

Trench Rescue - Awareness Level

Student Manual

Technical Rescue
01-04-0061 (Rev. 02/10)



**Homeland Security
and Emergency Services**

**Fire Prevention
and Control**



Welcome to the New York State Fire Training Program

Trench Rescue - Awareness Level

The Division of Homeland Security and Emergency Services recognizes that providing training for paid and volunteer firefighters and related officials is an important part of the services it makes available. Our Office of Fire Prevention and Control (OFPC) places a very high priority on training because we believe it is essential for the men and women of the fire and emergency services in New York State.

The Office of Fire Prevention and Control's programs include the most complete progression of training available today -- beginning with probationary firefighters and extending the full length of a firefighter's career with the fire service. While our training programs address specific fire and arson prevention and control issues, we also encourage expansion and improvement of local training facilities and programs in cooperation with fire companies, municipal corporations and districts.

Trench Rescue - Awareness Level will discuss problems that can and do occur in trench rescue incidents. The safety techniques, shoring techniques, proper procedures, team operations, and hazard assessment will all be discussed and explained in depth.

Your comments and suggestions about this student manual, our training classes or any OFPC program are always welcome. Your input will help us build on our successes and make needed changes, when appropriate.

On behalf of the citizens you serve, we want you to know that your participation and commitment are greatly appreciated.



Albany, NY 12231-0001

TRENCH RESCUE - AWARENESS LEVEL

ACKNOWLEDGMENTS

The preparation of this course was made possible through the assistance, cooperation and dedication of many people. The Department of State's Office of Fire Prevention and Control wishes to thank the following persons for their roles in the development of this course.

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MEMORIUM

The Office of Fire Prevention and Control wishes to dedicate this program to the memory of Principle Development Group members Raymond Meisenheimer and Dennis Mojica. Both of these outstanding and courageous individuals perished in the line of duty at the World Trade Center on September 11, 2001. Their loyalty and dedication to the fire service in New York City and State will never be forgotten.

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Unit 1: Introduction to Trench Rescue

Introduction

Course Overview

The Trench Rescue – Awareness Level course consists of two units totaling eight hours. This course is designed to provide information to adequately prepare you to identify a trench incident and provide assistance to those trained and qualified to enter the trench to perform rescue services. The overall objective of the **Trench Rescue – Awareness Level** course is to impart rescuer awareness of the safety concerns at trench collapse situations. Topics include: regulations and standards, worker protection systems, safety, equipment, incident management and written testing.

Trench Rescue – Awareness Level is part of a series of courses designed to develop and enhance your skills as a rescuer. These courses are delivered both in the field as well as being taught as part of the residential offerings at the New York State Academy of Fire Science to allow you the opportunity to continue your education and training as a rescuer.

This course, plus Rescue Technician: Basic; and Medium Structural Collapse Operations: Tools are the prerequisites for taking the 16 hour Trench Rescue – Operations Level course.

The Trench Rescue – Awareness Level course consists of the following subjects:

Unit 1 – Introduction to Trench Rescue

- 1.1 Introduction
- 1.2 Regulations and Standards
- 1.3 Introduction to Trench Operations
- 1.4 Worker Protection Systems

Unit 2 – Operations at Trench Rescue Incidents

- 2.1 Trench Incident Safety
- 2.2 Trench Rescue Equipment
- 2.3 Trench Rescue Operations
- 2.4 Student Exercises
- 2.5 Final Exam

Course Objectives

While each lesson has specific enabling objectives, the overall course objectives; that each student is expected to be knowledgeable in; are listed below.

1. Demonstrate an understanding of the procedures and requirements of a trench incident size-up.
2. Demonstrate an understanding of the procedures and requirements of a trench incident action plan.
3. Demonstrate an understanding of the various standards that apply to trench excavations and emergency operations at incidents involving trench excavations.
4. Demonstrate an understanding of the various support operations to be provided at trench excavation incidents.
5. Demonstrate an understanding of the various trench stabilization systems available and the appropriate use of each by rescuers.
6. Demonstrate an understanding of the various victim stabilization and extrication methods used in trench excavation emergencies including non entry and self rescue.

Regulations and Standards

Introduction to Regulations and Standards

When it rains or the weather is inclement, we don't work in trenches. When the weather is dry and clear we work in trenches. Thus we drop our guard thinking the trench is safe. This is when accidents happen. Excavation is one of the most dangerous types of work in construction, cave-in the primary type of accident.

This unit covers the work of three organizations:

NIOSH (National Institute for Occupational Safety & Health).

OSHA (Occupational Safety & Health Administration)

NFPA (National Fire Protection Association).

NOTE: Additional material on this lesson is located in the Appendix at the rear of this student manual.

NIOSH

National Institute for Occupational Safety and Health (NIOSH) studies incidents and compiles statistics and makes recommendations to OSHA.

NIOSH facts:

- Deaths and injuries
 - Average of 73 persons killed per year in cave-ins.
 - Average of 97 persons killed per year in excavation related accidents.
 - Average of 140 permanent disabilities.
 - 1000 – 4000 injuries per year.
- Most trench accidents happen in trenches 5ft to 15ft in depth. This is the depth that utility companies work in or the homeowner attempts to dig to save a few dollars.
- Causes of Death:
 - Suffocation – unable to breathe
 - Crushing Injury – Damage to internal organs, acidosis
 - Loss of Circulation – Depriving vital organs the needed oxygen
 - Being struck by fallen objects – Becoming unconscious, blocked airway

OSHA

OSHA is a division of the U.S. Department of Labor and is charged with making the standards that apply to worker safety. While the following excavation standards do not technically apply to rescue services, we follow them just the same.

1926.650 – Scope, Application & Definitions

Includes definitions used throughout subpart P (excavations) and important Terms contained in 1926.650 such as:

- Excavation – any man-made cut, cavity, trench or depression in the earth's surface formed by the removal of that earth.

- Trench – 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.
- Competent Person – one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous and who has authorization to take prompt corrective measures to eliminate them.

Every excavation site (including rescue operations) must have a competent person. Specific responsibilities include:

- Conduct test for soil classification
- Understand the standards and data
- Recognize and classify soil after changing conditions
- Determine if damage to equipment renders it inadequate for employee safety.
- Conduct air tests for hazardous atmosphere
- Design of structural ramps
- Locate underground utilities
- Monitor water removal
- Perform daily inspections

You should be familiar with these terms and any other terms contained within the standard. Refer to glossary in the appendix for other definitions.

1926.651 – Specific Excavation Requirements

- Includes requirements on:
 - Surface encumbrances
 - Underground installations (utilities)
 - Access & egress
 - Exposure to vehicular traffic
 - Exposure to falling loads
 - Warning system for mobile vehicles
 - Hazardous atmospheres
 - Testing and controls
 - Emergency rescue equipment
 - Water accumulation
 - Stability of adjacent structures
 - Protection from loose rock or soil
 - Inspections
 - Fall protection

1926.652 – Requirements for Protective Systems

Includes requirements on:

- General protection of employees
- Design of sloping and benching systems
- Design of support systems, shield systems and other protective systems
- Materials and equipment
- Installation and removal of support
- Sloping and benching systems
- Shield systems

Subpart P – Appendix A-F

Appendix A – Soil Classification including:

- Scope & application 0 describes methods of classifying soil & rock deposits
- Definitions of soil types: described in detail in next lesson
- Requirements for:
 - Classification of soil & rock deposits
 - Basis of classification
 - Visual & manual analyses
 - Layered systems
 - Reclassification
- Acceptable visual & manual tests
 - Visual tests such as:
 - Observing soil samples
 - Observing soil as it is excavated
 - Observing sides of trench for spalling, cracks, layered systems and utilities
 - Observing adjacent area for surface water & water seeping
 - Observing for sources of vibration
 - Manual tests
 - Plasticity
 - Dry strength
 - Pocket Penetrometer or shear vane
 - Drying tests
 - Cracks as it dries – fissures
 - Dries without cracking – cohesion
 - Pulverize, granular

The above test shows why we (rescue services) classify soil as Type C soil. These tests require experience, expertise and time. Rescue services rarely have any of these.

Appendix B – Sloping and Benching

- Scope & application
- Definitions
- Requirements
 - Soil classification
 - Maximum allowable slope
 - Actual slope
 - Configurations (based on soil type and depth)

Appendix C – Timber Shoring for Trenches

- Uses tables to determine timber shoring needs based on soil type and depth

Appendix D – Aluminum Hydraulic Shoring for Trenches

- Uses tables and diagrams to determine aluminum hydraulic needs based on soil type and depth.

Appendix E – Alternatives to Timber Shoring

- Includes graphics of aluminum hydraulic shoring, Pneumatic/hydraulic shoring, trench jacks and trench shields

Appendix F – Selection of Protective Systems

- Contains flow charts used in determining requirements for excavations 20 feet or less in depth. Excavations more than 20 feet in depth must have protective systems designed by a registered professional engineer.

Other OSHA standards

1910.146 – Permit Required Confined Spaces
1910.133 – Eye & Face Protection
1910.134 – Respiratory Protection
1910.135 – Occupational Head Protection
1910.136 – Occupational Foot Protection
1910.120 – Hazardous Waste operations and Emergency Response
1910.1030 – Blood borne Pathogens
1926.500 – Fall Protection

NFPA Standards

NFPA 1670 “Operations and Training for Technical Search and Rescue Incidents” is designed to assist organizations in developing a technical rescue capability in their community. Commonly referred to as “organizational standard”, the organization as a whole (as compared to individual members) must comply with the requirements of this standard. It is designed as a core + (plus) standard meaning that all specialties share a common set of needs and there is no point in repeating these for each individual specialty.

