Excavation and trenching safety

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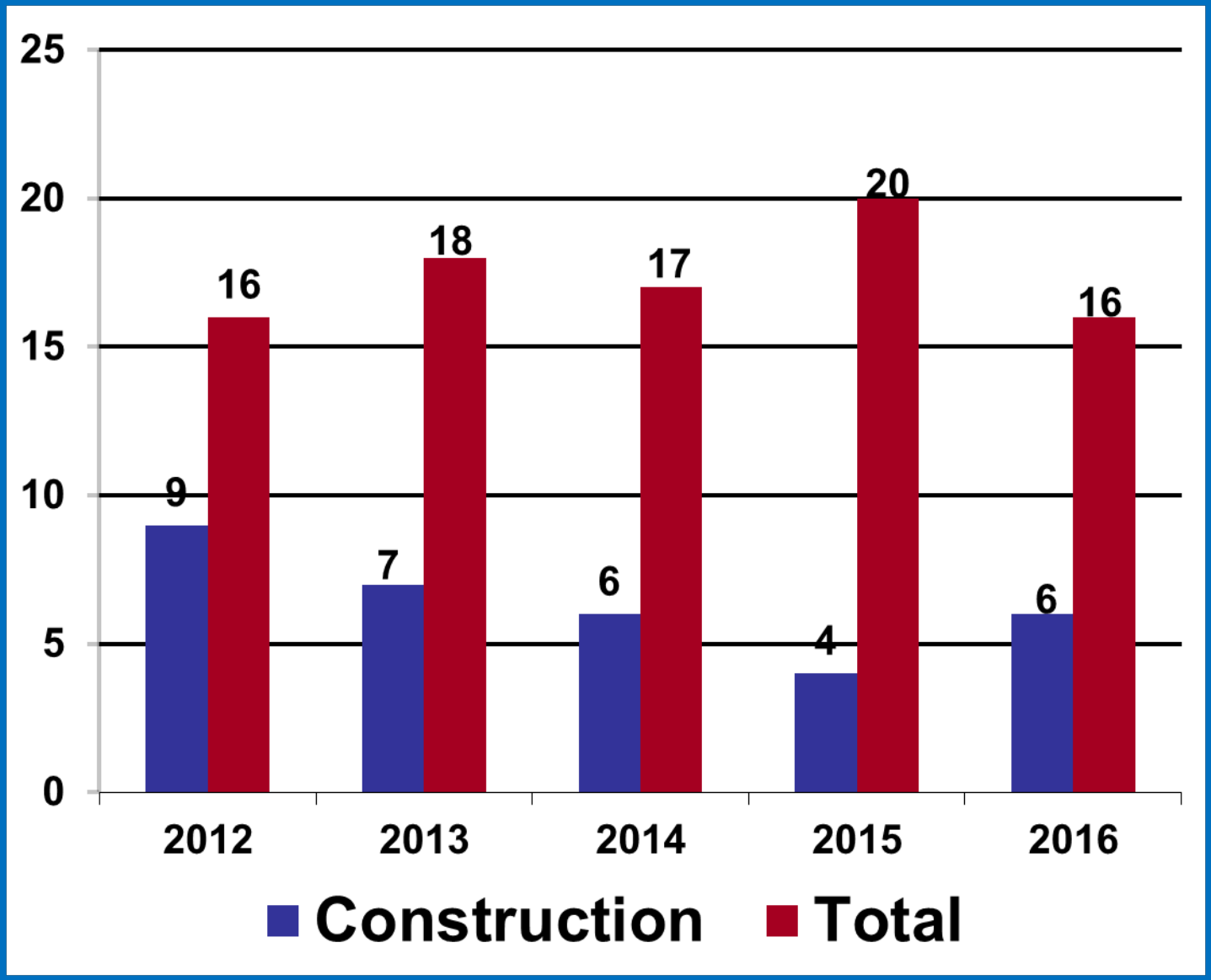
MNOSHA Compliance fatality investigations FFYs 2012 through 2016

During the period from Oct. 1, 2011, through Sept. 30, 2016, the annual average number of fatalities under Minnesota OSHA jurisdiction was 17.

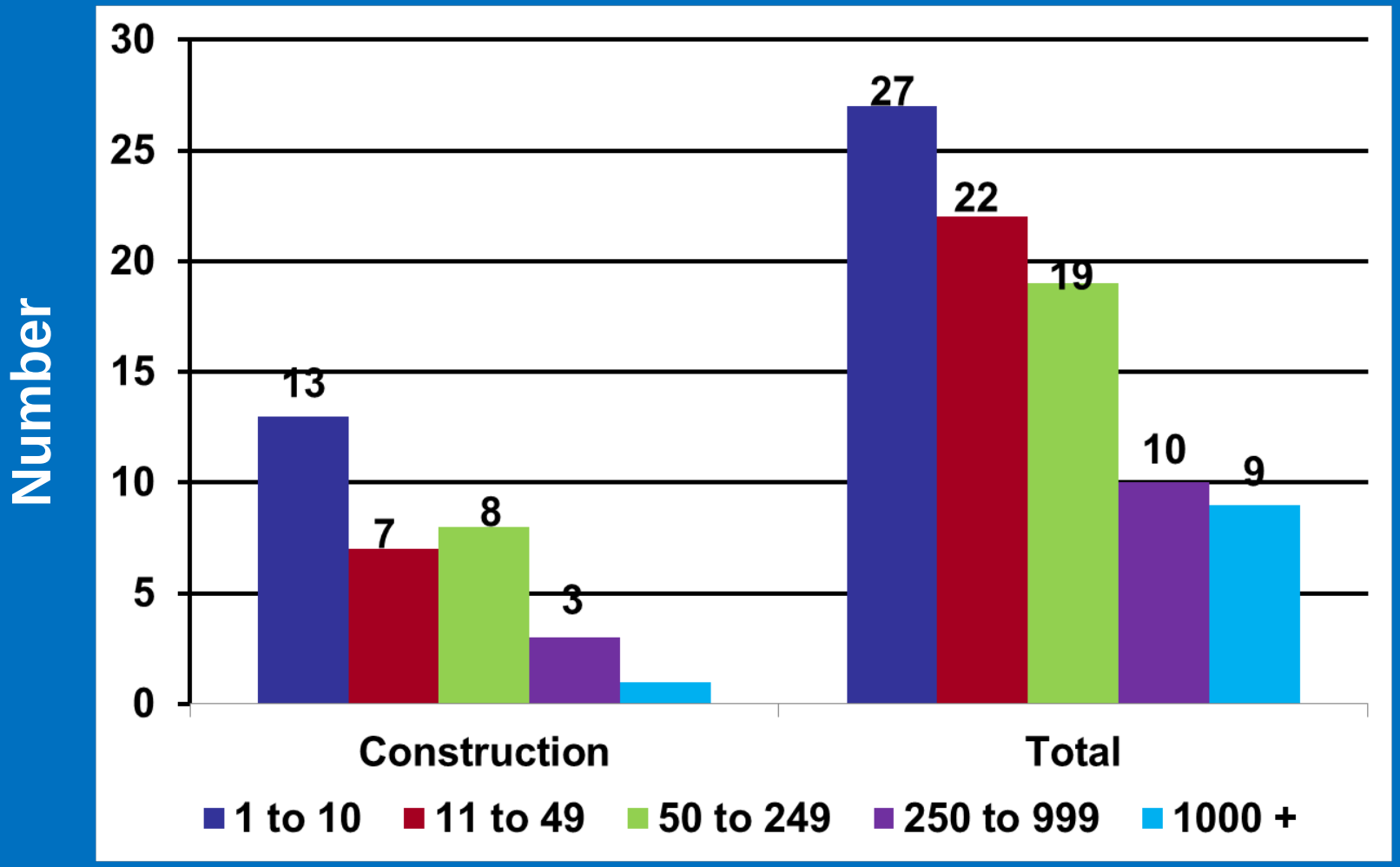
The most common types of workplace fatalities were:

