. Such protection may be provided by barricades, fences, guardrails, warning signs or flags. The protection provided should be kept in place until backfilling is completed. Under conditions of heavy traffic, a watchman may be needed. From sunset to sunrise the excavated area, including the barricades and fences, should be adequately illuminated by whatever means local regulations specify.

24. Trench excavations may intercept utility lines or public services. The locations of these should be determined by consulting representatives of the various utilities and

services. The locations should be marked by stakes driven into the ground or in some other manner. Care should be taken to avoid damaging any of these.

25. Serious hazards are created by gas leaks or contacts with power lines. If sewer lines and drains, usually of bell-flange tile construction, are to remain undisturbed they will require support of all the exposed area. Support of conduits, power cables or metal pipes depends on the actual lengths exposed.

26. When employees are required to be in trenches 4 feet or more deep, an adequate means of exit, such as a ladder or steps, should be provided and located so no more than 25 feet of lateral travel is required. If ladders are used, their tops should extend 3 feet above ground level.

27. The amount of soil to be removed, as well as the nature of the soil structure, will determine how far back from the edge of the trench the spoil must be piled. Excavated material and other superimposed loads should never be placed nearer than 2 feet from the sides of the trench to prevent rollbacks. When superimposed loads or equipment are within the limiting plane of rupture, shoring must be increased to withstand the additional pressures.

28. Where trenches cross gas mains, sewers or soil saturated with organic material, artificial ventilation may be necessary. Where explosive, flammable or toxic gas is suspected, tests should be made by qualified personnel to determine the need for ventilation. Portable blowers equipped with canvas tubes for carrying air to the points where it is needed can provide sufficient ventilation. Equipment producing sparks and open flames should be avoided where concentrations of flammable gas or vapor are suspected. Blowers used for ventilation removal of flammable gases should be rated for such use.

29. When internal combustion engines are used in or near trenches, precautions should be taken against exhaust gases entering the trenches. Where necessary ducts should be attached to exhausts to conduct gases away from the trench.

30. Because the problem of falls is present in any trench, the deeper the trench, the more serious the problem. Every precaution should be taken to prevent falls of people, materials, equipment and tools. Handrails, barricades, toe boards, fences, warning signs, personal protective equipment and apparel should be used to minimize the hazards. Necessary personal protective equipment may include goggles, rubber boots, respirators, fall arrest systems including safety lines and harnesses. Wearing of hard hats should be mandatory.

## Personal protective equipment

31. Care should be taken to prevent employees from working too closely together to minimize the danger of being struck by tools or materials. Employees should never be standing under an excavator while excavation is in progress.

32. Employees working in trenches should be required to wear approved safety hats as a protection against falling material. Safety shoes also should be worn.

33. Safety glasses or goggles are recommended to prevent particles from getting in workers' eyes as when they look up or work overhead.

If harmful gases or an inadequate supply of oxygen exist, proper respiratory protection should be provided and used.

## Sliding trench shields

34. A trench box (sliding trench shield) may be used to advantage in sewer and pipeline work, where the installation of the line closely follows the excavator and where cave-in of trench walls or soil movement

after the line is installed is of no importance. The use of a sliding trench shield, however, allows backfilling and thereby reduces the probability of a cave-in.

35. Another advantage of prompt backfilling is that streets can be made available for surface traffic sooner than usually is possible when using conventional methods. Where work is being done in populated areas, this is a matter of good public relations and serves the best interests of public safety.

36. No two sewer or pipeline construction projects present identical working conditions for excavation. Consequently, sliding trench shields are generally tailored to meet particular job requirements such as soil structure, trench depth, nearby utility installations and the type of excavating equipment used. Conventional shoring may not be entirely replaced by movable shields, but its use is thereby greatly reduced.

## Fabricated trench shielding

37. Shields must be constructed with adequate strength to support the earth pressure to which they may be subjected, such as by welding steel plate sides to heavy steel or pipe framework.

38. Shields should be mounted on skids to allow ease of movement along a trench; pipe or flat steel is preferred. Substantial pad eyes or rings should be welded at convenient points for handling (puffing or raising) the shield by digger or crane (Figure 1).

39. Shields may be made with top and lower sections, thus providing adaptability to trenches of varying depth. When trench walls are higher than the top of the shield, a substantial roof with hatches should be provided. Forced ventilation may be necessary if shields are fully enclosed. (This is to dilute gases, improve ventilation and remove dust.) A mid-point location for an access ladder is preferred, but one should be provided somewhere within the shield.