Standard Components

- Core requirement for all specialties including:
 - Establish operational procedures consistent with organizational response level
 - Medical care.
 - Hazard analysis & risk assessment
 - Training
 - Continuing education
 - Evaluation of training programs
 - Documentation of required training
 - Initial training to the level of response
 - Incident response planning
 - Mutual aid agreements are implemented
 - Equipment
 - Shall be commensurate with response level
 - Training provided on all equipment
 - Inventory and accountability procedure established
 - Safety
 - AHJ ensures rescuers are trained to the appropriate response level
 - AHJ ensures all rescuers comply with NFPA 1500
 - Safety Officer
 - Incident management system

- Nuclear, Biological and Chemical response
- Fitness

Specific requirements for the following specialties:

- Structural Collapse
- Rope Rescue
- Confined Space
- Vehicle
- Machinery
- Water
 - Dive
 - Ice
 - Surf
 - Surface/Swift Water
- Wilderness Search & Rescue
- Trench and Excavation
- Cave
- Mine & Tunnel
- Helicopter

This standard is also based on a 3 operational level system. These include: Awareness, Operations and Technician. All members of any type of emergency response should have at least the Awareness level of training (EMS, Police, Fire) and fire departments that respond to emergencies to perform rescues involving entry need to be trained and equipped as a minimum to the Operational level. The Operation level response allows the organization to work in non-intersecting trenches up to 8 feet deep. The Technician level response allows the organization to work in trenches greater than 8 feet deep and intersecting trenches. Trench rescue requirement areas include:

Awareness Level

- Recognize the need for trench rescue
- Resource identification
- Response system & scene mgt. procedures
- Hazard recognition and mitigation
- Recognition of collapse patterns, reasons for collapse & potential for secondary collapse
- Procedures for making a rapid, non-entry rescue.
- Hazards recognition of soil weight & associated entrapping characteristics.
- Must be trained to the Awareness level for Confined Space Rescue
- Must meet the requirements of NFPA 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents, and a competent person identified as defined in section 3.3.18

Organizations at this level shall meet the definition of an OSHA “competent person”. The NYS Trench Rescue – Awareness Level course is designed to bring an individual to the Awareness level.

Operations Level – Awareness plus:

- Must be at the Operations level for Rope Rescue
- Must be at the Operations level for Confined Space Rescue
- Must be at the Operations level for Vehicle and Machinery Rescue
- Must be capable of identifying hazards at trench incidents involving a single trench less than 8 feet deep that does not have severe environmental concerns or require the use of supplemental sheeting and shoring
- Size-up
- Procedures to make entry into the trench
- Recognition of unstable areas
- Identify probable victim location and survivability
- Making the rescue area safe
- Initiating a one-call utility location service
- Identification of soil types
- Ventilation of the trench
- Identification of bell-bottom excavation & its associated hazards
- Procedures for placing ground pads
- Provide entry & egress paths for entry personnel
- Pre-entry briefing
- Record keeping and documentation during entry
- Selecting, utilizing and applying shield systems
- Selecting, utilizing and applying sloping and benching systems
- Identifying the duties of panel teams, entry teams, and shoring teams
- Assessing the needs for victim removal
- Extrication

The NYS Trench Rescue – Operations Level course is designed to bring an individual to the operations level.

Technical Level – Operations plus:

- Technician level for Confined Space Rescue
- Technician level for Vehicle and Machinery Rescue
- Involves trenches deeper than 8 feet where severe environment conditions exist, supplemental sheeting and shoring may be needed or manufactured trench boxes or isolation devices will be used.
- Involves intersecting trenches
- Supplemental sheeting and shoring
- Atmospheric monitoring
- Manufactured protection
- Isolation systems
- Ability to adjust the protective system based on digging operations and environmental conditions
- Rigging and placement of isolation systems

The NYS Trench Rescue – Technician Level course is designed to bring an individual to the technician level.

NFPA 1006 “Technical Rescuer Professional Qualifications” is designed to specify minimum job performance requirements for service as a rescuer in an emergency response agency. It is commonly referred to as an “individual standard” and requires both knowledge and skills be demonstrated in various subject areas to provide for the certification of the individual as a “Technical Rescuer” in a given specialty. There are 2 levels of certification:

- Level 1 – corresponds with “Operations” level in NFPA 1670
- Level 2 – corresponds with “Technician” level in NFPA 1670

Certification involves both written testing (knowledge) and skills testing performed by someone other than the instructor. As with NFPA 1670 it is also designed as a core + (plus) standard meaning that all specialties share a common set of needs and there was no point in repeating these for each individual specialty.

Standard Components

Core requirements for all specialties including:

- Site Operations
 - Includes areas such as resource management, action planning, incident management system, search, helicopter ops and recordkeeping.
- Victim Management
 - Includes areas such as victim access, stabilization, triage, packaging, moving and transfer.
- Ropes & Rigging
 - Includes ability in low-angle rope rescue.

Specific requirements for the following specialties:

- Rope Rescue
- Surface Water
- Vehicle & Machinery
- Confined Space
- Structural Collapse
- Trench & Excavation
- Swift Water
- Dive Rescue
- Ice
- Surf
- Wilderness
- Mine & Tunnel
- Cave

Trench rescue requirement areas include:

- Size-up
- Incident management
- Non-entry rescue
- Emergency action planning
- Scene safety
- Equipment & resources
- Environmental concerns
- Load stabilization systems & lifting heavy loads
- Coordination of heavy equipment
- Construction & placement of shoring & shielding systems
- Victim release & extrication

Introduction to Trench Operations

Introduction

An understanding of the basic factors involved in excavation collapse is critical to a safe and effective operation. These factors all impact the ability of rescue services to perform safe, effective and timely rescues in this dangerous environment.

Weight & volume of soil – these figures show why weight, volume and speed are important considerations in trench collapse

Approximate weights

- 1 cubic yard weighs 2,700 lbs.
- 1 gallon weighs approximately 13 lbs.
- 1 cubic foot weighs 100 –120 lbs. – Sand as little as 65 lbs.
- 24 inches of soil on the chest can weigh 750 –1000 lbs.
- 18 inches of soil covering the entire body can weigh 1000 – 3000 lbs.

Volumes

- 1 cubic foot will equal 8 gallons
- 1 cubic yard is approximately 230 gallons

Victim considerations

- Speed of soil collapsing + weight of the soil causes various injuries including:
 - Crush injuries
 - Suffocation and/or toxic atmospheres
 - Mouth fills with soil
 - Chest unable to expand
 - Chest unable to continue expanding
 - Uncover victim's head and chest first.
 - This is because of the weight of the soil
 - Take care pulling on the victim
 - Weight can hold the victim
 - Dislocation injuries

Most accidents happen in trenches 6-8 feet deep. Many trenches this depth are dug to place or repair water, sewer lines etc. At this depth you are below the frost line allowing the soil to be looser. Many people don't think they need to use a protective shield for a small size trench. This can be because of a lack of contractor training and enforcement and some will cut corners to save time and money.

Soil Types

Clay/mud is the most common type of soil encountered. We tend to be careful in sand but let our guard down in clay, which we think is safe when it is not safe at all. Soils are classified by OSHA as one of three types:

- Type "A"
 - Most stable (other than stable rock)
 - Includes strong clay soils, cemented soils and hard pan.

- Type “B”
 - Next most stable
 - Includes granular soils, weaker clay soil and disturbed soils.
- Type “C”
 - Least stable
 - Includes gravel, sand and weakest clays

Other terms that are frequently used to classify soil include:

- Compact (Visual)
 - Appears compact or hard
- Saturated (Visual)
 - Soil with water seeping from it.
- Running (Visual)
 - Loose, free-flowing soil, i.e., sand etc.

All trench rescues should be considered type “C” soil. This will eliminate the problem of trying to classify the soil as Type “A”, “B” or “C” soil.

Soil Testing

The following is given for information purposes and to show how difficult and time consuming it is to accurately determine the type of soil you are dealing with. We can test soil to determine which “type” it is. OSHA requires at least one visual and one manual test performed by a competent person. A sample is taken from soil pile, and tested quickly as possible to preserve natural moisture content. These tests take time and some level of expertise. Because of this we classify all soils as type “C”.

Visual testing – Observe soil excavated as well as soil in and around excavation.

- With excavated soil look for:
 - Soil particle size
 - Clumping
- In excavation and adjacent areas look for:
 - Cracking
 - Utilities
 - Disturbed soil
 - Layered systems
 - Water
 - Vibration

Manual soil testing

- Plasticity
 - Test to determine the cohesion of the soil.
 - Includes thread test and ribbon test.
- Dry strength
 - Used to help determine fissured or unfissured soil.
- Thumb penetration
 - Used to estimate the unconfined compressive strength of cohesive soils.
- Drying test

- Used to differentiate between fissured cohesive material, unfissured cohesive materials and granular materials.
- Requires that samples be taken & then dried completely – time consuming.
- Pocket penetrometer or shearvane
 - Used to estimate unconfined compressive strength of soil.
- Sedimentation test
 - Determines how much silt & clay are in sandy soil
- Wet shake test
 - Another method to determine amount of sand vs. clay in the soil.

Mechanics of Collapse

Understanding the mechanics of collapse requires an understanding of the material presented in this unit. Trenches collapse because of various factors including:

- Weight of soil (Figure 1-1)
 - Remember soil weighs 100 lbs. or more per cubic foot. An example of the weight of soil: 1 cubic yard (3'x3'x3') contains 27 cubic feet of soil. At 100 lbs per cubic foot, this equals 2700 lbs. That is nearly 1 ½ tons (the equivalent weight of a car) in a space less than the size of the average office desk. Wet soil, rocky soil or rock is usually heavier.
- Lateral pressure = ½ the vertical pressure.
 - Example: Trench 5 ft. high has force of 250 lbs lateral pressure at the bottom.
- Soil type
 - Defined earlier in this lesson. A trench may contain multiple soil types.
- Tension cracks or fissures
 - Indicator of possible failure
- Hydraulic forces
 - Water flowing from the soil can indicate lack of soil cohesion as well as additional weight.