- **contact with an object or equipment – average of eight workers each year;**
- **falls – average of five workers each year; and**
- **electrocution – average of 1.2 workers each year.**

Construction fatalities, FFYs 2012-2016



Construction fatalities by company size, FFYs 2012-2016



Fatal occupational injuries per 100,000 full-time-equivalent workers, 2016

State	Fatality rate
Iowa	6.0
Minnesota	2.3
North Dakota	9.8
South Dakota	7.2
Wisconsin	3.5

Statistics: 2011 through 2016

- 1926.651 cited 228 times
- 1926.652 cited 262 times
- Three fatalities, all in 2015 and 2016
- Five serious injuries, one in each year
- 2.7 percent of citations issued as Repeat
- Average total penalty, $3,494

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MNOSHA's most-frequently cited standards in construction, FFY 2016

Standard	Description	Frequency
1926.501	Fall protection	284
1926.451	General requirements for scaffolds	79
Minnesota Statutes 182.653, subd. 8	A Workplace Accident and Injury Reduction (AWAIR) program	63
1926.1053	Ladders	55
Minnesota Rules 5207.1100	Fall protection on elevating work platforms	44
1926.651	Specific requirements for excavations	41
1926.652	Protective systems for excavations	38
1926.100	Head protection	33
1910.1200	Hazard communication	32
1926.405	Electrical wiring, components and equipment	28
1926.1052	Stairways	28


“Nothing can be more deceptive than the harmless appearance of a deep trench!”
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Trench

"Trench" (or trench excavation) means a narrow excavation – in relation to its length – made below the surface of the ground. **In general, the depth is greater than the width**, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

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Trenching safety

The time to think about worker protection in trenches is before the digging even begins.

Statistic to consider

The trenching fatality rate is *112 percent* greater than that for all construction accidents.

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Statistic to consider

Fifty percent of those who perish in cave-ins were people attempting a rescue.

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Statistic to consider

The vast majority of trench fatalities are occurring in trenches five to 15 feet deep!

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Statistic to consider

One cubic yard of soil weighs approximately 3,000 pounds.

=

Competent person for excavations

Who is a competent person?

Why do we need a competent person present when excavating a trench?

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Competent person for excavations

When applied to trenching and excavation operations, a competent person shall have specific training about and be knowledgeable about:

- **soil analysis;**
- **the use of protective systems; and**
- **the requirements of subpart P.**

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Two most important points for a competent person

1) One who is capable of **identifying existing or predictable hazards** during working conditions that are hazardous or dangerous to employees.

2) One who has the **authorization to take prompt corrective measures to eliminate existing or predictable hazards**.

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Competent person

The competent person is the key to a safe trench excavation. The decisions the compentent person makes will determine the safety of all employees working in and around trenches.

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Employee training

Employees must be trained:

- **when to evacuate if conditions look suspicious;**
- **when to wear proper personal protective equipment (PPE);**
- **about the proper usage of access points; and**
- **to understand the use of disciplinary action.**

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Soil classification

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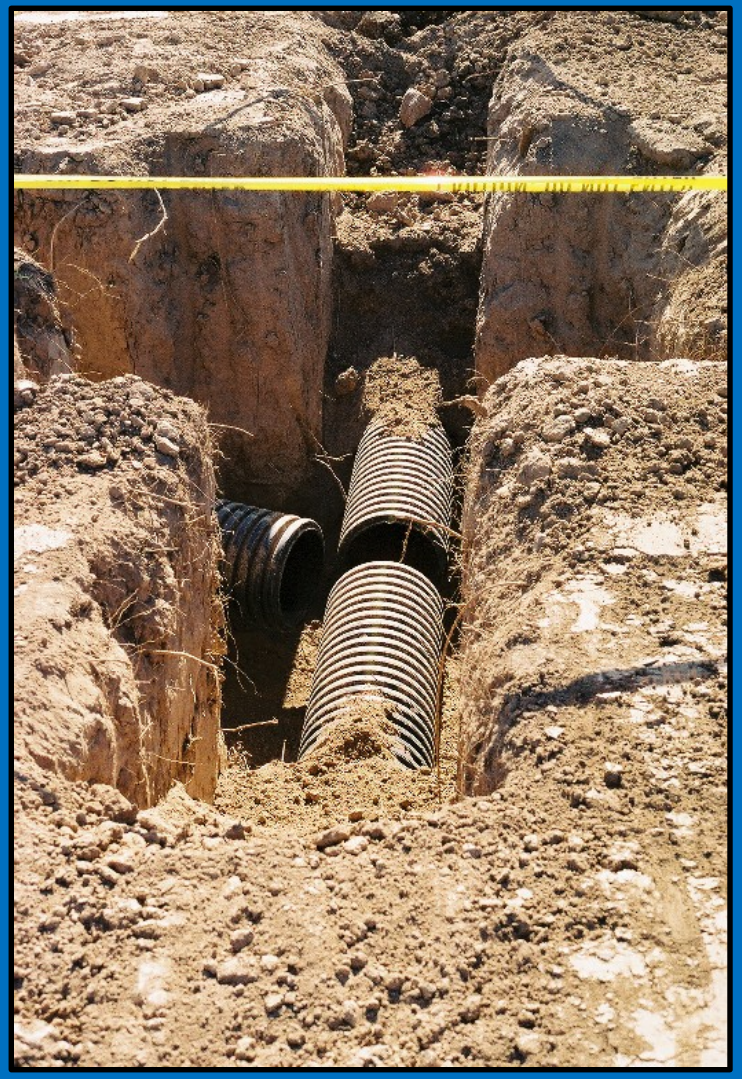
Soil classification

Why do we need to classify the soil where we are excavating a trench?



