Trench Safety Handbook

This handbook was designed by the
Michigan Infrastructure & Transportation Association

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INTRODUCTION

The underground construction industry is no different than any other. If underground construction is not performed properly, employees can be exposed to even the most common hazards.

This Trench Safety Handbook was designed by MITA, Inc. to assist you in complying with Part 9 of the MIOSHA Standards. Its purpose is to give you a quick reference in terms of avoiding some of the potential hazards associated with excavations. It is not intended to be a substitute for the MIOSHA standards and you are encouraged to familiarize yourself with the specifics of Part 9.

If you have any questions or comments, or if you need a copy of the MIOSHA Standards, please contact your employer or the MITA office at 1-800-878-2821.

BEFORE YOU START

When performing open-cut construction, MIOSHA requires that you have a qualified person on hand to perform certain procedures.

A qualified person does not have to be an engineer or have a degree. Any person who, by extensive knowledge, training and experience, can solve or resolve problems that occur on the jobsite is considered to be a qualified person. This person could be the superintendent, foreman, or anyone else on the project designated by the owner.

As you read this handbook you will notice various tasks that are the responsibility of the qualified person. Make sure that you designate an individual for this job and make certain the crew knows who it is.

PROTECTION OF UNDERGROUND UTILITIES

State law requires that you call the MISS DIG System at (800) 482-7171 at least three working days, but no more than 21 days, prior to any excavation.

• You are required to hand expose an underground utility line to determine its exact location once it has been staked or marked.

• If necessary, you are required to adequately support any utility that is exposed or disturbed by your construction operation.

• You are required to evacuate your employees should you damage a utility that could present a dangerous situation.

• You are required to notify the affected utility immediately should damage occur. This includes damage to any protective coating.

• You are required to call MISS DIG for a restake if hand digging does not expose the utility.

EXCAVATION ISSUES:
ANGLE OF REPOSE

All trenches 5' deep or more must be cut back to the proper angle of repose unless a trench box or shoring is being used.

• All trenches under 5' deep must be inspected constantly for signs of instability—cracks, water, flaking, etc.

• The proper angle of repose varies depending on the soil type (see chart on page 7).

• Use of a hand-held penetrometer is the only accurate method of determining the unconfined strength of soil. Penetrometers are available for purchase through the MITA office.

• The proper angle of repose can be calculated as shown on the following pages.

• An ongoing inspection of a trench shall be made by a qualified person.

DETERMINE THE PROPER ANGLE OF REPOSE

1. Excavate to a depth less than 5' and push a penetrometer in the side of each bank. Note the reading in tons per square foot (TSF) on the penetrometer.

2. Refer to chart "A" for the proper angle. For example, a reading of 1.5 to 2.5 TSF would require an angle somewhere between 56 and 63 degrees.

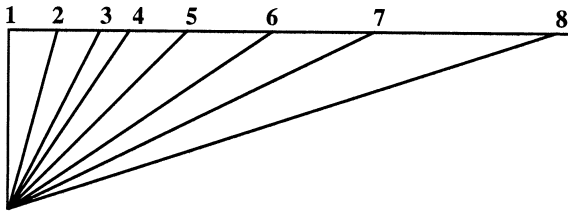
3. If the soil changes with depth, take additional readings but make certain the employee performing this task is protected. The lowest TSF reading will apply in all instances.

4. To determine if your trench is cut to the proper angle, refer to chart "B."

5. Using the calculation on chart "B," you divide the height over the width as shown and the resulting number is the tangent.

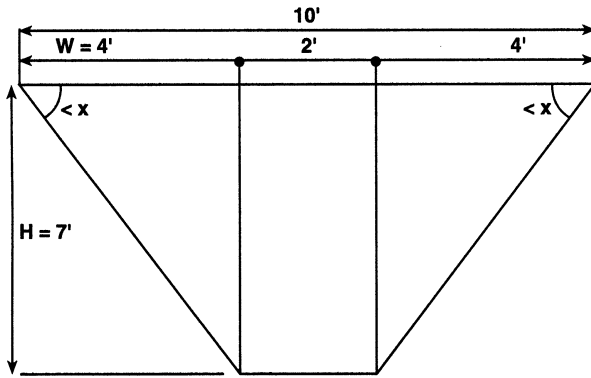
6. Refer to chart "C" to convert the tangent into the angle. For example, the measurements indicated in chart "B" result in a tangent of 1.76 which is converted to 60 degrees as shown in chart "C."