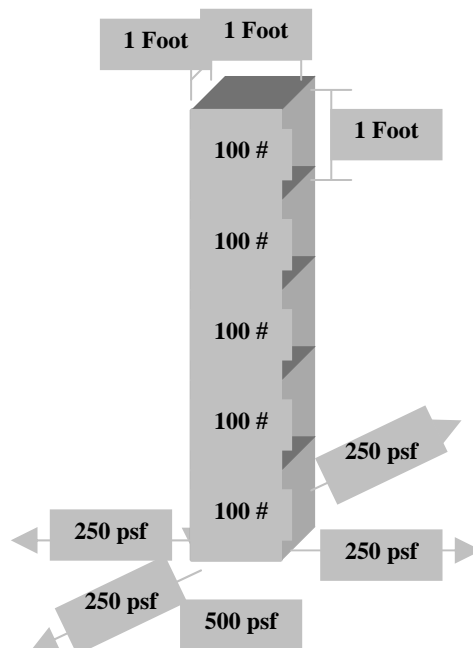


Figure 1-1

Anatomy of a trench (Figure 1-2):

- Lip – 2 feet down from the ground surface
- Toe – 2 feet up from the floor of the trench
- Belly – Area between the lip and toe
- Spoil Pile – Soil that is removed from the trench
 - Should be located at least 2 feet back from the lip of the trench

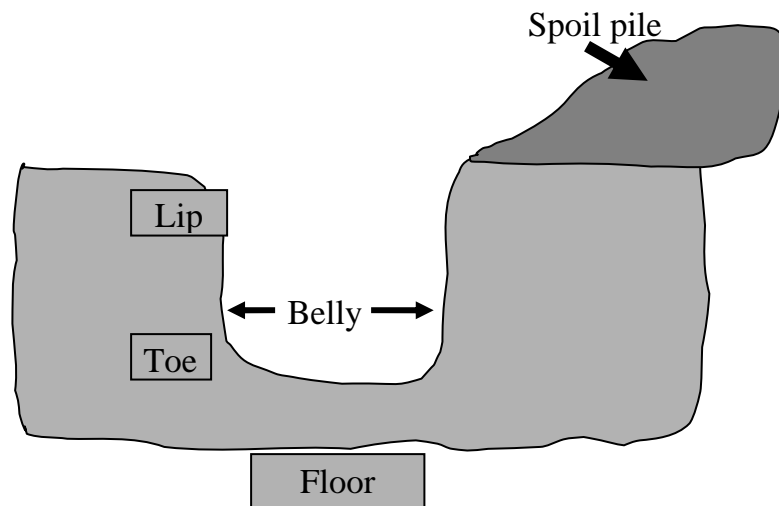


Figure 1-2

Different types of cave-ins:

- Lip Slide (Figure 1-3)
 - Could occur on one or both sides

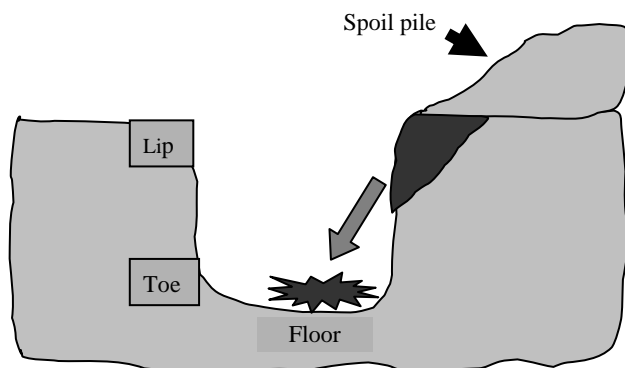


Figure 1-3

- Belly/Slough In (Figure 1-4)

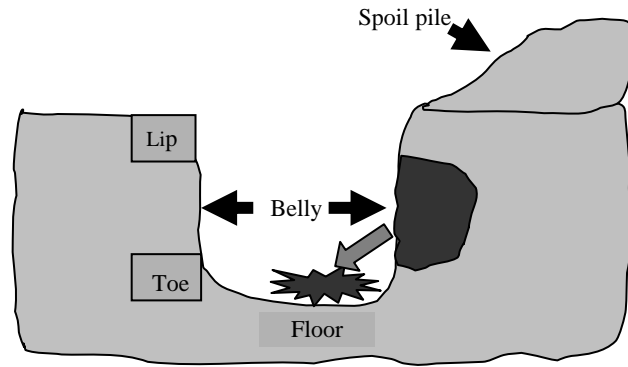


Figure 1-4

- Wall Shear (Figure 1-5)

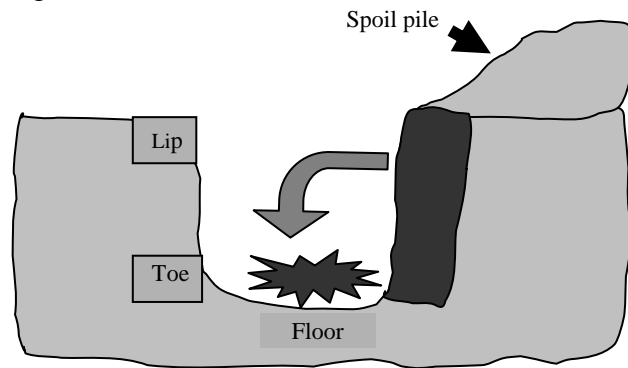


Figure 1-5

- Spoil Pile slide in (Figure 1-6)

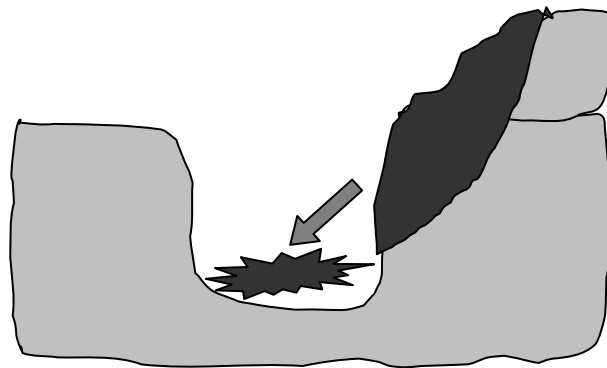


Figure 1-6

NOTE: Additional material on this lesson is located in the Appendix at the rear of this student manual.

Worker Protection Systems

Introduction

OSHA requires that an excavation be protected from cave-ins by an adequate protective system. The two exceptions to this rule is when the excavation is entirely in stable rock or when it is less than 5 feet in depth and the soil provides no indication of potential cave-in.

Protective systems can be provided in one (or more) of 4 ways: sloping, benching, shielding or shoring. Rescue services, as a general rule, primarily use shoring systems but it is important for the rescuer to understand the various methods that they may encounter.

One of the reasons why trenches are not protected is because time does not allow for it. Additionally, it takes money to allow for the added time to install systems as well as to train the worker properly.

Protective Systems

Sloping

Sloping requires a large open area so the sides of the trench can be sloped. This process takes more time and TIME = MONEY.

The slope also referred to as “Maximum Allowable Slope”. The OSHA maximum allowable slope (less than 20 feet) for soil types is:

Type A - $\frac{3}{4}$:1 (53 degrees)

Type B – 1:1 (45 degrees)

Type C – 1 $\frac{1}{2}$:1 (34 degrees)

In stable rock – vertical is considered Type D soil. Because of its stability, we do not normally deal with this type. The OSHA maximum allowable slope (more than 20 feet) must be engineered

Benching

This process takes longer than sloping and requires a large open area to dig. Additional information on sloping and benching can be found in OSHA 1926 Subpart P Appendix B (Appendix to Lesson 1.3 of this course).

Shielding

- Manufactured protective system
- Engineered system drawn from tabulated data.
- Made of steel, aluminum or fiberglass.
- Fixed shields are of one of the most common type of trench boxes / shields that you will see.
- Lightweight, expanding boxes/shields are also available

Moving and installing trench boxes/shields

Heavy equipment is the normal way most trench boxes are moved. Vibration and weak soil need to be considered when operating heavy equipment around a trench. Trench shields are put together in sections as the trench is expanded.

Care needs to be exercised when using trench boxes in conjunction with dewatering pumps. This will be dealt with in more detail in Lesson 2.1 “Trench Incident Safety”. Trench boxes can and are moved horizontally with workers inside. This should never, however, be done when moving the box vertically.

Shoring

Shoring is used for the temporary support of a trench for work or rescue. They may be site made or of commercial manufacture. Additional information on shoring can be found in OSHA 1926 Subpart P Appendix C - E (Appendix at the rear of this student manual).

Sheeting (panels) may be of plywood, dimensional lumber or aluminum, which OSHA determines. When working around the trench, ground pads should be used and consist of:

- 2” x 12” planks
- 3/4” plywood (4’ x 8’)
- Overlap all planks and plywood by 6”
- Trip hazards can be nailed and covered with dirt

Unit 2: Operations at Trench Rescue Incidents

Operations at Trench Rescue Incidents

Introduction

The purpose of this lesson is to show the types of hazards a responding agency might encounter upon arrival at a trench incident and where the responding agency can get assistance in dealing with these hazards. These incidents can occur at any time but primarily occur during the daytime and good weather. This is because this is when the vast majority of trench work is being performed.