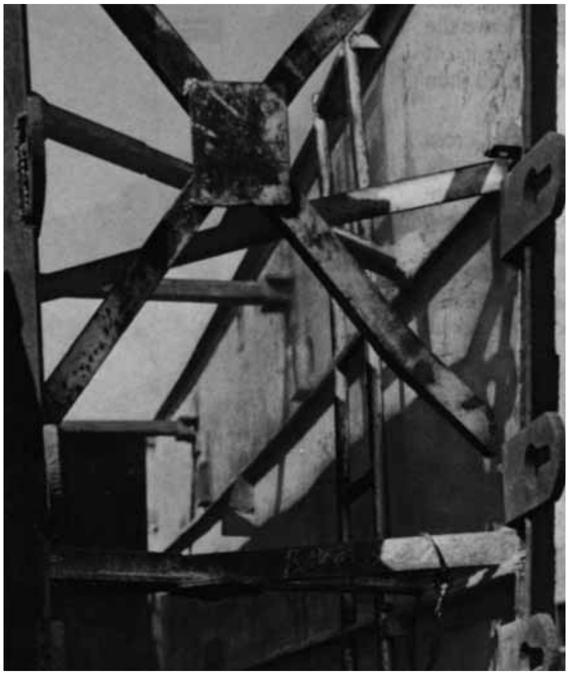

**Figure 1**

40. It is usually beneficial to construct sliding trench shields with the bottom a bit narrower than the top. This shape makes the shield somewhat easier to lift out or pull forward, if soil shifting occurs.

41. Shield width will usually be governed by trench width, but it should always be large enough to allow materials and equipment to be moved in and out easily and to prevent employees from being impeded in their work.

42. Design and construction of trench boxes should be reviewed by competent persons with engineering principles considered, including a life safety factor built in.

## Other considerations

43. Some states or localities have specific trenching and excavating requirements as policy or law which must be considered, as well as with all other safety matters. The constructor should consult the local ordinances and comply with the regulations as required. This applies to federal and state OSHA regulations as well.

## General excavation safety

44. Shore line excavating and shaft work involve special problems such as flooding due to overflow or cofferdam failure, damage to temporary structures from ships or barges, compressed air work and emergency escape facilities. Protection against failure in trenches is usually accomplished by the relative narrowness and shallowness of the cut. Also, trenches generally are backfilled in a comparatively short time and are not subjected to the changing soil conditions that may occur when excavations are open for long periods.

45. Soil includes all earth material between the ground surface and bedrock. The soil mass is a complex and variable mixture of solids, water and air. Because of inherent construction hazards, the soil mass must be treated as an important and distinct engineering problem in the planning and execution of any job requiring excavation work of appreciable magnitude.

46. The principal hazard of excavation work is death by suffocation or crushing when exposed soil fails and buries the workers. Workers also are subjected to hazards of falling materials, tools, and equipment and to hazards involving utilities – electricity, water, steam and gas, natural gases, and oxygen-deficient atmospheres. Muddy conditions, common to excavations, increase dangers of slips and falls. Hazards of striking against or being struck by objects are increased by congestion of personnel, materials and equipment.

47. Unguarded or unlighted excavations; or lack of or inadequate barricades, fences and warning signs increase hazards to the public. Damage may occur to structures, streets or highways, public walks, utility installations or to any other adjacent property because of soil changes due to various complex causes.

48. Most excavation failures occur as a result of one or more of the following:

a. Taking a risk without proper and adequate investigation
b. Failure to use methods and install safeguards indicated by an engineering analysis of the soil structure and of the soil's ability to resist shear and support the weight to which it will be subjected
c. Improper or improvised shoring
d. Defective shoring materials
e. Failure to recognize and compensate for loads imposed by surrounding structures
f. Failure of apparently adequate support due to superimposed transient loads (excavated material, equipment or traffic, and excessive vibration)
g. Improper maintenance of shoring during operations
h. Changing weather conditions and the effect on the ground water and the soil

49. Death, injury and property damage during or resulting from excavation work can be eliminated – but only if adequate protective measures are made a part of the job. This requires a complete study of all pre-excavation conditions to evaluate changes in soil conditions that might develop. Bracing of adequate strength must be designed, or soil stabilization must be provided for, in some other manner. Such study, design and planning generally require the services of a competent soils engineer.