Chart "A"
Angle of Repose



1. Solid Rock Formation (90°)
2. Fractured Rock Formation (75°) 1/4:1
3. Stiff Clay (63°) 1/2:1; 2.5 TSF minimum
4. Firm Clay (56°) 2/3:1; 1.5 TSF minimum
5. Granular Soil - Dry (45°) 1:1; 1.0 TSF minimum
6. Granular Soil- Wet (34°) 1 1/2:1; <1.0 TSF
7. Saturated Granular Soil (26°) 2:1
8. Running Soil (18°) 3:1

Chart "B"
CALCULATING ANGLE OF REPOSE



TANG < -H/W = 7/4 = 1.76 = 60º Angle

Chart "C"

TANGENT > = H/W = DEGREE OF ANGLE FROM THE HORIZONTAL

Tangent	Degree	Tangent	Degree
0.000	0	0.424	23
0.017	1	0.445	24
0.035	2	0.466	25
0.052	3	0.488	26
0.070	4	0.510	27
0.087	5	0.532	28
0.105	6	0.554	29
0.123	7	0.577	30
0.141	8	0.601	31
0.158	9	0.625	32
0.176	10	0.649	33
0.194	11	0.675	34
0.213	12	0.700	35
0.231	13	0.727	36
0.249	14	0.754	37
0.268	15	0.781	38
0.287	16	0.810	39
0.306	17	0.839	40
0.325	18	0.869	41
0.344	19	0.900	42
0.364	20	0.933	43
0.384	21	0.966	44
0.404	22	1.000	45

Chart “C” continued

TANGENT > = H/W = DEGREE OF ANGLE FROM THE HORIZONTAL

Tangent	Degree	Tangent	Degree
1.036	46	2.605	69
1.072	47	2.748	70
1.111	48	2.904	71
1.150	49	3.078	72
1.192	50	3.271	73
1.235	51	3.487	74
1.280	52	3.732	75
1.327	53	4.011	76
1.376	54	4.332	77
1.428	55	4.705	78
1.483	56	5.145	79
1.540	57	5.671	80
1.600	58	6.314	81
1.664	59	7.115	82
1.732	60	8.144	83
1.804	61	9.514	84
1.881	62	11.43	85
1.963	63	14.30	86
2.050	64	19.08	87
2.145	65	28.64	88
2.246	66	57.29	89
2.356	67		
2.475	68		

TRENCH BOXES

Trench boxes are a safe and effective method of protecting employees who are working in excavations and trenches. Some points to remember:

• Your trench box must be designed/built by a qualified person.

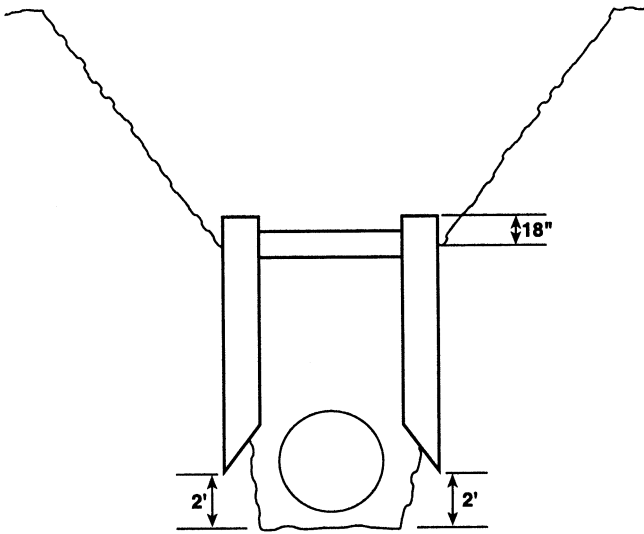
• The bottom of the trench box must be no more than 2' from the bottom of a trench unless suitable protection is provided below the bottom of the box.

• No employee can be in the trench box while it is being moved.

• The sides of the excavation must be kept at least 18" below the top of the box. Any soils above the trench box must meet the angle of repose requirements.

• Proper access to a trench box should be used. This could be done with a ladder or proper ramp.

TRENCH BOX USE



INGRESS AND EGRESS

Trenches greater than 4' deep must maintain a means of ingress/egress by one of the following methods:

- A ladder extended 3' above the top of the trench.