General Safety Requirements

- Trenches greater than 5 feet in depth must be shored.
- Trenches greater than 4 feet in depth must have a ladder, stairway or ramp every 25 feet of lateral travel.
 - Ladders must be at least 3' above the lip of the trench and secured.

General Trench Hazards

- Secondary collapse
 - Usually a case of “when”, not “if”. Can be caused by a variety of factors
 - Keep the number of rescuers near the trench minimized.
 - Pad the lip.
 - Eliminate vibrations.
 - Control surface water flowing into the trench.
- Spoil pile
 - Should be moved back from the edge of the trench.
 - Provides necessary working room.
 - A flat surface allows better distribution of weight while using ground pads.
 - Reduces potential for secondary collapse (or at least reduces amount of material going into trench).
 - Should be done by hand if possible, at least along the trench edge.
- Atmosphere
 - Should be monitored and ventilated if necessary.
- Utilities
 - Shut down if involved and presents any kind of a hazard.
- Water (Hydraulic Pressure)
 - Surface and sub-surface
 - Underground pipes
- Surface encumbrances
 - Trees, boulders, etc. must be moved. Rescue services would only do this when necessary for operational or safety reasons.
- Utilities
 - Water

- ✓ Typically under control of the local government.
- ✓ Property owner typically responsible for lines starting at the property line.
- ✓ Occasionally the distribution system will be privately owned.

- Sewer
 - ✓ Typically under control of the local government.
 - ✓ Property owner typically responsible for lines starting at the property line.
 - ✓ Occasionally the distribution system will be privately owned.

- Electrical
 - ✓ May be private or publicly owned.
 - ✓ Property owner may be responsible for lines starting at the property line or pole connection.

- Gas
 - ✓ Typically privately owned.

- Communications
 - ✓ Typically privately owned.

Utility Information and Safety

The Underground Facilities Protective Organization (UFPO) is a utility notification service that covers all of New York State except New York City & Long Island. The New York City One Call Center is the utility notification service that covers New York City & Long Island.

Utility Safety

- Colored flags are used to identify the location of the specific utility in the ground.
 - Newer underground lines will have colored tape above the lines.
 - Each utility is identified by a specific color.
 - Underground utilities must be supported if you are to dig under them.

Trench Rescue Equipment

Introduction

There is a variety of equipment that is used in trench rescue. Not all of this equipment is used at every incident and some of the equipment listed can be replaced by less expensive options. An example of this is using wood instead of pneumatic struts. The following is not intended to be an exhaustive listing but the equipment considered to be providing a basic capability.

Trench Rescue Equipment

- Air Monitoring
 - Air quality should be monitored like a confined space unless constant ventilation is provided.
- Ventilation
 - Should be used when indicated by monitoring or as a general precaution.
 - Take into consideration effect this has on victim (i.e. Hypothermia, etc).
- Ladders
 - Used to access the trench and for rescuer safety should an emergency egress be necessary.
 - Can be used to provide high point anchor for raising and lowering systems.
 - Can be used to assist in non-entry rescue.
- Lighting
 - Trench should be well lit.
 - Lighting may even be required during the daytime.
- Hazard Control
 - Lock-out/tag-out equipment.
 - Specialized wrenches for water & gas shutoff.
- Hand & power tools
 - Hand tools include:
 - ✓ Hammers
 - ✓ Pry bars
 - ✓ Shovels
 - ✓ Saws
 - ✓ Hand operated jacks
 - ✓ Cribbing

- Power tools include:
 - ✓ Saws
 - ✓ Pneumatic or hydraulic jacks
 - ✓ Pneumatic struts
 - ✓ Air bags
 - ✓ Pneumatic or hydraulic chisels or jackhammers
- Ground pads
 - Plywood (3/4" x 4' x 8')
 - Planks (2" x 10" or 12" x 12')
- Patient Packaging
 - Includes stokes, Sked®, etc.
- Heavy equipment
 - Backhoes, bucket loaders, etc.
 - ✓ Can be used to move spoil material away from the trench or some material in the trench if necessary.
 - ✓ Should never be used to dig close to the victim.
 - Cranes
 - ✓ Used for lifting, moving or holding heavy objects.
- De-watering
 - Use electric pumps if possible.
 - Gas or diesel engines can put CO into the trench.
 - May need to create a "sump" to channel water away from the victim and remove as much water as possible
- Rehab
 - Includes:
 - ✓ Facilities
 - ✓ Food & liquids
 - ✓ Adequate rest
 - ✓ Rotate crews on a regular basis.
- Shoring
 - Panels
 - ✓ Wood or lightweight metal
 - Cross members
 - ✓ Wood, screw jacks or air struts
- Whalers
 - Wood or Lightweight metal

Sample Pneumatic (Air) Strut System

Note: This segment on Paratech® struts are provided because this is the equipment used in the NYS trench program. Other manufacturers also make pneumatic type struts. This segment is not intended to be an endorsement of any manufacturer's product.

Paratech® strut types and accessories:

- Lock stroke strut – locks automatically in ¼” increments. The sizes range from approximately 16 inches to 90 inches.
- Acme thread strut – permits “soft” placement with sensitive positioning. The sizes range from approximately 16 inches to 87 inches.
- Extensions
 - Extensions come in three lengths. 1’ 2’ & 3’
 - The rule of thumb is no more than 3’ of extensions and/or 2 extensions not to exceed 3’ in length.
 - The extensions should be added to the base of the struts
- Bases
 - The Paratech® strut system comes with many different types of bases.
 - The 20 degree swivel is the best base to use for trench rescue

Strut Construction

The lock stroke strut has a movable grooved shaft and locks automatically in .25” increments. To release the struts after they have been loaded, you must increase the pressure to above the loading pressure and push the locking collar towards the movable end. Once the collar is pushed, the pressure can be released and you can collapse the strut.

The Acme strut has a movable threaded shaft. When the strut is pressurized, the locking collar has to manually lock prior to releasing the air pressure. To release the struts after they have been loaded, you must increase the pressure to above the loading pressure and unthread the locking collar. Once the collar is threaded past the total release point, the pressure can be released and you can collapse the strut.

Struts constructed of a 3” aluminum alloy tube with a solid 2 ½” diameter aluminum shaft. The axial crush strength exceeds 80,000 lbs. and the maximum on center working load is 20,000 lbs.

Regulator System

- System comes with a two stage regulator and attaches to the air supply system.
 - Should not exceed 200 psi. of pressure when pressurizing the strut.
 - When you release the strut you must increase the pressure to greater than the pressure that was used to inflate the strut (maximum of 310 psi).
- The controller can control 2 struts at one time.
 - Strut controllers are gray in color so you can differentiate between controllers used for the high pressure air bags (black).
 - To release the pressure from the controller after the air supply is turned off; you must depress all four (4) buttons at once.
- Air hoses
 - Assorted colors available.
 - Always try to use different colors for ease of identification.

Trench Rescue Operations

Introduction

The primary function of rescue is to locate and extricate trapped victims, transferring the victims to a stable and safe area while providing basic life support. A secondary function is to restore the area to a safe condition, thus precluding additional rescue at the incident site.

The purpose of this lesson is to assist in: establishment of a functional ICS, the proper assessment of an incident, development of an appropriate action plan, and development of an understanding of the components of a successful trench rescue operation.

The Incident Command System

A rescue scene can be one of confusion if a command system is not established early in the incident. The command system must be versatile, adaptable to any type or size of emergency or incident, relatively familiar if it is going to be useable throughout the state and be able to expand in a logical manner if changing conditions dictate. The majority of technical rescue operations will be most efficiently managed with a pared down version of the full-blown ICS model. It will be the rare technical rescue incident that will require filling positions such as Planning; Logistics; Finance, etc.

Span of Control

The ICS allows for a manageable span of control of people and resources. Utilizing an ICS takes much of the pressures off the Incident Commander. The **maximum** span of control is 7 (seven) persons while the **recommended** effective span of control of 5 to 1 allows for most effective management. The system is set up so that the IC is only **communicating** to and **receiving information from** a maximum of five people, rather than the whole assignment of personnel at the scene. Individual managers of personnel and resources within ICS are also working within a manageable span of control.

ICS Positions for the typical trench rescue scenario (Figure 2.1):

The Incident Commander (I.C.) or “command” is the individual responsible for the management of all incident operations. The **I.C.** does not need to be well versed in trench rescue, however should be well versed in the I.C.S. The **I.C.** should be stationed at a command post remote from the incident. On large, complex, and or protracted incidents, the **I.C.** may delegate functional responsibilities by appointing an:

- Operations Officer (Operations),
- Planning Officer (Planning),
- Logistics Officer (Logistics),
- Finance Officer (Finance).

The **I.C.** also communicates directly with Command Staff:

- Public Information Officer (PIO),
- Safety Officer (Safety),
- Liaison Officer (Liaison).

The **Operations Section Chief** is responsible for direction and coordination of all tactical operations. On modest sized rescue incidents, Operations may fulfill the functions of a Rescue Branch Director. At large scale rescues, Operations may designate a Rescue Branch Director. Operations also may interface with other appropriate agencies.

The **Safety Officer** is responsible for enforcing general safety rules, and developing measures for ensuring personnel safety. This includes ensuring that personnel working in and around the trench are using appropriate techniques and procedures. While not recommended, when manpower is limited the Safety Officer position may be combined with the Rescue Branch Director and/or Operations Chief positions. The Safety Officer can bypass the chain of command when necessary to correct unsafe acts immediately.

The Rescue Branch Director is responsible for the rescue operation. This person is normally the most experienced rescue technician on the team and assumes the lead role in designing set-up of the rescue system. When the set-up is complete the Director will check the entire system. The Director is the liaison between the rescue site and the Operation Section Chief and designates “tactical” level positions in the ICS as needed.