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Soil classification

"Type A" means cohesive soils with an unconfined, compressive strength of 1.5 tons per square foot (TSF) or greater.

- **Clay**
- **Silty clay**
- **Sandy clay**
- **Clay loam**
- **Silty clay loam, sandy clay loam (in some cases)**

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Soil classification

However, no soil is type A if:

- **the soil is fissured;**
- **the soil is subject to vibration;**
- **the soil has been previously disturbed; or**
- **other factors are present.**

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Soil classification

"Type B" means cohesive soils with an unconfined compressive strength greater than 0.5 TSF, but less than 1.5 TSF.

- **Angular gravel (similar to crushed rock)**
- **Silt**
- **Silt loam**
- **Sandy loam**
- **Silty clay loam and sandy clay loam**

Soil classification

"Type B" includes:

- previously disturbed soils, except those classed as type C soil;
- soil that meets the compressive strength requirements for type A, but is fissured or subject to vibration; and
- dry rock that is not stable.

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Soil classification

"Type C" means cohesive soils with an unconfined compressive strength of 0.5 TSF or less.

- **Gravel**
- **Sand**
- **Loamy sand**
- **Submerged soil, where water is freely seeping**
- **Submerged rock that is not stable**

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Soil classification

Requirements:

- **shall be classified by a competent person;**
- ***based on at least one visual and at least one manual analysis*;**
- **layered system, classified in accordance with its weakest layer; and**
- **reclassified as necessary to reflect the changed circumstances.**

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Cave-in protection

Adequate protection shall be provided by sloping, shoring and shielding.

Sloping
Shoring
Shielding

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Sloping

Sloping

Soil or rock type	Maximum allowable slopes (H:V) for excavations less than 20 feet deep
Stable rock	Vertical (90 degrees)
Type A	3/4:1 (53 degrees)
Type B	1:1 (45 degrees)
Type C	1-1/2:1 (34 degrees)

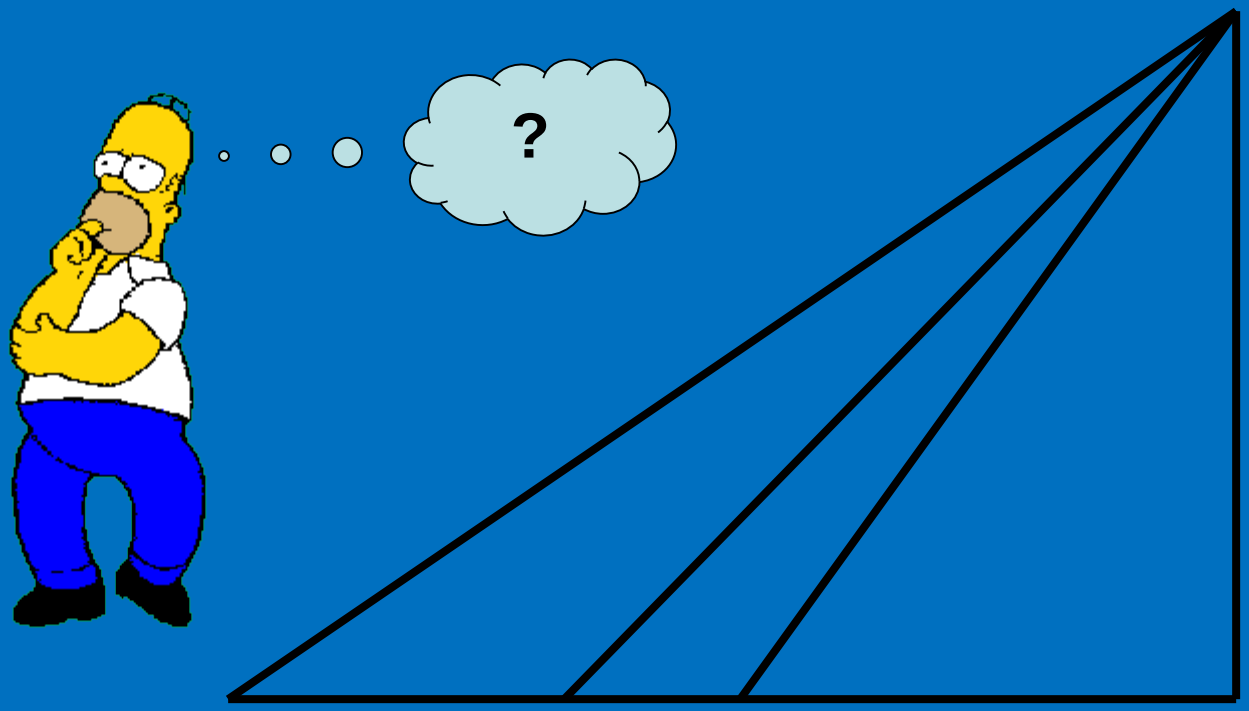
Notes

1) Numbers shown above in parentheses, next to maximum allowable slopes, are angles expressed in degrees from the horizontal. Angles have been rounded off.

2) A short-term maximum allowable slope of 1/2H:1V (63 degrees) is allowed in excavations in type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53 degrees).

3) Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

Sloping for A, B and C soils



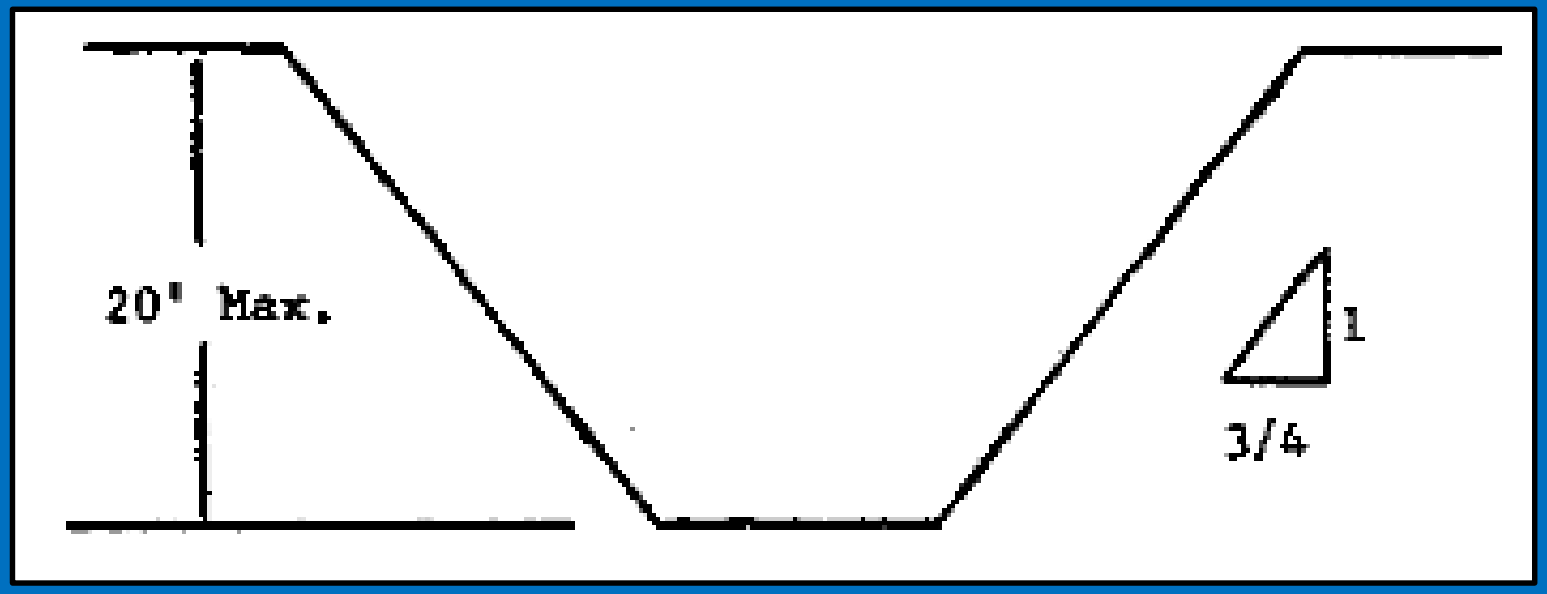
C soil:
slope 1.5 to 1

B soil:
slope 1 to 1

A soil:
slope .75 to 1

Excavations in type A soil

Simple slope – general: Twenty feet or less in depth shall have a maximum allowable slope of ¾:1.



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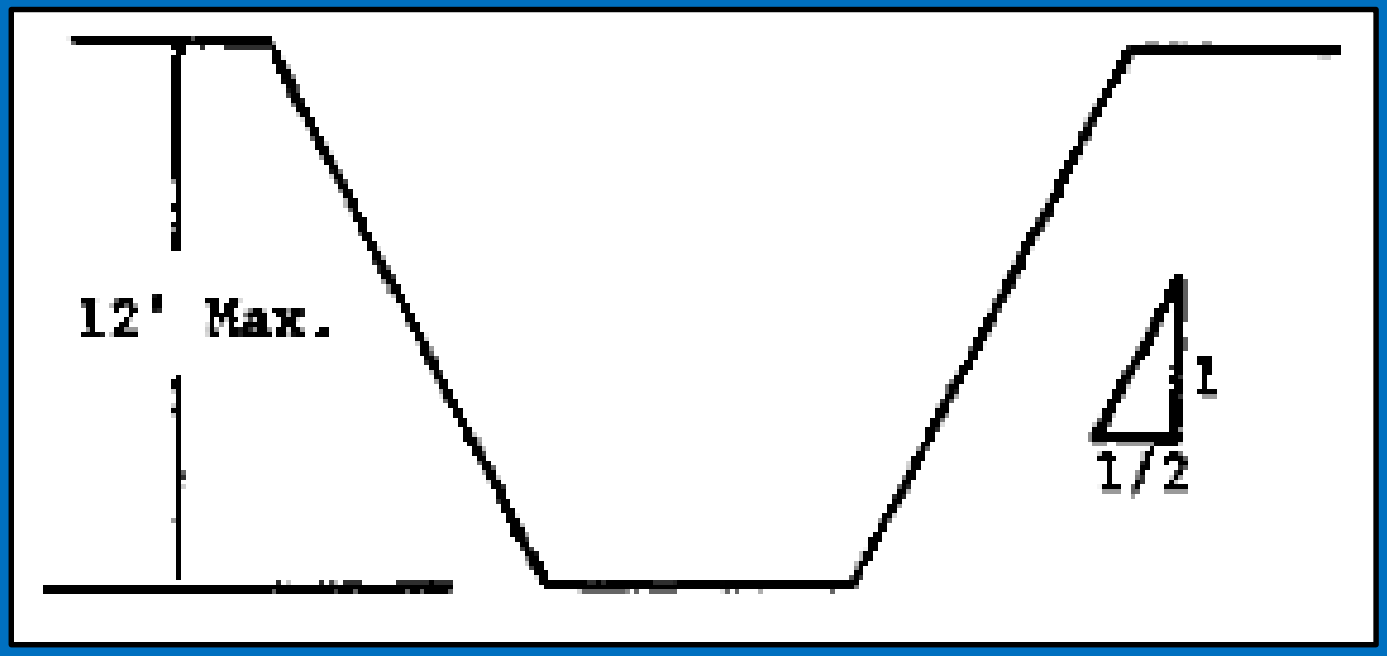
Excavations in type A soil

An exception: Twenty-four hours or fewer (short-term) and that are 12 feet or less in depth shall have a maximum allowable slope of 1/2:1.