- A ramp constructed at a 45° angle, free of obstructions, relatively firm and has sides that are cut to the proper angle of repose.

- Entrance and exit through manholes, large diameter pipe, etc., are acceptable but are treated as a confined space. Such means of travel must be tested for oxygen content and combustible and toxic gases. These test results must be kept at the jobsite.

Lateral travel: A means of egress (ladder, ramp, etc.) must be provided every 25' along the wall of a trench.

EXCAVATED MATERIAL

Excavated materials must be stored at least 2' from the edge of the trench.

ACCUMULATING WATER

Accumulating water must be controlled or prevented by use of one or a combination of the following methods:

- The use of water removal equipment that is monitored by a qualified person or monitoring system.
- Place a trench box in the trench to guard against possible cave-ins or slides.
- A qualified person must continuously maintain inspections of the trench if wet conditions persist.

ENERGIZED LINES

Maintain 10’ minimum clearance from energized lines; use a spotter in difficult areas.

	Voltage	Clearance with Boom Raised
To	50 kV	10’
	69 kV	10’ - 7.6"
	120 kV	12’- 4.0"
	138 kV	12’ - 11.2"
	345 kV	19’ - 10.4"
	765 kV	33’ - 10.0"

Spotters must maintain visual contact with the operator and limit their work activity to only spotting.

FALL PROTECTION

The MIOSHA Fall Protection standard requires that all employees be protected from falls either by guarding or eliminating the hazard. Most excavations are exempt from fall protection rules, however, you should consider the following:

- All manholes should be covered or guarded. If temporary covers are used they should identify the hazard and be made of sufficient material to prevent dislodging.

- Stationary excavations (i.e., bore pits or long term excavations) should be guarded in a manner that would prevent individuals from falling in them. If snow fencing is used as a barrier, be sure it is back from the edge of the hazard a reasonable distance, in order to eliminate the hazard.

- Guardrails placed at the edge of a fall hazard should be 42” high plus or minus 3 inches with midrail and be able to withstand 200 lbs. of force.

- Open excavations should be properly guarded when work is not performed and crews are not on site.

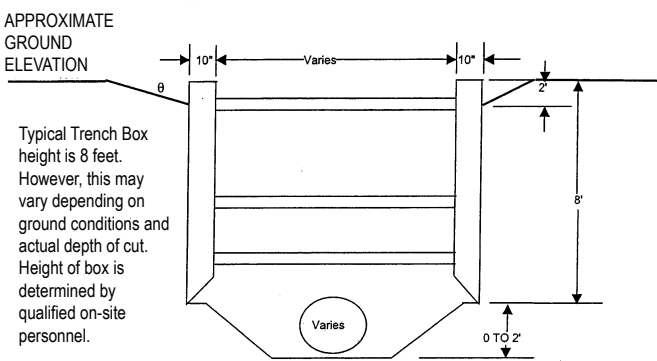
DISCLAIMER

MITA has provided this handbook as an overview of some of the important rules in Part 9 Excavation, Trenching and Shoring of the MIOSHA Construction Safety Standards. It is intended to provide general information, but not advice regarding any particular situation. This handbook is not intended to set forth all the requirements of the applicable MIOSHA standards and should never be used as a substitute for the standards. Contractors and employees should always be familiar with the current and complete MIOSHA Construction Safety Standards before commencing construction. Neither MITA nor its officers, employees, directors, members or publisher may be held responsible in any manner for any damage or loss, or any action whatsoever, resulting from inaccuracies or omissions in this handbook.

The following pages are intended to serve as a guide on various types of shoring designs. They are not part of the MIOSHA Standards and are to be used only for reference purpose.