The **Cutting Station Group** is responsible for the supply of dimensional lumber that is cut to fit the trench shoring or associated operations.

The **Shoring Group** is responsible for the proper placement and securing of shoring systems used in the rescue operation.

The **Entry Group** is responsible for entry into the trench to extricate the victim. They are also responsible for the placement and securing of additional sheeting or shoring as required.

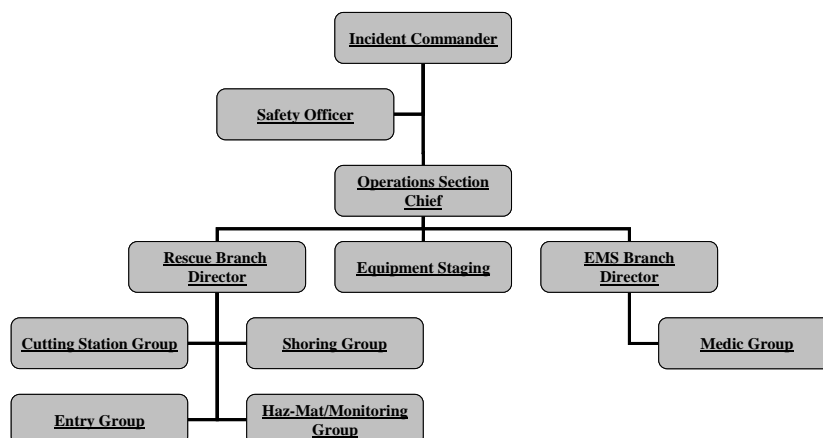
The **Medic Group** provides initial medical assessment and stabilization and should be trained to at least the CFR level.

The **EMS Branch Director** oversees the medical care of the victim/victims and makes triage, treatment and transport decisions on multiple victim rescues. They also advise the Medic(s) on medical issues and provides advanced life support care for patients who have been removed to grade.

The **Equipment Staging Officer** is especially useful if personnel resources allow. He/she assembles all available rescue equipment on a tarp in a neat organized manner.

The **Hazardous Materials/Monitoring Group** is responsible for the monitoring of the incident for hazardous materials. This will primarily involve the monitoring of the atmosphere in the trench and providing ventilation if necessary.

Figure 2.1
Sample Trench Rescue Incident Command System



Hazard and Risk Assessment

These components include:

- Preplan Information
- Site Survey
 - Soil type & conditions
 - Accessibility
- Analysis of past incidents (Where, how, probability of survivability)
- Assessment of available resources
 - In-house
 - Mutual aid

Determination of Rescue versus Recovery

Rescue involves the moving of victims to a safer environment. When it is unknown if a victim is alive, the operation should proceed as a rescue. Recovery is the removal of a body from a trapped location to a location where it can be examined and identified. It is unfortunate that there are times when we can tell with assurance that there is no possibility of rescue. The following list may help in understanding the decision process to be followed.

- Know victim is alive.
 - Can see or hear victim.
 - Report from a reliable source.
- High probability victim is alive.
 - No known toxic conditions.
 - Air space available.
- Low probability victim is alive.
 - Exposed to toxic or hazardous gases or highly probable exposures.
 - Minimal chance of air space remaining.
- Certain victim is dead.
 - Exposed to high concentration of toxic gases.
 - Trapped with no air voids (example: sand bank or farm grain silo).
 - Body decapitated or dismembered.

Determination of Hazards

Hazards present at a scene may prohibit rescue of live victims. Hazard assessment of scene may dictate whether incident is a patient rescue or a victim recovery. The size-up or scene survey can assist decision-making process and should include the entire area to determine potential hazards. General hazards present or potentially present include:

- Unsafe ground or unsafe footing
- Improper equipment
- Potential for secondary collapse

Determination of Risk versus Benefit.

Another way of analyzing the “patient rescue” versus “victim recovery” issue is to weigh the risks versus the benefit. All rescue work involves some risk, but some operations are riskier than others. The following should be considered when calculating risk vs. benefit:

- Danger to rescuers
- Number of victims
- Are the victims salvageable?
- Capabilities of the department
- Anything overlooked?

Operations at Trench Rescue Incidents

Operations at technical rescue incidents are no different than other emergency situations in that a consistent approach in dealing with an incident will produce a more favorable outcome. The following is intended to provide you with a step by step approach in preparing for, assessing and responding to technical rescue incidents.

✓ Preparation: Includes training, equipment and personnel.

✓ Initial Response: the first arriving unit should:

- Establish command
- Keep apparatus at least 100' away.
- Determine utility involvement
- Establish victim contact.
- Set up initial safety zones.

✓ Assessment and Planning

The initial size-up includes gathering information such as:

- Verify who is in command.
- What happened?
- How many victims.
- Potential for non-entry or victim self rescue.
- Victim location.
- Type of soil
- Hazards
- Type of injuries
- Initial assessment of rescue vs. recovery.
- Cave-in or entrapment.

✓ Development of the Incident Action Plan (IAP)

An IAP should deal with the following as a minimum.

- Establishment of “safety” zones.
- Complete risk/benefit analysis.
- Safety of the trench and general area.
- Establishment and confirmation of the incident strategy and tactics.
- Establishment and assignment of operational and support tasks.
- Establishment of a Rapid Intervention Team.
- Hazard mitigation.
- Resource staging.
- Selection and use of protective systems.

- Gaining access.
- Placement of pads
- Ladders
- Panel placement
- Voids behind the panels.
- Disentanglement
- Lifting or removal of large or heavy objects
- Equipment considerations such as:
 - Hand operated tools
 - Heavy machinery
 - Crane
 - Bucket loader
 - Backhoe
- ✓ Entanglement
 - May require additional digging to release the victim.
 - May or may not be able to move or cut the item the victim is entangled in.
- ✓ Victim packaging and removal
 - Victim is packaged in the trench if practical
 - Crush injuries are not uncommon
 - Package with consideration for EMS needs.
 - Remove by way of ladder or secure mechanical advantage system with high point anchor over the trench.
- ✓ Incident termination
 - Removal of equipment from the trench.
 - Cleanup and replacement of equipment on the vehicles.
 - Completion of documentation and reports.
- ✓ Incident debriefing.
 - Stress debriefing (as appropriate).

Student Activities

Introduction

The purpose of this lesson is to allow the students the opportunity to use some of the information provided in this course to 1) identify some common problems found in trench incidents, and 2) given a specific scenario, perform an incident size-up and develop an Incident Action Plan.

Student Activity 1

The purpose of this activity is to have you identify key items in each picture and how the items effect the decisions we make at trench rescue incidents. Room is provided under each picture (Figures #-#) for notes.



Figure 2.2

Notes:



Figure 2.3

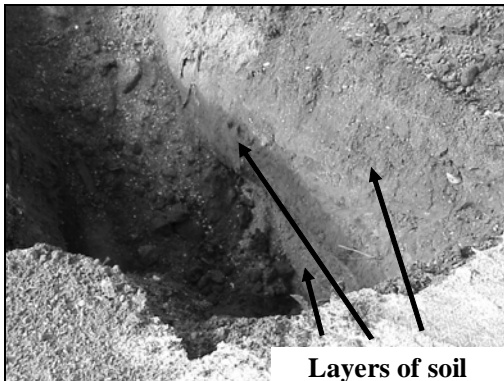


Figure 2.4

Notes:

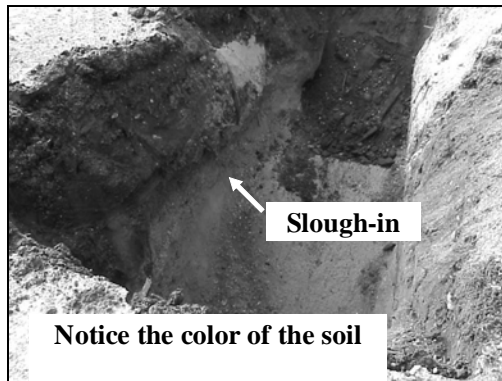


Figure 2.5

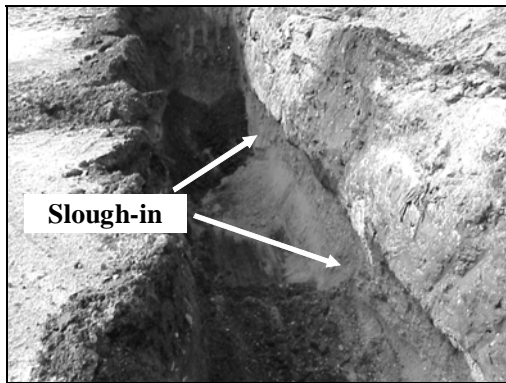


Figure 2.6



Figure 2.7

Notes:

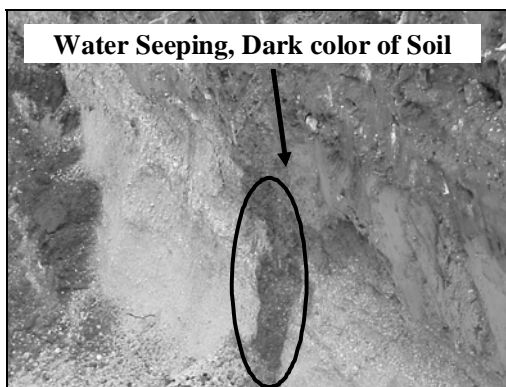


Figure 2.8

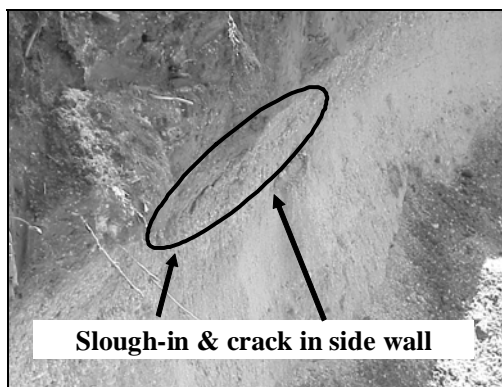


Figure 2.9

Notes:

