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PROPER TRENCHING PROCEDURES

HOW-TO GUIDE FOR MAINTAINING SAFETY IN AND AROUND OPEN TRENCHES

Source: The Occupational Safety and Health Association (OSHA) Technical Manual
http://www.osha.gov/dts/osta/otm/otm_v/otm_v_2.html

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Construction of new or rehabilitation of existing underground utilities is commonly conducted using open-cut trenches. Proper understanding of trenching mechanics, soil types encountered, and shoring and shielding techniques are critical for maintaining safety during operation in and around open trenches. This tech brief provides background information on trenching and focuses on the safety of open-cut construction procedure. This document (text and figures) is a summary of *The Occupational Safety and Health Association (*OSHA*)* technical manual. Please review the original OSHA text for further details of trench failure and safety measures.

THE HAZARDS OF OPEN-CUT TRENCHES

Open-cut trench construction results in a weakened soil zone around the trench due to the loss of lateral support during construction. This weakened zone is called the "zone of influence," which may result in toppling, cave-ins, and/or sliding. When a trench is open and because most soils cannot remain stable with vertical walls, soils of the sides of the trench may slide or topple, risking the safety of the workers.

UNDERSTANDING TRENCH-RELATED DEFINITIONS

Trench: A manmade narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth of a trench is greater than its width.

Protective system: A method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, and from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Underground installations: Installations include, but are not limited to, utilities (sewer, telephone, fuel, electric, water, and other product lines), tunnels, shafts, vaults, foundations, and other underground fixtures or equipment that may be encountered during excavation or trenching work.

Unit weight of soil: The weight of one unit of a particular soil. One cubic foot of soil can weigh from 110 to 140 pounds or more.

MECHANICS OF OPEN-TRENCH FAILURE

The failure of open-cut trenches can occur in different modes. These failure conditions are dependent on soil properties, the depth of the trench, and changes in the moisture content of the soil. The following diagrams show some of the frequently identified causes of trench failure (more details are presented in OSHA).

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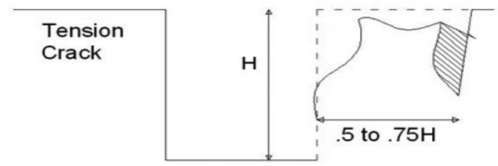
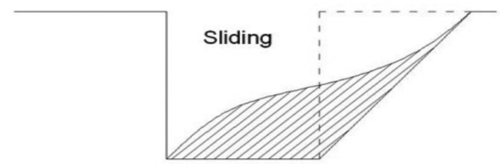
CAUSES OF TRENCH FAILURE

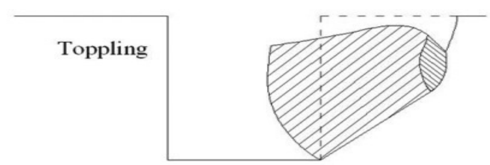
Tension cracks: Tension cracks usually form at a horizontal distance of 0.5 to 0.75 times the depth of the trench, measured from the top of the vertical face of the trench.



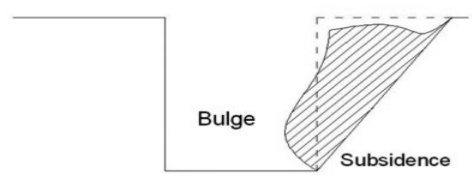
Sliding: Sliding, or sluffing, may occur as a result of tension cracks.



Toppling: Tension cracks can also cause toppling. Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation.



Subsidence and bulging: An unsupported excavation can create an unbalanced stress in the soil, which, in turn, causes subsidence at the surface and bulging of the vertical face of the trench. If uncorrected, this condition can cause face failure and entrapment of workers in the trench.