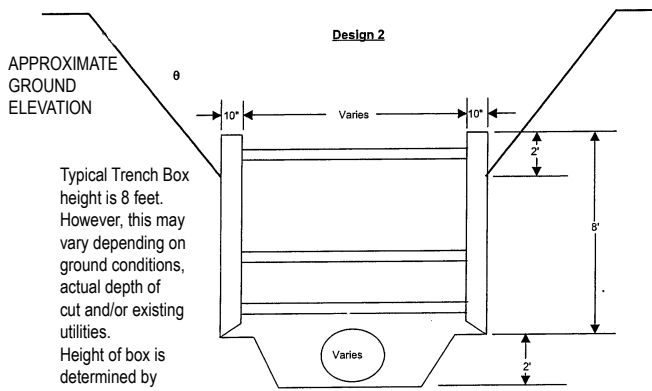
APPENDIX: SHORING DESIGNS

Design 1



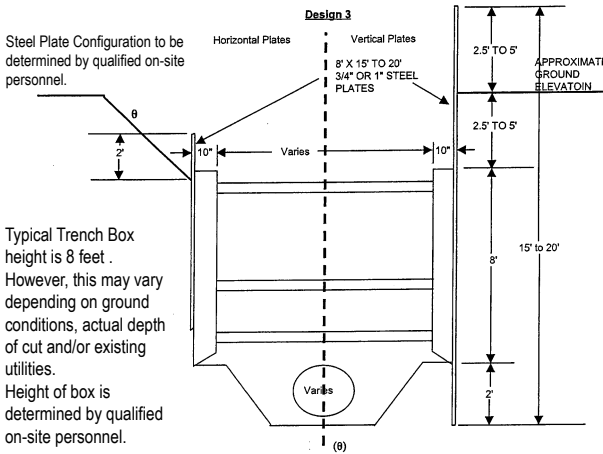
Typical Trench Box height is 8 feet. However, this may vary depending on ground conditions and actual depth of cut. Height of box is determined by qualified on-site personnel.

Single Box



Typical Trench Box height is 8 feet. However, this may vary depending on ground conditions, actual depth of cut and/or existing utilities.
Height of box is determined by qualified on-site personnel.

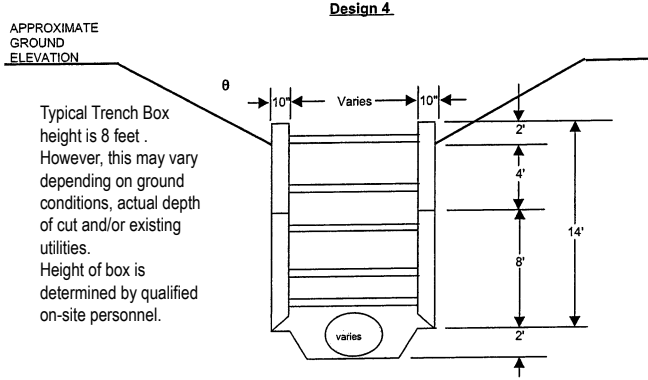
Single Box, Ground Cut to Proper Angle of Repose Above Box



Typical Trench Box height is 8 feet . However, this may vary depending on ground conditions, actual depth of cut and/or existing utilities.
Height of box is determined by qualified on-site personnel.

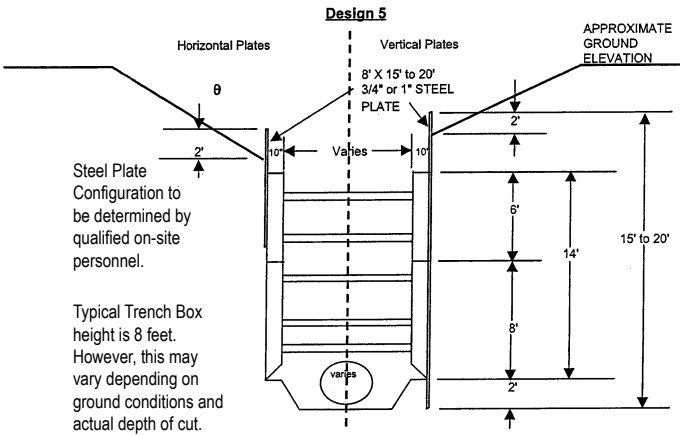
Single Box with Plates

Design 4



Typical Trench Box height is 8 feet . However, this may vary depending on ground conditions, actual depth of cut and/or existing utilities.
Height of box is determined by qualified on-site personnel.

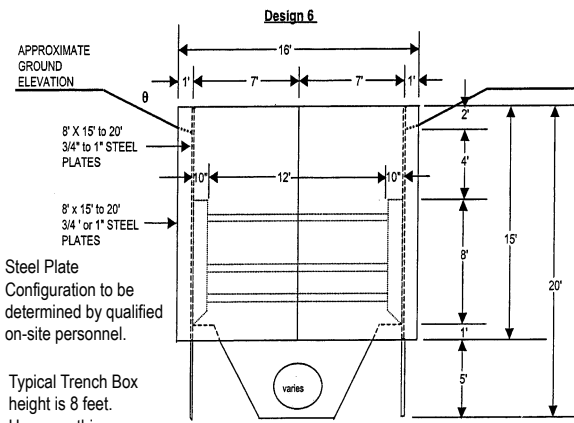
Stacked Boxes



Steel Plate Configuration to be determined by qualified on-site personnel.