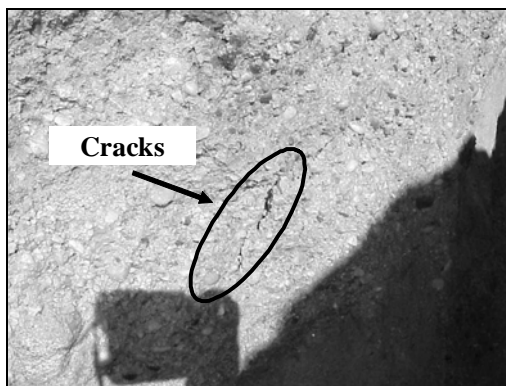


Figure 2.10

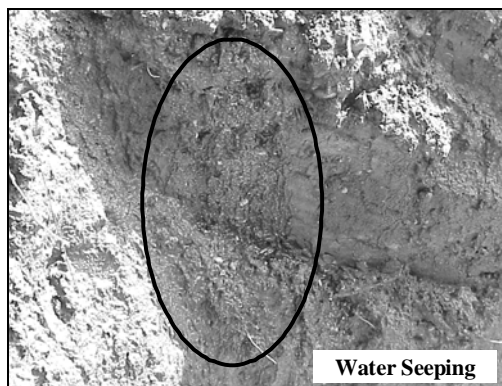


Figure 2.11

Notes:

Student Activity 2

Given the available apparatus and assigned incident, you shall perform the following:

- Perform and document an initial set-up.
- Develop an initial IAP using the provided ICS 201 form that is provided.

Each group will have 5 minutes for its spokesman to present one or both elements of the assignment (as directed by the instructor)

Available Responding Resources – Any town FD

2 Engines – 3 Firefighters

1 Truck – 4 Firefighters

1 Rescue – 4 Firefighters

1 Battalion Chief

Any town FD is currently an Operations Level team in accordance with NFPA 1670. The nearest technical level team is 1 hour away.

Incident 1

An employee was working in a trench 4 feet wide and 7 feet deep. About 30 feet away a backhoe was straddling the trench when the backhoe operator noticed a large chunk of dirt fall from the side wall behind the worker in the trench, he called out a warning.

Before the worker could climb out, 6 to 8 feet of the trench wall collapsed on him and covered his body up to his neck. There were no exit ladders nor was any sloping or shoring used.

Incident 2

Employees were laying sewer pipe in a trench 15 feet deep. The sides of the trench, 4 feet wide at the bottom and 15 feet wide at the top were not shored or protected to prevent a cave-in. Soil in the lower portion of the trench was mostly sand and gravel and the upper portion was clay and loam.

The trench was not protected from vibration caused by heavy vehicular traffic on the road nearby. To leave the trench, the employees had to exit by climbing over the backfill.

As they attempted to leave the trench, a small cave-in occurred covering one employee to his ankles. When the other employee went to his coworker's aid, another cave-in occurred covering him to his waist. The first employee was completely buried.

INCIDENT BRIEFING	1. Incident Name	2. Date	3. Time
4. Map Sketch			
5. Current Organization			
<div style="text-align: center;"> <div style="border: 1px solid black; width: 150px; margin: 0 auto; padding: 5px; text-align: center;">Incident Commander</div> <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="border: 1px solid black; width: 120px; height: 50px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.8em; margin-bottom: 2px;">Planning</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 120px; height: 50px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.8em; margin-bottom: 2px;">Operations</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 120px; height: 50px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.8em; margin-bottom: 2px;">Logistics</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 120px; height: 50px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.8em; margin-bottom: 2px;">Finance</div> <div style="flex-grow: 1;"></div> </div> </div> <div style="margin-top: 10px;"> <div style="display: flex; justify-content: space-between; margin-bottom: 5px;"> <div style="border: 1px solid black; width: 120px; height: 80px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.7em; margin-bottom: 2px;">Div. _____</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 120px; height: 80px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.7em; margin-bottom: 2px;">Div. _____</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 120px; height: 80px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.7em; margin-bottom: 2px;">Div. _____</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 120px; height: 80px; display: flex; flex-direction: column; justify-content: center; align-items: center;"> <div style="font-size: 0.7em; margin-bottom: 2px;">Div. _____</div> <div style="flex-grow: 1;"></div> </div> <div style="border: 1px solid black; width: 180px; height: 80px; padding: 5px;"> <div style="text-align: center; font-size: 0.8em; margin-bottom: 5px;">Air</div> <div style="font-size: 0.7em;"> Air Operations _____ Air Support _____ Air Attack _____ Air Tanker Coord _____ Helicopter Coord _____ </div> </div> </div> </div> </div>			
Page 1 of	6. Prepared by (Name and Position)		

[illegible]

APPENDIX

OSHA Standard Overview

In the back of this manual all the standards are included.

Standard Number 1926.650 Scope, Application, and Definitions Applicable to this subpart:

Defines some of the following terms:

Benching, Cave-in, Competent person, Excavation, Failure, Hazardous Atmosphere, Protective System, Shield, Shoring, Sloping, Stable Rock, Trench, Wales

The above is a small sample of terms that are defined in this standard.

Standard Number 1926. 651 Specific Excavation Requirements:

Covers the following topics:

- (a) Surface Encumbrances – shall be removed or supported as necessary
- (b) Underground Installation –
 - Estimated location of utility installations
 - Utility companies/owners notified
 - Approach of estimated underground installations
 - While excavation is open
- (c) Access and Egress
 - Structural ramps
 - Means of egress from trench
 -
- (d) Exposure to Vehicle Traffic
- (e) Exposure to Falling Loads
- (f) Warning System for Mobile Equipment
- (g) Hazardous Atmosphere
 - Testing and Controls
 - Emergency Rescue equipment
- (h) Protection from Hazards Associated with Water Accumulation
- (i) Stability of Adjacent Structures
 - Stability of Adjoining Buildings, Walls, or other Structures Endangered
 - Excavation below the Level of the base or Footing of any Foundation
 - Sidewalks, Pavements and Appurtenant Structures
- (j) Protection of Employees from Loose Rock or Soil
 - Adequate Protection Shall be provided to protect employees from Loose Rock or soil
 - Employees shall be protected from Excavated or Other materials or equipment
- (k) Inspections
 - Daily Inspections of Excavations
 - Competent Person Finds Evidence of a Situation that could Result in a Possible cave-in
- (l) Fall Protection
 - Walkways shall be Provided
 - Adequate Barrier Physical protection

Standard Number 1926.652 Requirements for Protective Systems:

- (a) Protection of Employees in Excavation
 - Each Employee in an Excavation Shall be Protected from Cave-ins
 - Protective Systems Shall Have the Capacity to Resist without Failure
- (b) Design and Sloping and Benching Systems
 - (1) Option (1) Allowable Configurations and Slopes
 - (2) Option (2) Determination of Slopes and Configurations Using Appendices A & B
 - (3) Option (3) Designs using other Tabulated Data
 - (4) Option (4) Design by a Registered Professional Engineer
- (c) Design of Support Systems, Shield Systems, and other protective Systems
 - (1) Option (1) Design Using Appendices A,C, & D
 - (2) Option (2) Designs Using Manufacturer's Tabulated Data
 - (3) Option (3) Designs Using Other Tabulated data
 - (4) Option (4) Design by a Registered Professional Engineer
- (d) Materials and Equipment
 - Materials and equipment Used for Protective Systems
 - Manufactured Materials and equipment Used for protective Systems
 - When Material or Equipment That is Used for protective Systems is Damaged
- (e) Installation and Removal of Support
 - General
 - Additional Requirements for Support Systems for Trench Excavations
- (f) Sloping and Benching Systems
- (g) Shield Systems
 - General
 - Additional Requirements for Shield Systems Used in Trench Excavations

Standard Number 1926, Subpart P, App. A Soil Classification:

- (a) Scope and Applications
- (b) Definitions
- (c) Requirements
 - Classification of Soil and Rock Deposits
 - Basis of Classification
 - Visual and Manual Analyses
 - Layered Systems
 - Reclassifications
- (d) Acceptable Visual and manual Tests
 - Visual Tests
 - Observe samples of soil excavated
 - Observe soil as it is excavated
 - Observe the sides of the trench
 - Observe the area adjacent to the excavation
 - Observe the opened side of the trench to identify layered systems
 - Observe area adjacent for evidence of water, water seeping from sides of trench
 - Observe for sources of vibrations
 - Manual Tests
 - Plasticity
 - Dry Strength
 - Thumb Penetration
 - Other Strength tests
 - Drying Test

Standard Number 1926, Subpart P, App. B Sloping and Benching:

- (a) Scope and Application
- (b) Definitions
- (c) Requirements
 - Soil Classification
 - Maximum Allowable Slope
 - Actual Slope
 - Configuration

Standard Number 1926, Subpart P, App. c Timber Shoring for Trenches:

- (a) Scope
- (b) Soil Classifications
- (c) Presentation of Information
- (d) Basis and Limitations of Timber Members
 - Dimensions of Timber Members
 - Limitations of Application
- (e) Use of tables
- (f) Examples to Illustrate the Use of Tables C-1.1 through C-1.3
- (g) Notes for Tables

Standard Number 1926 Subpart P, App. D Aluminum Hydraulic Shoring for Trenches:

- (a) Scope
- (b) Soil Classifications
- (c) Presentation of Information
- (d) Basis and Limitations of the Data
- (e) Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4
- (f) Example to Illustrate the Use of the Tables
- (g) Footnotes and General Notes for Tables D-1.1, D-1.2, D-1.3, and D-1.4
 - For applications other than those listed in the tables
 - 2 inch diameter cylinders
 - Hydraulic cylinders capacities
 - All spacing indicated is measured center to center
 - Vertical shoring rails shall have a minimum section Modulus of 0.40 inch
 - When vertical shores are used
 - Plywood shall be 1.25 inch thick softwood or 0.75 thick 14 ply, arctic white birch (Finland form)
 - Timber Specifications
 - Wales are calculated for simple span conditions
 - Basis and limitations of the data

Glossary:

Accepted Engineering practices- Those requirements which are compatible with standards of practice required by a registered professional engineer.