50. Because the problem of falls is present in any excavation, the deeper the excavation, the more serious the problem. Every precaution should be taken to prevent falls of people, materials, equipment and tools. Handrails, barricades, toe boards, fences, warning signs, PPE and apparel should be used to minimize the hazards. Necessary PPE may include goggles, rubber boots, respirators, and fall arrest systems including safety lines and harnesses. Wearing of hard hats should be mandatory.

51. Health hazards should not be overlooked in excavation work. Health hazards may arise from the presence of silica dust, methane or other natural gas of a toxic or flammable nature, oxygen deficiency, or poisonous or irritating substances. All such possibilities should be considered both in the planning stage and when the work is being executed. Necessary respiratory and resuscitation equipment should be available for emergency use.

52. Every excavation 4 feet or more in depth should have ladders, stairways or ramps for entry and exit. Such facilities should be in sufficient number and should be spaced so no worker in the excavation will be more than 25 feet from one of them.

53. Every area of the job should be properly illuminated. For night work, the lighting intensity should not be less than 3 foot-candles with a minimum of glare and intensity contrast. Appropriate warning lights should be installed where special hazards exist.

54. Public utility companies, municipal departments or private owners should be asked to furnish all data on known underground facilities. In order to protect utility lines when excavating, a utility company representative should be present. Understandings should be reached with respect to disconnecting or protecting service on both above- and below-ground service lines, and other appropriate arrangements should be made.

55. The data and understandings should not be considered conclusive. Positive controls should be established to prevent contacts with overhead distribution lines and known underground facilities. Care should be exercised at all times to minimize the possibility of contact with uncharted underground facilities.

56. Careful planning and close supervision of the work to prevent congestion of personnel and equipment are essential. Because space is limited in most excavations, every precaution should be taken to minimize congestion in the area and the dangers resulting from the movement of workers and equipment.

57. Excavation equipment such as shovels, draglines and trucks should be inspected regularly and properly maintained. Schedules for regular maintenance and inspection by fully qualified personnel should be established. Servicing of any equipment or machine while it is operating or in motion should be prohibited. Cranes shall be tested and inspected per the manufacturer's recommendation and OSHA requirements.

58. Employees should be carefully selected for the work they are to perform. New as well as long-term employees should be made aware of all job hazards. Equipment operators should be tested for competency prior to assignment. Qualifications should never be assumed.

59. While the hazard of fire is unusual in excavation work, potential hazards can be created where combustible materials are extensively used in bracing, guarding or facilitating the work. Where such conditions exist, ample and suitable first aid firefighting equipment should be provided and properly maintained.

60. Construction work of any nature, and excavation work in particular, attracts the public and is classed as an "attractive nuisance" to children. Every possible precaution suitable to the project should be taken to ensure public safety. Walks, rails, barricades, fencing. overhead protection and warning signs are means of control. In some eases, guard service, traffic controls and the assistance of local law enforcement authorities may be used. Warning lights and proper illumination also are essential.

61. The critical strength of any material is its minimum resistance per unit area to sliding along its internal planes. In terms of

self-support, soils may be roughly classed as cohesive or cohesionless (non-cohesive). Clear sands and gravels, or mixtures of the two, are easily recognized and, lacking any cohesive qualities, receive prompt attention in excavation work. Cohesive soils generally are the source of most excavation troubles because they may appear stable at the time of excavating.

62. Soil mass failure occurs when stresses exceed soil strength. In determining if a soil failure is likely to occur, it is necessary to study factors that increase soil stress and decrease soil strength. Soil stress is increased by the following:

a. Deep cuts and steep slopes (removal of the natural restraint or support of the excavated material).
b. Superimposed loads on the ground surface adjacent to the excavation (excavated material piled along edges of the excavation, digging equipment or other construction equipment and material).
c. Shock and vibration (pile driving, blasting, transient loads or vibration-producing machinery).
d. Water pressure from ground water flow (fills cracks in the soil and increases the horizontal stress).
e. Saturation of soil (increases the weight of the soil, and in some types of soil, the mass of the soil).

63. Soil strength may be reduced by the following:

a. Excess water pressure in sandy soils (may cause boils, saturate the soil and increase plasticity).
b. Drying of the soil (reduction of cohesion in sandy soils and soils high in organic content [topsoil])
c. Prolonged stress (resulting in plastic deformity).