Typical Trench Box height is 8 feet. However, this may vary depending on ground conditions and actual depth of cut. Height of box is determined by qualified on-site personnel.

Single Boxes with Plates



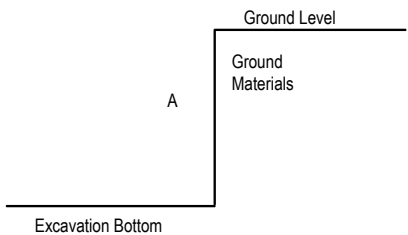
Steel Plate Configuration to be determined by qualified on-site personnel.

Typical Trench Box height is 8 feet. However, this may vary depending on ground conditions and actual depth of cut. Height of box is determined by qualified on-site personnel.

Trench Box and Plates

APPENDIX: Open Cut Examples

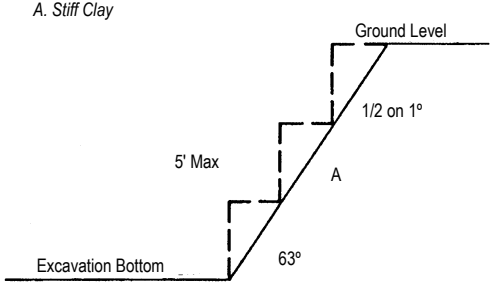
EXAMPLE 1 0-5' Deep



Side A: If the ground shows indication of hazardous movement, Side A shall be cut to proper angle of repose or a supporting system shall be provided.

EXAMPLE 2 More than 5' Deep

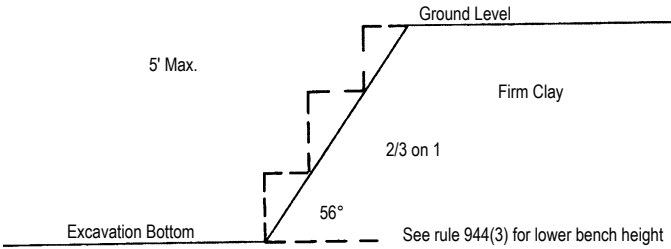
A. Stiff Clay



* 1/2 HORIZONTAL: 1 VERTICAL

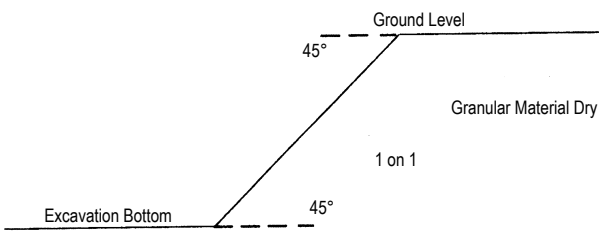
Penetrometer reading 2.5 TSF or greater required

B. *Firm Clay*



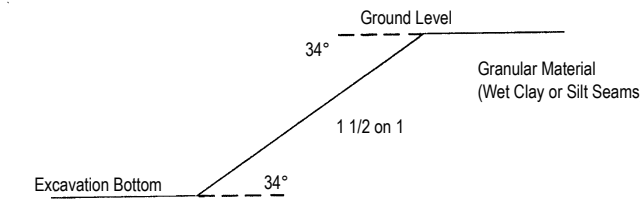
Penetrometer reading of 1.5 TSF or greater required

C. *Granular Material*

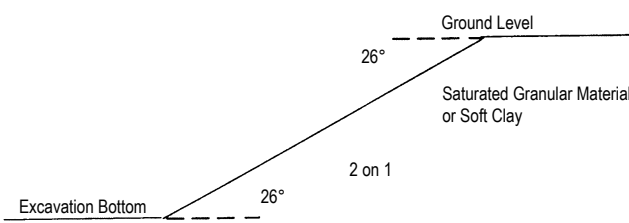


EXAMPLE 2 More than 5' Deep (continued)