Angle of Repose – The greatest angle above the horizontal plane at which loose material (soil) will lie without sliding.

Approach Assessment – The period of time from the moment when the incident site first becomes visible, to the time when the initial size-up is completed.

Atmospheric monitor – A device used to analyze the atmosphere, for Oxygen, LEL, CO and toxic gases.

Backfill – Refilling if a trench or the material used to refill a trench.

Backhoe – Excavating machine equipped with an articulating boom and a bucket. Can have either crawler tracks or tires.

Bell-bottom pier hole- A type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a bell shape.

Benching – Method of protecting personnel by excavating sides of a trench to form one or a series of horizontal levels or steps.

Bulldozer – Crawler equipped machine with a large horizontal blade designed for land clearing and earth moving.

Cathead – A shore running between wailers, it also has a 6” long plank nailed to the top of it.

Cave-in – Collapse of unsupported trench walls in sufficient quantity to en-trap, bury, or other wise injure and immobilize a person.

Cohesive - Holding together firmly.

Cohesive Soil – A type of soil with a high clay content that holds together firmly.

Command Post – Location where the IC (incident commander) can meet with other emergency services and community resources. Should also have the necessary communications needed for this emergency.

Compact Soil – Soil that is hard and stable in appearance, can be indented by the thumb, but penetrated with difficulty.

Competent Person- One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross Bracing – Horizontal members of a shoring system installed perpendicular to the sides of an excavation, the ends which bear against either shores, uprights or wailers.

Cut Sheet – A job foreman’s daily worksheet shows depths and grades of pipes and work progress.

Danger Zone – Area surrounding the accident site, the size of this zone depends on the severity of the Emergency.

Dewatering – The process of removing water from the trench

Disturbed Soil – Ground that has been previously excavated.

Double Headed Nail – Nail that has two heads, designed not to be fully driven into the lumber.

Engulfment – The surrounding and effective capture of a person that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

Excavation – An opening in the ground that results from digging effort.

Faces or Sides- The vertical or inclined earth surfaces formed as a result of excavation work.

Fissure – A narrow opening in the ground; a crack of some length and considerable depth.

Front-end Loader – Tire or crawler equipped machine with a movable bucket at one end.

Freestanding Time – The period of time during which the walls of a trench remain unsupported.

Frost Line – The depth to which frost penetrates the soil.

Grade Pole – A wood or fiberglass pole that is either cut or has markings, Used to set pipes on a grade.

Ground Cover – A tarp that is used to place equipment on it.

Ground Pads – Sheets of ¾” plywood or sections of lumber placed adjacent to the trench distributing the weight of rescue personnel.

Hauling Line – A length of rope used to hoist or lower equipment.

Hazard Analysis – The process of identifying situations or conditions that have the potential to cause injury to people, damage to property, or damage to the environment.

Hazardous Atmosphere- An atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Imminent Hazard – An act or condition that is judged to present a danger to persons or property and is so immediate and severe that it requires immediate corrective or preventive action.

Incident Management System - the management system or command structure used during emergency operations to identify clearly who is in command of the incident and what roles and responsibilities are assigned to various members.

Incident Response Plan – Written procedures, including standard operating guidelines, for managing an emergency response and operation.

Landfill – A collection point for trash and garbage. .

Loam – A combination of sand and clay.

Mechanical Strut – An adjustable strut.

Mitigation – Activities taken, either prior to or following an incident, to eliminate or reduce the degree of risk to life and property from hazards.

OSHA – The Occupational Safety and Health Administration, a division of the U.S. Department of Labor.

Panels – Multi-layered sheets of plywood used to support then trench walls (usually 4’x8’)

Pipe String - Lengths of pipe laid parallel to the trench in preparation for lowering into the trench and being joined together.

Parallel trench – A previously excavated and backfilled trench close to and paralleling the trench being dug.

Pneumatic Shoring – Shores or jacks with movable parts that are activated by the action of compressed air.

Primary Assessment – The initial determination of what has occurred in an accident situation.

Profile – A job blueprint that shows sectional elevation.

Rapid Intervention Team – At least two members available for rescue of a member or a team if the need arises. They shall be fully equipped with the necessary equipment needed.

Recovery Mode – Level of operational urgency where there is no chance of rescuing a victim alive.

Rescue Mode – Level of operational urgency where there is a chance that a victim will be rescued alive.

Right of Way – A strip of land temporarily granted to the contractor so that he can perform his work.

Risk / Benefit Analysis – A decision made by a responder based on a hazard and situation assessment that weighs the risks likely to be taken against the benefits to be gained for taking those risks. A live victim suggests a rescue and its high level of urgency. A deceased victim, however, is a body recovery that suggests a far less urgent response.

Running Soil – Loose free flowing soil, fine sand is an example.

Safing – To make a portion of a trench safe, by using panels and shoring or by slopping.

Saturated Soil – Contains a high quantity of water, which fills the voids in that soil.

Scab – A short piece of wood nailed to an upright to prevent shifting of a shore.

Screw Jack – A trench shore or jack with interchangeable threaded parts. The threaded parts allow for adjustments to the shore.

Secondary Assessment – Determination to see whether the on scene capabilities are sufficient to handle the emergency situation.

Secondary Cave-in – Collapse of another portion of the trench wall after initial incident.

Shall – Indicates a mandatory requirement.

Should – Indicates a recommendation or that which is advised but not required.

Shear Wall Collapse – A type of collapse where the ground cracks parallel to the trench and that section topples into the trench.

Sheeting – Generally, wood planks and wood panels.

Shorform – A laminated panel used for sheeting trench walls.

Shoring – A term used for lengths of timbers, screw jacks, pneumatic jacks.

Size-up – A mental process of evaluating the influencing factors at an incident prior to committing resources to a course of action.

Skip-shoring – Supporting trench walls with uprights that are spaced at specific intervals.

Slopping – Method of protecting employees from cave-ins by excavating the sides of a trench to form an angled wall, which will prevent the soil from sliding into the trench.

Slough-in Collapse – Collapse of a trench wall in such a fashion that an overhang remains, dangerous and difficult to shore.

Spoil Pile Slide – When the excavated material slides back into the trench.

Spot Bracing – See “skip shoring”

Staging Area – A gathering point for emergency services and support apparatus, equipment and personnel.

Standard Operating Guideline – An organizational directive that establishes a standard course of action or policy.

Standard Operating Procedure – An organizational directive that establishes a stand course of action

Strong back – See “Upright”

Story Pole – See “Grade pole”

Technical Rescue Incident – Complex rescue incidents requiring specially trained personnel and special equipment to complete the mission.

Tension Cracks – Cracks in the ground adjacent to the trench indicating that the ground has shifted and should be considered a warning sign.

Trench – A temporary excavation in which it is deeper then wider and no wider than 15 feet at the bottom.

Trench Box – Steel or aluminum structure that is placed in a trench to protect workman from a collapse of the side walls.

Trench Lip – The top edge of the trench.

Tripping Hazards - Debris, tools, ground pads, and anything that may cause a person to stumble at a construction site.

Uprights – Planks that are held in place against sections of panels or sheeting by the use of shores, adds strength to the shoring system by distributing the loads applied to the sheeting.

Virgin Soil – Ground that has never been excavated.

Whales – Braces that are placed horizontally against sheeting, transmitting the load from the sheeting to the shores also called walers or stringers.

Well Point System – A series of pipes driven into the ground around the trench for the purpose of dewatering the area by the use of a pump.

Classifying Soil:

The soil type will influence the stability of a trench. OSHA requires a “Competent Person” to classify the soil prior to excavation. This allows the proper protective device to be chosen and used to protect the workers. Keeping this in mind the Technical Rescue Team should have a good understanding how soil is classified.

Soil Types as Classified by OSHA:

Type A	Most stable – includes heavy, strong, clay, hardpan soils (resists penetration).
Type B	Less Stable (medium stability), silt, sandy loam, medium clay, and unstable dry rock.
Type C	Least Stable, gravel, loamy sand, soft clay, submerged soil or dense, heavy unstable rock.

When soil is classified, several soil qualities are assessed in addition to the type. These would not be limited to grain size, saturation, cohesiveness and compressive strength. A simple way to review this is, if the grain of soil is larger then a piece of pencil lead, its considered gravel. If it were smaller, it would be sand.

There are four (4) different grain sizes:

- Gravel
- Sand
- Silt
- Clay

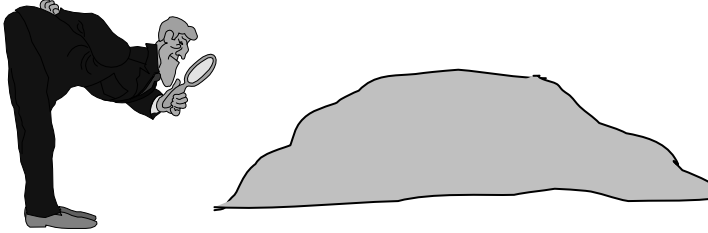
A general rule that the BIGGER the grain, the least stable the soil will be. You must proceed with caution!