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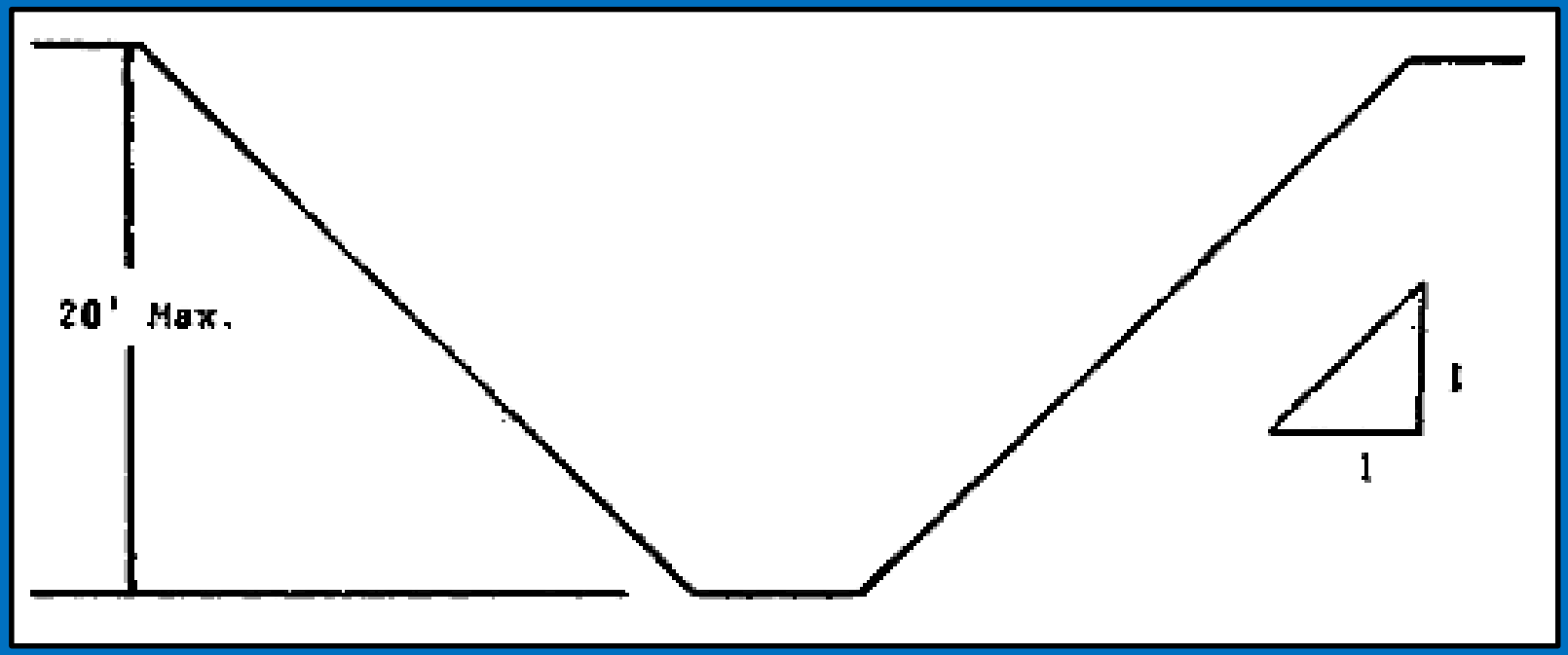
Excavations in type B soil

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



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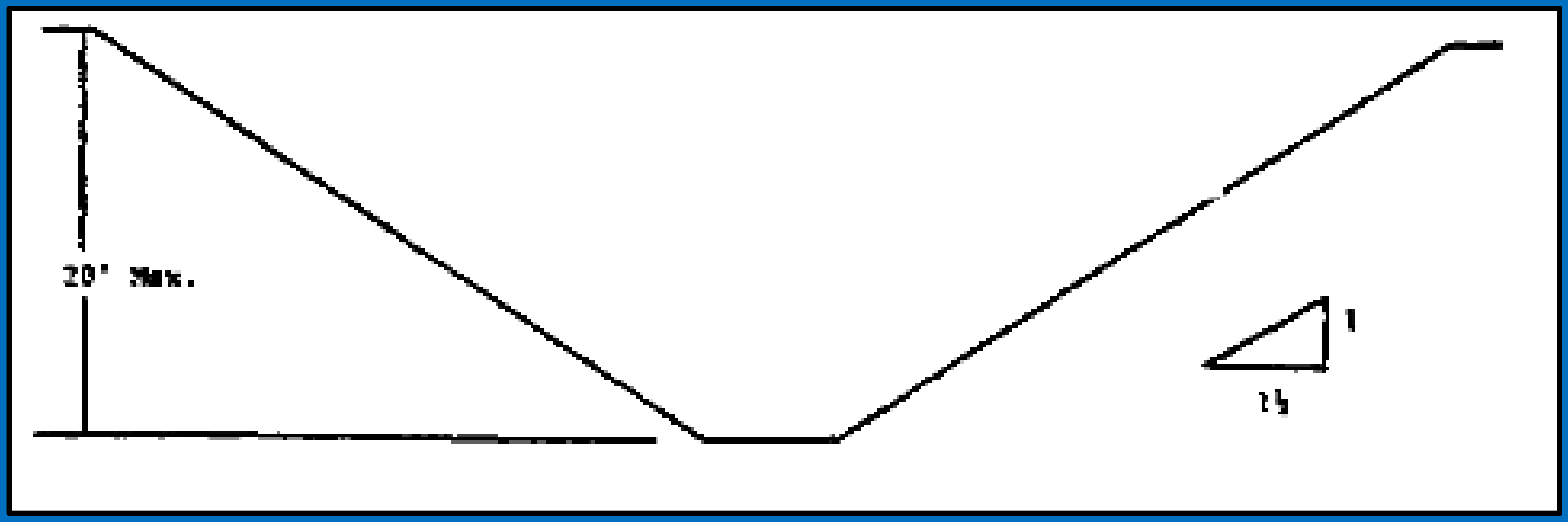
Excavations in type C soil

Simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1-1/2:1.