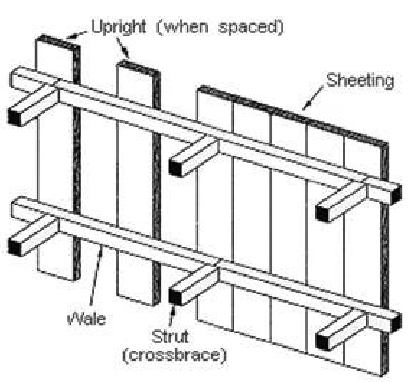


Figure 1: Timber shoring (OSHA Technical Manual)

SHORING TYPES

Trench support is commonly provided through the use of shoring. Shoring of the trench faces is used to prevent movement of soil, underground utilities, roadways, and foundations. Shoring or shielding is used when the location or depth of the cut makes sloping back to the maximum allowable slope impractical. Shoring systems consist of posts, wales, struts, and sheeting (see *Figure 1*). All shoring should be installed from the top down and removed from the bottom up.

Hydraulic shoring: This is a prefabricated strut and/or wale system manufactured of aluminum or steel. Hydraulic shoring provides a critical safety advantage over timber shoring because workers do not have to enter the trench to install or remove hydraulic shoring *(see Figure 2).* Hydraulic shoring should be checked at least once per shift for leaking hoses and/or cylinders, broken connections, cracked nipples, bent bases, and any other damaged or defective parts.

Screw jacks: Screw jack systems differ from hydraulic in that the struts of a screw jack system must be adjusted manually. This creates a hazard because the worker is required to be in the trench to adjust the strut. In addition, uniform "preloading" cannot be achieved with screw jacks, and their weight creates handling difficulties.

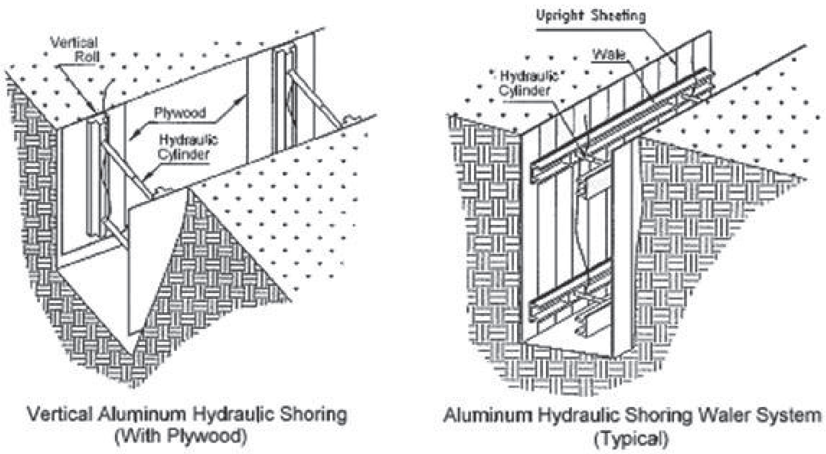


Figure 2: Shoring systems (OSHA Technical Manual)

SHIELDING TYPES

Trench boxes: These are different from shoring because instead of shoring up or otherwise supporting the trench face, they are intended primarily to protect workers from cave-ins and similar incidents *(see Figure 3)*. The excavated area between the outside of the trench box and the face of the trench should be as small as possible. The space between the trench boxes and the excavation side are backfilled to prevent lateral movement of the box. Shields *may not be* subjected to loads exceeding those which the system was designed to withstand.

Combined use: Trench boxes are generally used in open areas, but they may also be employed in combination with sloping and benching. The box should extend at least 18 inches above the surrounding area if there is sloping toward excavation. This can be accomplished by providing a benched area adjacent to the box. Excavation to a depth of 2 feet below the shield is permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench and there are no indications while the trench is open of possible loss of soil from behind or below the bottom of the support system. Careful visual inspection of the open trench failure conditions mentioned above is the primary approach to hazard identification.

Sloping: Maximum allowable slopes for excavations less than 20 feet depend on soil properties and can be found in the OSHA guidelines. To determine soil properties, consult with the geotechnical engineer.

SPOIL

Temporary spoil: Temporary spoil must be placed no closer than 2 feet from the surface edge of the excavation, measured from the nearest base of the spoil to the cut. This distance requirement ensures that loose rock or soil from the temporary spoil will not fall on employees in the trench *(see Figure 4)*.