64. Water is a major factor in most excavation soil failures although failures occur from any combination of circumstances affecting the relationship between the soil strength and stress. Failures can develop slowly through time or occur suddenly with little forewarning.

65. There are four types of failures in a vertical excavation slope.

a. Sliding, the most common failure is the downward and outward movement of a fairly well-defined mass.
b. Sloughing is the release of material from the surface of an excavated face usually due to drying and cracking, or freezing and thawing.
c. Slumping is the bulging of the lower excavation face surface. Because this is generally the location of the maximum shear stresses, slumping indicates an overstressed condition.
d. Squeezing is the uplifting of the base or bottom. It may cause other types of failure as well.

66. In most cases, failures give some warning sign before occurring. Signs of failure in the excavation wall are subsidence of the adjacent ground surface, tension cracks parallel to the wall and spalling from the face.

67. Bottom heave generally occurs slowly. Warning signs are subsidence of the ground surface and, in some instances, the need to remove more soil than the volume would indicate. Occasionally, small boils give warning.

68. Preventing soil failures is based on this principle: prevent stress increase or decrease in soil strength. This problem cannot be handled haphazardly. The procedure should be as follows:

a. By exploration and tests, determine soil characteristics and variations in the area of the proposed excavation.
b. Study the various factors and variables that may be encountered in the excavation work.

c. Study the sources and control of both ground and surface water.
d. Analyze all factors and, on the basis of the engineering findings, solve the problems and arrive at a work method.

69. Each job is an individual problem requiring attention to all job variables. Some such variables are:

a. Type of soil and soil structure, including ground water level and method of drainage if drainage is required
b. Underground utilities, sewers, tanks, and other subsurface installations in and adjacent to the excavation area
c. Superimposed loads. Fixed loads, such as adjacent buildings, towers, tanks, highways, railways and transient loads caused by excavating equipment, handling and disposal of excavated materials, subsequent construction necessities (i.e. pile driving, equipment, materials), and highway and rail travel
d. Weather expectations and control of surface water
e. Length of time the excavation will be open
f. Local laws and regulations relative to blasting and public protection, and any rule or restriction that might affect the job

70. A system of shoring and bracing is the method generally used to compensate for the unbalanced stresses resulting from soil removal. Shoring and bracing design is a basic engineering problem involving both structural design and soil mechanics. To maintain stability in the area surrounding an excavation, the bracing must be designed to withstand the variable stresses caused by changing soil conditions and the bracing must be installed according to the design. The bracing system should be maintained at design strength by occasional stressing, by correcting faults that may develop or by reinforcing where indicated. Correction or reinforcement is required if one or more braces show evidence of movement or buckling; also, if any sheeting or wales start to bulge or bend. Either condition indicates adjacent soil subsidence.

71. Superimposed loading is subject to control and is dependent on the strength of the soil surrounding the excavation. As a general rule, excavated material, equipment, trucks and other loads should be kept back from the edge a distance equal to one-half the depth of the excavation. In all instances the excavated material should be kept back far enough to ensure none of the rubble will fall back into the excavation, or the edges should be protected in a manner that will effectively contain the excavated material. In excavations that workers may be required to enter, excavated or other material shall be effectively stored and retained at least 2 feet or more from the edge of the excavation.

72. Shock or vibration can be controlled. Small charges and millisecond delay detonators when blasting, light hammers for pile driving, and elimination of unnecessary movement of heavy equipment will keep shock and vibration at a low magnitude.

73. Because water is a major factor in most excavating troubles, the sources and control of water, both surface and ground, should be a major consideration in planning the work. Surface water should be diverted away from excavated and denuded areas. Prolonged drainage, either because of seepage into the excavated area or pump removal of ground water from the surrounding area, will lower the water table or tend to dry out the surrounding soils. The drainage system should not remove sand and small particles from the soil surrounding the excavation. Drying may result in soil shrinkage, and removal of sand and small particles can create a void, either of which

might cause settlement of adjacent surface areas, including structures.

74. In some instances, soil strength has been retained by freezing the soil adjacent to the excavation. Some soils may be strengthened and controlled by grouting. Walls of cut-through rock may be restrained by rock bolting. All such methods must be directed by foundation or soil experts.

75. In excavations where only open bracing (not solidly sheeted) or no bracing of the walls is necessary spalling of cut faces may be controlled by various methods: small-mesh wire, chain-link fencing, tarpaulins or burlap sheets stretched over the cut surface or guniting of the exposed face.