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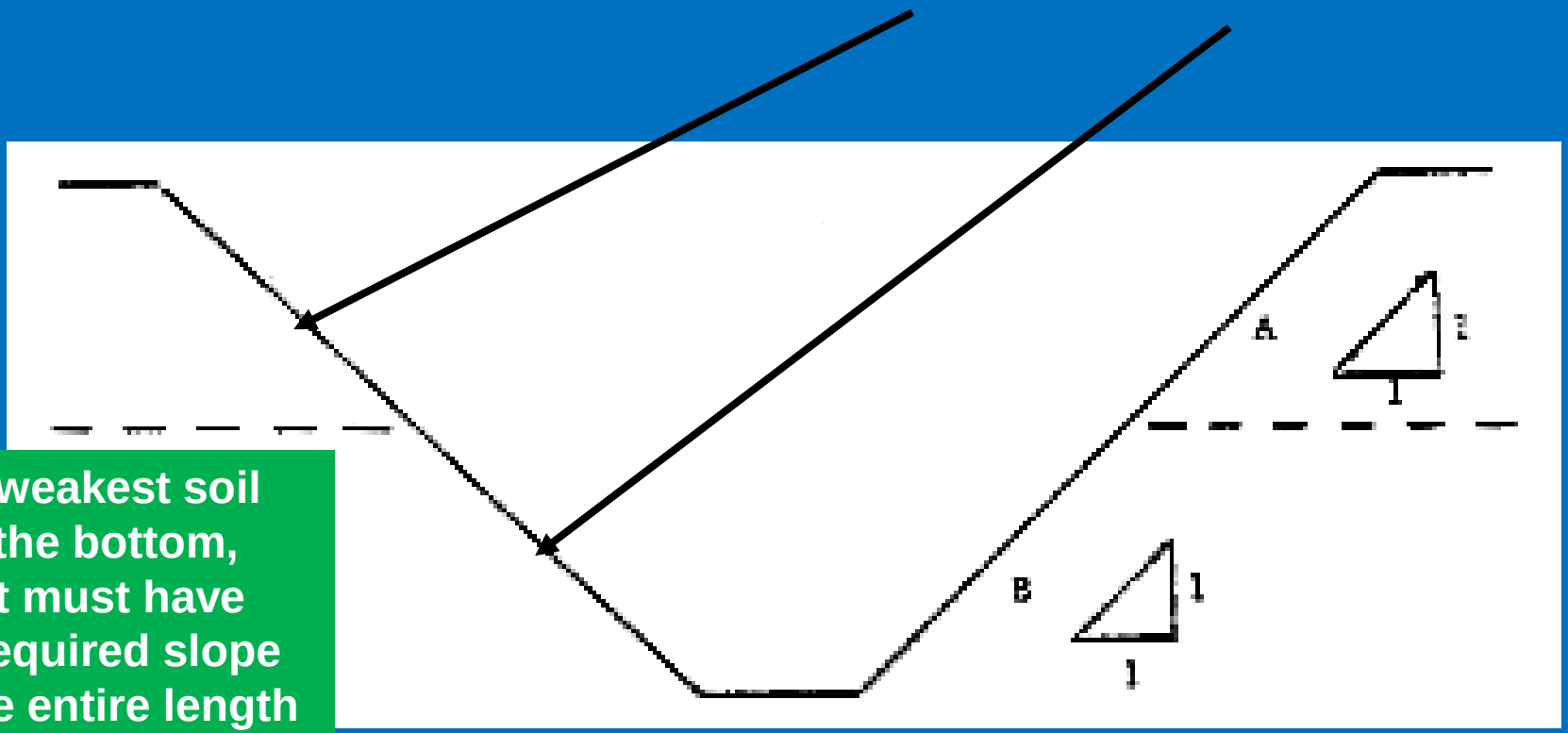
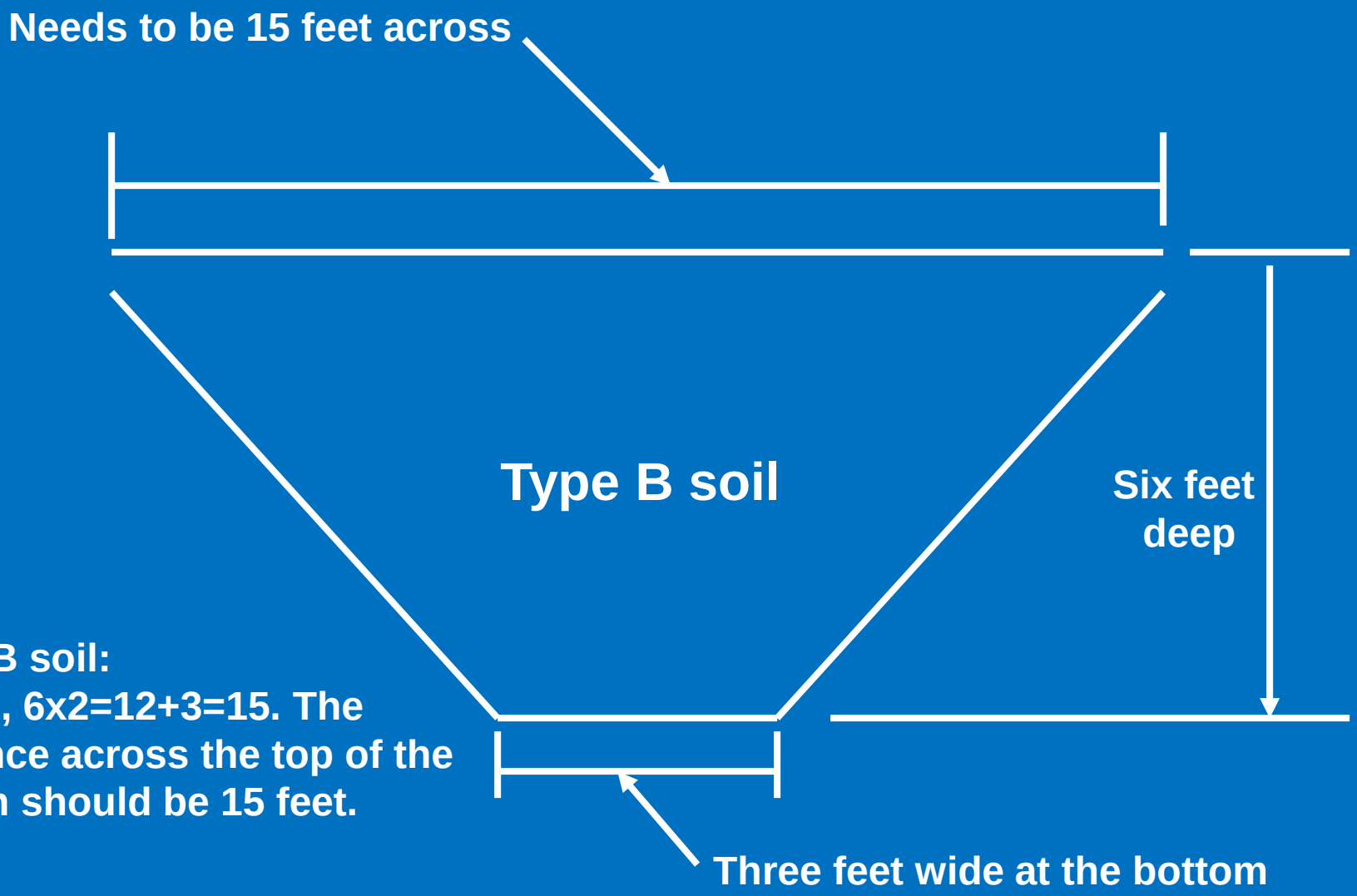
Excavations in layered soils

Excavations 20 feet or less in depth made in layered soils: A over B.