D. *Granular Material (Wet Clay or Silt Seams)*

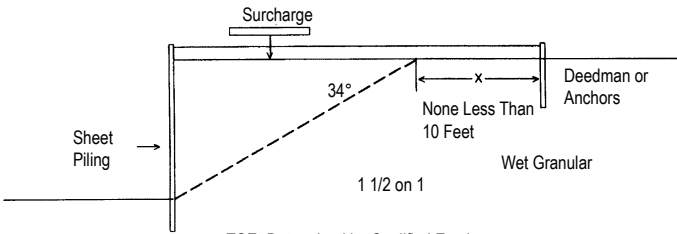


E. Saturated Granular Material or Soft Clay



EXAMPLE 3 Supporting System - Sheet Piling

Wet Granular Material

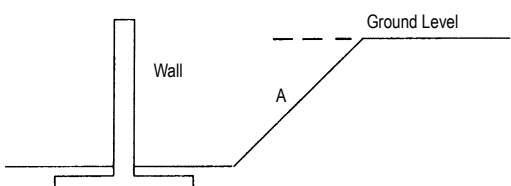


TOE- Determined by Qualified Employee

The design of the supporting system should take into consideration any surcharges, such as, stockpile material, equipment, or hydrostatic pressure that must be supported by the system.

X = Not Less than 10'

EXAMPLE 4 Wall In Place

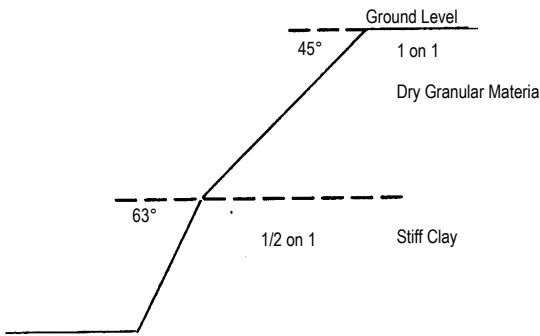


Side A: Side A should be cut to the angle of repose or a supporting system provided.

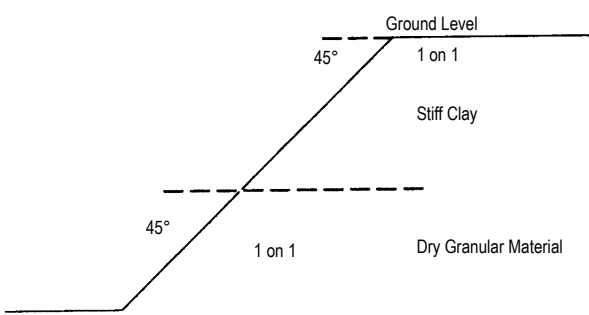
If support system is designed for Side A, no braces or members should bear against the wall unless the wall is designed to withstand bracing loads.

EXAMPLE 5 Different Textured Soils

Case 1

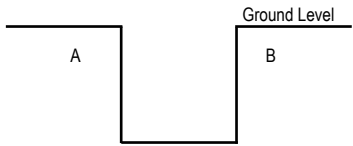


Case 2



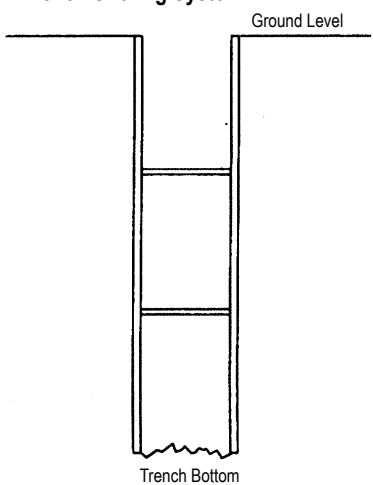
EXAMPLE 6 0 - 5' Deep

TRENCHES



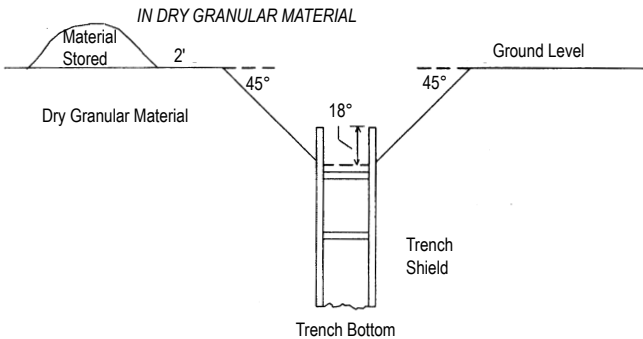
Side A & B: If examination of the ground indicates hazardous ground, movement may be expected. Sides A & B shall be sloped to the proper angle of repose.