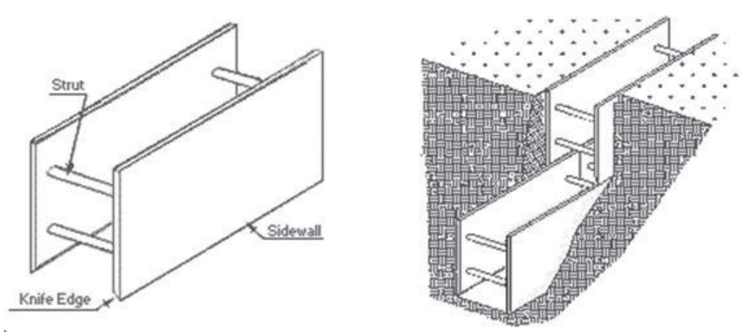


Figure 3: Trench boxes (OSHA Technical Manual)

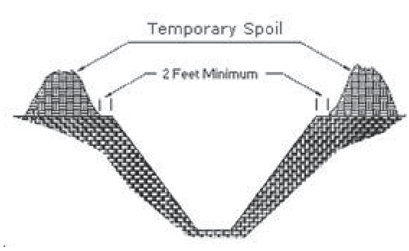


Figure 4: Sloping trenches (OSHA Technical Manual)

STANDING WATER AND WATER ACCUMULATION

Methods for controlling standing water and water accumulation must be provided and should consist of the following if employees are permitted to work in the excavation:

1) use of special support or shield systems approved by a registered professional engineer;
2) water removal equipment (i.e., well pointing, used and monitored by a competent person);
3) safety harnesses and lifelines used in conformance with 29 CFR 1926.104;
4) surface water diverted away from the trench;
5) employees removed from the trench during rainstorms;
6) trenches carefully inspected by a competent person after each rain and before employees are permitted to reenter.

INSPECTIONS

Inspections must be made by a competent person and should be documented. The following guidelines specify the frequency and conditions requiring inspections:

1) daily and before the start of each shift;
2) as dictated by the work being done in the trench;
3) after every rainstorm;
4) after other events that could increase hazards (e.g., snowstorm, windstorm, thaw, earthquake);
5) when fissures, tension cracks, sloughing, undercutting, water seepage, bulging at the bottom, or other similar conditions occur;
6) when there is a change in the size, location, or placement of the spoil pile; and
7) when there is any indication of change or movement in adjacent structures.

HAZARDOUS ATMOSPHERES AND CONFINED SPACES

Employees must not be permitted to work in hazardous and/or toxic atmospheres. Such atmospheres include those with the following characteristics:

1) less than 19.5 percent or more than 23.5 percent oxygen;
2) a combustible gas concentration greater than 20 percent of the lower flammable limit; and
3) concentrations of hazardous substances that exceed those specified in the *Threshold Limit Values for Airborne Contaminants* established by the ACGIH (American Conference of Governmental Industrial Hygienists).

All operations involving such atmospheres must be conducted in accordance with OSHA requirements for occupational health and environmental controls (see Subpart D of 29 CPR 1926) for personal protective equipment and for lifesaving equipment (see Subpart E, 29 CFR 1926). Engineering controls (e.g., ventilation) and respiratory protection may be required.

When testing for atmospheric contaminants, the following should be considered:

1) testing should be conducted before employees enter the trench and should be done regularly to ensure that the trench remains safe;
2) the frequency of testing should be increased if equipment is operating in the trench; and
3) testing frequency should also be increased if welding, cutting, or burning is done in the trench.

Employees required to wear respiratory protection must be trained, fit-tested, and enrolled in a respiratory protection program. Some trenches qualify as confined spaces for which compliance with the Confined Space Standard is also required.

EMERGENCY RESCUE EQUIPMENT

Emergency rescue equipment is required when a hazardous atmosphere exists or can reasonably be expected to exist. Requirements are:

1) respirators must be of the type suitable for the exposure;
2) employees must be trained in their use, and a respirator program must be instituted;
3) attended (at all times) lifelines must be provided when employees enter bell-bottom pier holes, deep confined spaces, or other similar hazards; and
4) employees who enter confined spaces must be trained.