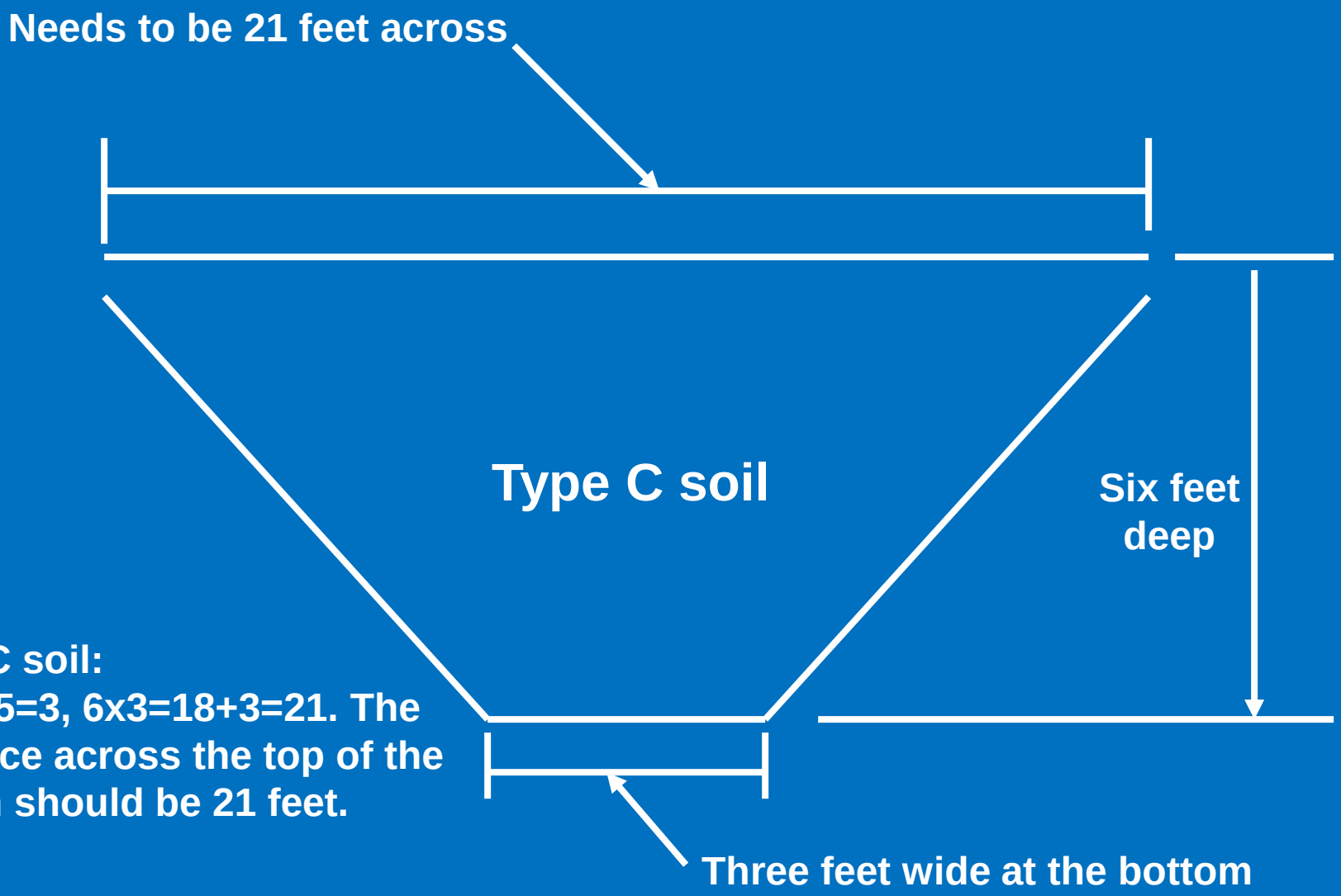
If the weakest soil is on the bottom, then it must have that required slope for the entire length of the slope.

Quick, easy method to determine maximum slope allowed for a trench



Type B soil:
1+1=2, 6x2=12+3=15. The distance across the top of the trench should be 15 feet.

Quick, easy method to determine maximum slope allowed for a trench



Type C soil:
1.5+1.5=3, 6x3=18+3=21. The distance across the top of the trench should be 21 feet.

Aluminum hydraulic shoring

Two-inch cylinders shall be a minimum two-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds.

Three-inch cylinders shall be a minimum three-inch inside diameter with a safe working capacity of not less than 30,000 pounds.

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Aluminum hydraulic shoring

Plywood shall be 1.125 inch thick softwood or 0.75 inch thick 14 ply, arctic white birch.

Plywood is not intended as a structural member.

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Aluminum hydraulic shoring

1

2

Aluminum hydraulic shoring

3

4

Aluminum hydraulic shoring

5

Shielding

Shield systems

Do not subject the trench box to loads exceeding those that the system was designed to withstand.

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Shield systems

Installation and removal of support:

- **install and remove trench boxes in a manner that protects employees from cave-ins; and**
- **backfill behind the box as the work is being completed.**

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Shield systems

Do not allow employees in trench boxes when the trench boxes are being installed, removed or moved vertically.

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Trenching hazard considerations

Basic rule

Four-foot rule – a means to get in and out of a trench if it is four or more feet deep. Must not have to travel more than 25 feet to reach the means of egress.

Five-foot rule – employees working in excavations are protected from cave-ins by adequate protective systems according to OSHA unless it's:

- stable rock; or
- less than five feet and the competent person inspects to ensure there is no potential for cave-in.

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Materials or equipment

Keep material and equipment at least two feet (.61 m) from the edge of excavations.

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Spoil piles

Spoil piles must be kept at least two feet from the edge of the trench.

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Exposure to falling loads

Do not permit employees to work underneath loads handled by lifting or digging equipment.

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Hazards associated with water accumulation

Do not allow employees to work in trenches where there is accumulated water.