EXAMPLE 7 Trench Shoring System

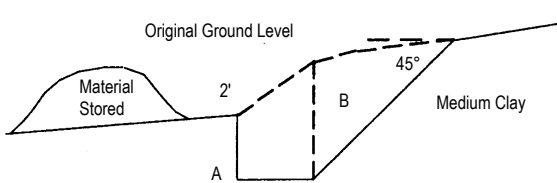


A trench support system shall be designed by a qualified employee knowledgeable in the field. The arrangement of stringers, struts, and braces should be as designed by the plans.

EXAMPLE 8 0 - 5' Use of a trench supporting set such as a trench shield not extending to ground level.



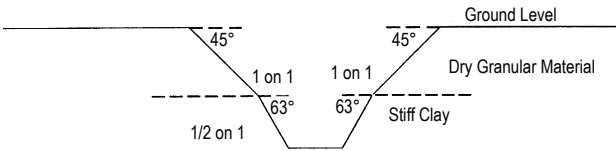
EXAMPLE 9 Trench Cut In Sloping Ground



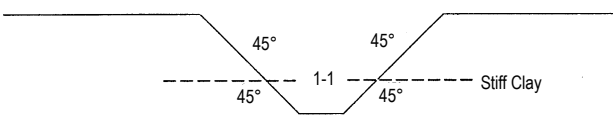
If Side A is 5' or less and Side B is more than 5':
(1) Side A should be sloped as provided for in Example 6.
(2) Side B should be cut to the correct angle of repose.
(3) All excavated material should be stored on the low side of the trench, if possible.

EXAMPLE 10 Trench Cut in Different Textured Materials

Case 1

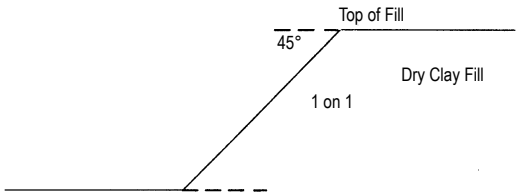


Case 2

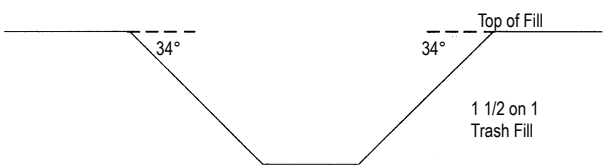


EXAMPLE 11 Fill Areas

Case 1 Dry Clay or Sand Fill

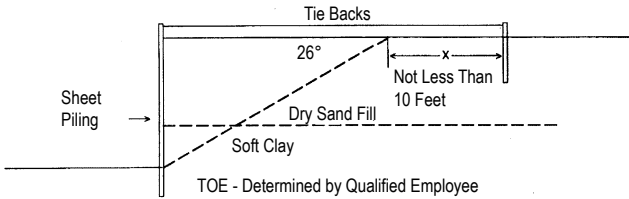


Case 2 Wet Soil, Rubble, Trash, Organic Material Fill



EXAMPLE 12

Excavation - Saturated sand, soft clay or organic soil encountered at depth under fill area.

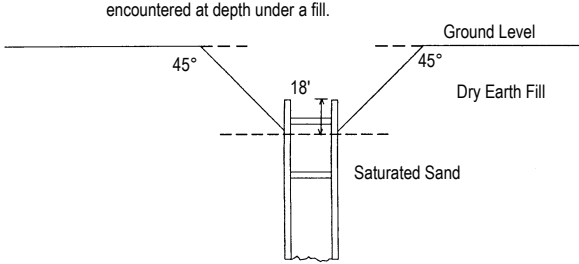


TOE - Determined by Qualified Employee

X = Not Less than 10'

EXAMPLE 13

Trench - Saturated sand, soft clay, or organic soil encountered at depth under a fill.



If the bottom of the trench extends into saturated sand, soft clay, or organic soil under a fill, a trench supporting system should be used to provide protection below the fill.

EMPLOYEE SIGN-OFF SHEET

_____ , an employee of this company has read and understands this Trench Safety Handbook. I also understand that if I have any questions concerning the handbook or safety in general, I may contact the company Safety Officer for clarification. Further, I understand that safety is everyone's responsibility, including my own.

NOTES

NOTES

TRENCH SAFETY

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