What do we mean when we refer to *saturation*? Saturation refers to how much water is in the voids between the grains. When these voids fill with water the soil becomes saturated. As to when the voids fill with air, the soil is then considered Oven dry. Soil having a certain amount of moisture is considered stable. Having too much or too little water causes cave-ins.

Cohesion refers to how well the grains hold together. This will help you predict how well the trench walls will hold together.

A “Competent Person” will conduct both a visual and manual tests to help them make their determination of the soil classification. They would be looking for some of the following.

- Soil particle size & Type
- Does soil clump when its dug



- Cracks in the side walls
- Hazards surrounding the trench area: Buildings, roads, machinery
- Water

If you find water in trench weather is standing or moving the soil would be considered type C soil.

Some facts about soil you should consider:

- ✓ One cubic yard of dirt weighs about 2,700 lbs.
- ✓ One gallon of dirt weighs approximately 13 lbs.
- ✓ One cubic foot of dirt will fill 8 – 1 gal buckets
- ✓ One cubic yard of dirt would fill approximately 230 – 1 gal buckets
- ✓ 13 lbs. x 230 (1 gal buckets) = 2678 lbs.



$$= 13 \text{ lbs.} \times 5 \text{ gal bucket} = 65 \text{ lbs}$$

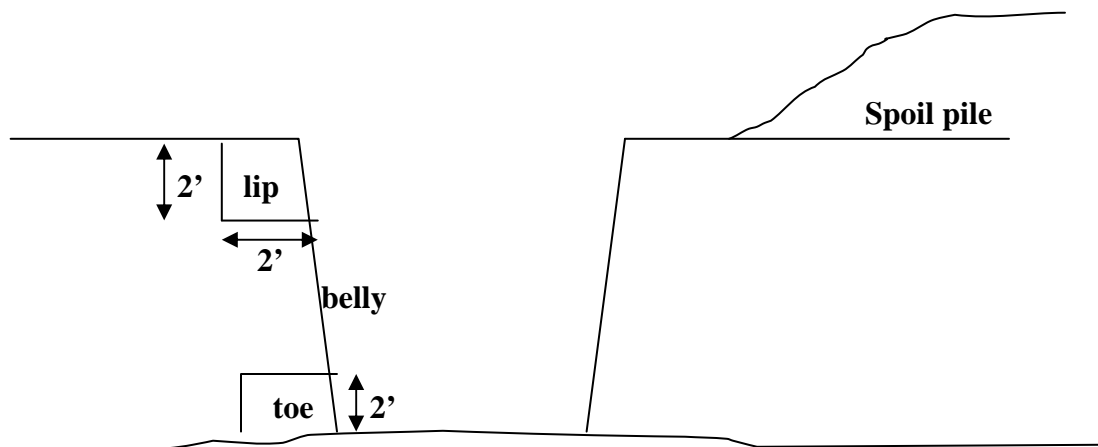
Only fill the 5-gallon bucket ½ way. You have to be able to lift these buckets safely

Some facts about Trenches:

Ninety percent of fatal trench accidents, workmen have died in trenches less than twenty (20) feet deep. A majority of fatalities have occurred involving trenches less than twelve (12) feet deep and six (6) foot wide.

As rescuers, those are properly trained in trench rescue we can use shoring techniques for trenches up to fifteen (15) feet deep. OSHA requires that an engineer design trench stabilization systems for trenches that are deeper then Twenty (20) feet.

OSHA also requires that all trenches that are deeper than five (5) feet must be made safe by shoring, use of a trench box, benching or slopping.

Parts of a Trench:**Types of Trench Accidents:**

- ✓ Lip cave in
- ✓ Lips of both sides cave in
- ✓ Wall slough in
- ✓ Both walls slough in
- ✓ Entire wall shear
- ✓ Both walls shear
- ✓ Spoil pile cave-in

Conditions that can lead to a Trench Collapse:

- ✓ **Disturbed Soil** - ground that has been previously excavated
- ✓ **Intersecting Trenches** - corners at intersection can break away
- ✓ **A Narrow Right of Way** - spoil pile can not be placed a safe distance from the lip of the trench
- ✓ **Vibrations - construction** equipment, responding emergency vehicles

- ✓ **Increased Seepage of Subsurface Water** - weather conditions or any condition to allow the soil to become saturated
- ✓ **Drying of exposed trench Walls** - the drying of the natural moisture that binds the soil together
- ✓ **Inclined Layers of Soil dipping into the Trench** - layers of different types of soil slide on top of each other which causes a collapse

Soil and Failure Types:

<u>Type of Soil</u>	<u>Number of Failures</u>
Clay	32
Sand	11
Wet Dirt	10
Sand, Gravel	8
Rock	7
Sand and gravel	2

Why is clay the highest in incidents and sand / gravel the least in incidents?
Is it that, we feel safe working inside trenches that are made in clay versus sand?

Contractors have a general rule that they follow. When the trench walls remain standing for five (5) minutes after the trench has been excavated this is known as “Freestanding Time”, it is likely that shoring can be installed without incident. This does not take into consideration the classification of the soil.

Manual Soil Testing

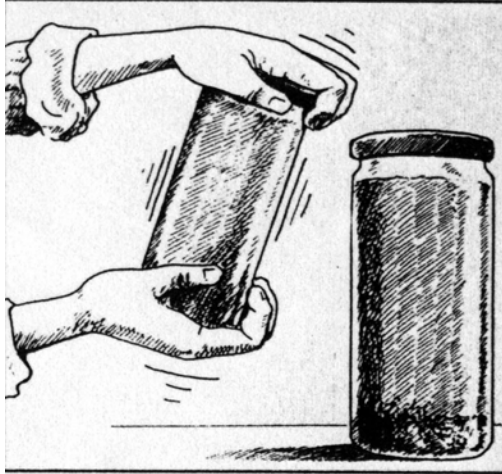
A sample of the soil is taken from the soil pile. Then it is test as soon as possible to preserve its natural moisture content. A “Competent Person” should do this manual test.

There are four (4) types of manual test that can be preformed.

- 1) Sedimentation Test
- 2) Wet Shaking test
- 3) Thread Test
- 4) Ribbon Test

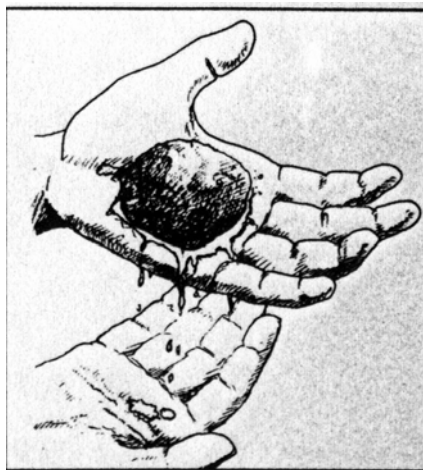
Sedimentation Test:

This test determines how much silt and clay are in sandy soil. Saturated sandy soil is put in to a straight-sided Jar that has approximately 5 inches of water in it. Thoroughly mix the sample in the jar by shaking the glass jar. Then allow the contents of the jar to settle. The percentage of sand is visible. Using this information the soil is classified: for example, a sample with 80 % sand will be classified Type C soil.



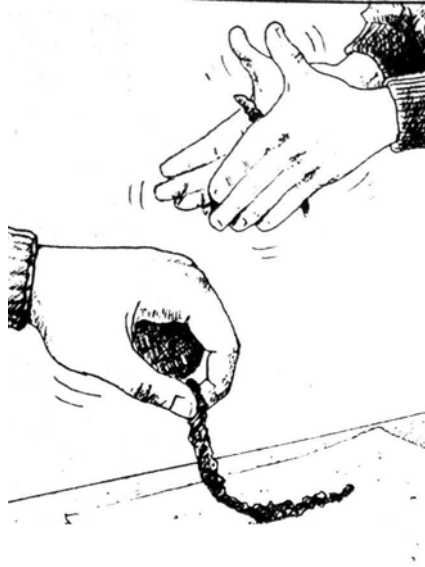
Wet Shaking Test:

This is another way to determine the amount of sand versus clay and silt in a soil sample. Take a sample of soil from the spoil pile; shake a saturated sample to gauge soil permeability. Shaken clay resists water movement through it. Water flows freely through sand and less freely through silt.



Thread Test:

This type of test will determine the cohesion of soil. Take a sample of soil from the spoil pile. Roll the sample between the palms of your hands to a diameter of 1/8" and several inches long. Place the rolled piece on a flat surface. Then pick up the piece you just laid down. If a sample holds together for two (2) inches, it's considered cohesive.



Ribbon Test:

This test also determines cohesion and is used as a backup for the Tread Test. Take a sample of soil from the spoil pile, and then roll it out using the palms of your hands to 3/4" in diameter, and several inches long. Then squeeze the sample between your thumb and forefinger into a flat unbroken ribbon 1/8" to 1/4" thick, at the same time let the sample fall freely over the fingers. If the ribbon does not break off before several inches are squeezed out, the soil is considered cohesive.





NYS Division of Homeland Security and Emergency Services

OFFICE OF FIRE PREVENTION & CONTROL

Organization:

Name:

FOLD

Please remember to:

- Enter into the discussion enthusiastically.
- Give freely of your experience.
- Keep confidences and assume others will, too.
- Confine your discussion to the topic.
- Listen alertly and take accurate notes.
- Provide constructive feedback.
- Appreciate the other person's point of view.
- Practice learned skills on the job.
- Be prompt and regular in attendance.