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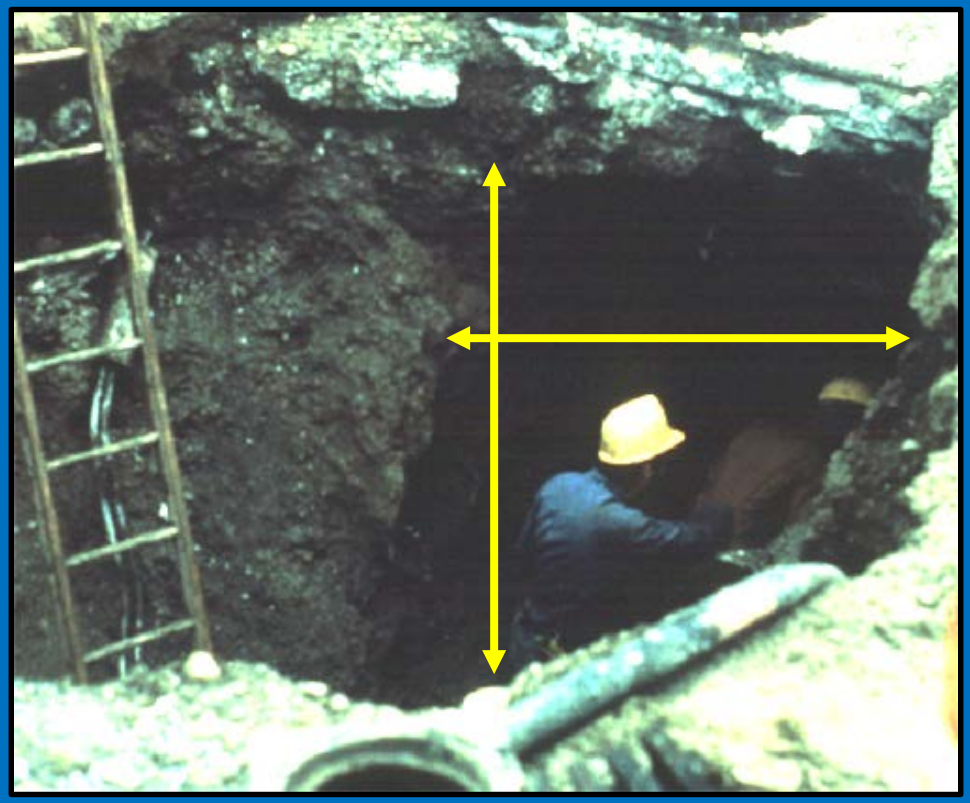
Stability of adjacent structures

Stabilize adjoining buildings, walls, footings, foundations, retaining walls, sidewalks or other structures by means of:

- **shoring;**
- **bracing; and**
- **underpinning.**



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Warning systems for mobile equipment

When an equipment operator does not have a clear and direct view of the edge of the excavation, use:

- **a warning system;**
- **barricades;**
- **hand or mechanical signals; or**
- **stop logs.**

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Fall protection

Walkways shall be provided where employees or equipment are required or permitted to cross over excavations.

Guardrails shall be provided where walkways are six feet or more above lower levels.

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Hazardous atmospheres

Where a hazardous atmosphere exists or could reasonably be expected to exist:

- **test before employees enter excavations greater than four feet (1.22 m) in depth;**
- **containing less than 19.5 percent oxygen; and**
- **provide ventilation.**

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Hazardous atmospheres

Hazardous atmospheres can be present by:

- **some type of landfill or dumping area;**
- **a chemical recycling or collection center;**
- **an area where chemicals or hazardous waste may be stored;**
- **underground petroleum tanks; or**
- **water treatment sites.**

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Operation of mobile earth-moving equipment

5207.1000, subpart 6 – Contractor responsibility

- If equipment is being used and exposes other contractor's employees to a hazard, the general contractor is responsible for holding a joint contractor safety awareness meeting.

- The meeting shall be documented, identifying when the meeting was and who attended, including a brief summary of what was reviewed. Documentation shall be retained for the duration of the project.

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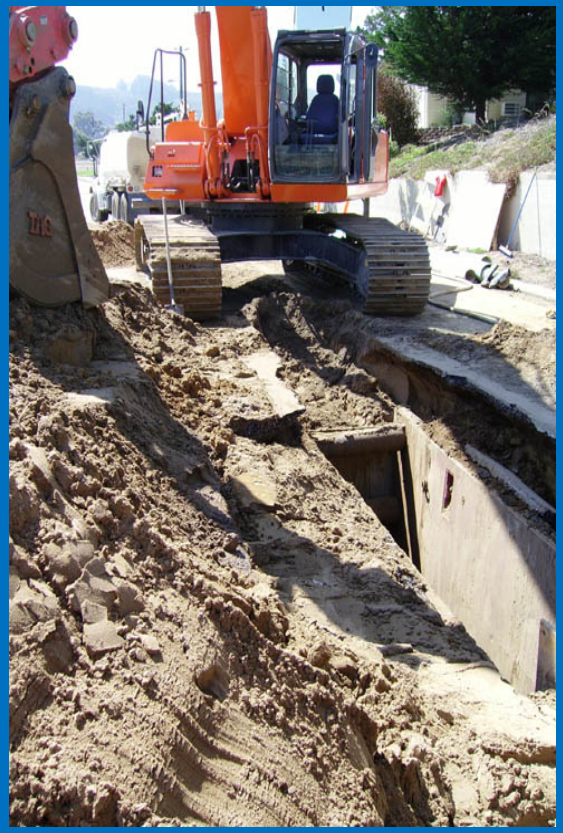
Remember trench inspections

Trench inspections must be made by a competent person, checking for hazardous conditions:

- **prior to the start of work;**
- **after every rainstorm; and**
- **as otherwise needed.**



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Most-cited excavation standards in the past five years

#1

29 CFR 1926.652 – cited 254 times

(a) Protection of employees in excavations

(1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system.

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Most-cited excavation standards in the past five years

#2

29 CFR 1926.651 – cited 94 times

(c) Access and egress

(2) Means of egress from trench excavations. A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are four feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

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Most-cited excavation standards in the past five years

#3

29 CFR 1926.651 – cited 77 times

(j) Protection of employees from loose rock or soil

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least two feet (.61 m) from the edge of excavations.

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Most cited excavation standards in the past five year

#4

29 CFR 1926.651 – cited 28 times

(k) Inspections

(1) Daily inspections of excavations, the adjacent areas and protective systems shall be made by a competent person.

(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, exposed employees shall be removed from the hazardous area.

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Most-cited excavation standards in the past five years

#5 and #6 (tie)

29 CFR 1926.651(h)(1) – cited eight times

29 CFR 1926.651(i)(3) – cited eight times

(h)(1) – Protection from hazards associated with water accumulation; and

(i)(3) – Stability of adjacent structures

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Gopher State One Call (GSOC)

The "Call Before You Dig" law (Minnesota Statutes 216D) requires that any excavator must call the statewide notification center at least 48 hours before the start of digging (excluding weekends, holidays and emergencies).

Metro area: (651) 454-0002

Statewide: 1-800-252-1166

All trenches will cave in, it is just a matter of time!

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This material can be provided to you in a different format (audio, Braille or large print) if you call the Minnesota OSHA Training/Outreach Office at (651) 284-5050 or 1-877-470-6742.

For more information, contact:
Minnesota Department of Labor and Industry
Occupational Safety and Health Division
443 Lafayette Road N.
St. Paul, MN 55155
Phone: (651) 284-5050 or 1-877-470-6742
Email: osha.compliance@state.mn.us
Web: www.dli.mn.gov/MnOsha.asp

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