76. During excavating operations, after the excavation is completed and for as long as it remains open, close control over the excavation proper and the surrounding area should be maintained. Frequent inspection should be made to look for evidence of impending failures. Supervisory personnel should be informed of all types of failure possibilities and instructed in the proper action to take if any evidence of soil failure develops.

## Classes of soil

**Stable rock –** Natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed. Determining if soil is this type may be difficult even though it appears as solid rock. It is hard to determine if cracks exist and whether the cracks run away or into the excavation.

**Type A soils –** Cohesive soils with an unconfined compressive strength of 1.5 tons per square foot or greater. These types of soil will generally contain clay or various combinations of clay mixtures.

**Type B soils –** Cohesive soils with an unconfined compressive strength greater than 0.5, but less than 1.5 tons per square foot. Examples of this type of soil are angular gravel, silt loam and previously disturbed soils unless classified as Type C soil.

**Type C soils –** Cohesive soils with an unconfined compressive strength of 0.5 tons per square foot or less. This includes any granular soil such as sand, gravel or any soil from which water is freely seeping

**Testing methods –** OSHA identifies the following methods to be used for the evaluation of soil types.

Pocket penetrometers are a direct-reading, spring-operated instrument used to test the compressive strength of saturated cohesive soils. When pushed into the soil, an indicator sleeve will display the reading.

Plasticity or wet thread test (cohesive) is conducted by molding a moist sample of soil into a ball attempting to roll it into a thin thread. The soil sample is then held by each end. If the sample does not break, the soil is considered cohesive.

Visual test is a qualitative evaluation of soil conditions. Observe the soil as it is being excavated. If the soil remains in clumps, it is cohesive. Checking the area for things such as underground utilities, etc. can help determine if the soil has been previously disturbed. The evaluator also should look for signs of bulging, boiling or sloughing as well as for signs of water seeping into the excavation.

## Competent person

Daily inspections of trenches, excavations, adjacent areas and protective systems shall be made by a “competent person” for evidence of a situation of possible cave-ins, hazardous atmospheres, indications of failure of protective systems and any other hazardous situations.

An inspection shall be conducted and documented by the competent person prior to the start of work and as needed throughout the work activity. Inspections shall be made whenever the conditions change, such as after a rainstorm or another hazard increasing situation.

Where a "competent person" finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

## Glossary

**Angle of repose.** The greatest angle above the horizontal plane at which a material will lay without sliding.

**Cleats (scabs).** Pieces of wood that solidly connect the crosspieces to the horizontal members (walers).

**Competent person.** An individual who by knowledge, experience and/or training has the ability to identify existing or predictable hazards and has the authority to initiate prompt corrective action. A competent person shall also be able to perform soil analysis.

**Excavation.** Any man-made cavity or depression in the earth's surface, including its sides, walls or faces, formed by earth removal and producing unsupported earth conditions by reasons of the excavation. If installed forms or similar structures reduce the depth-to-width relationship, an excavation may become a trench. A trench is always an excavation, but an excavation is not necessarily a trench.

**Sheeting Material** (wood, steel or concrete, which may form a continuous line) placed in close contact and providing a wall to resist the lateral pressure of water, adjacent earth or other materials.

**Spoil.** The earth and material drawn from an excavation.

**Struts** (braces). The horizontal members of the shoring system whose ends bear against the uprights or stringers.

**Tight sheeting.** Sheeting that is butted close together to form a continuous solid wall to resist the lateral pressure of earth, water or other material.

**Trench.** A narrow excavation made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench is not greater than 15 feet.

**Trench shield.** A shoring system composed of steel plate and bracing, welded or bolted together, which support the walls of a trench from the ground level to the trench bottom, and which can be moved along as the work progresses.

**Wales** (stringers). The horizontal members of a shoring system whose sides bear against the uprights or earth.

## Acknowledgment

This data sheet was revised by the Construction Division of the National Safety Council, 1121 Spring Lake Drive, Itasca, IL 60143.

## Sources of information

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National Safety Council: *"Accident Prevention Manual for Industrial Operations – Engineering and Technology,"* 1980.

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*General Protection Requirements,* Section 1926.650.

*Specific Excavation Requirements,* Section 1926.651.

*Specific Trenching Requirements.* Section 1926.652.

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