THE UNIVERSITY OF SOUTHERN MAINE (USM)

Trenching & Excavating Program
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POLICY:

EXCAVATING/TRENCHING PROGRAM

Statement of Purpose:

This program is intended primarily to protect University employees from the dangers/hazards while working in open trenches and excavations.

1.0 Scope

Any USM employee or student worker who operates within a USM facility or remote site and performs tasks involving trenching or excavation, shall comply with the rules set forth in this document. Student interns and Co-operative (Co-op) students that work outside USM premises and do not use USM owned equipment, are governed by the safety rules and regulations of the sponsoring organization. Sponsoring organizations are required to have written rules, which address safety and standard operating procedures. Interns and Co-op students who either work on USM premises or use USM owned equipment must comply with this program.

Reference document: OSHA Construction Standard - 1926 Subpart P - Excavations

2.0 Program Requirements

1. General Requirements
   a) Surface Encumbrances
   b) Underground Installations
   c) Access/Egress
   d) Exposure to Vehicular Traffic
   e) Exposure to Falling Loads
   f) Warning System for Mobile Equipment
   g) Hazardous Atmospheres
   h) Protection from Hazards Associated with Water Accumulation
   i) Stability of Adjacent Structures
   j) Protection of Employees from Loose Rock or Soil
   k) Inspections
   l) Fall Protection
2. Requirements for Protective Systems

   a) Protection of Employees
   b) Design of Sloping & Benching Systems
   c) Design of Support Systems, Shield Systems & Other Protective Systems
   d) Materials & Equipment
   e) Installation and Removal of Support
   f) Sloping & Benching Systems
   g) Shield Systems

3. There are two occasions when the present standards do not apply:

   a) If the excavation is made entirely in stable rock. Definition of stable rock – Natural solid mineral material that can be excavated with vertical slides that will remain intact while exposed. It should be noted that unstable rock may be considered stable if the sides can be secured against cave in or movement by rock bolts, or by another protective system that has been designed by a professional engineer.

   b) If the excavation is less than four feet in depth and examination by a competent person determines that there is no potential for cave in of the soils surrounding the excavated area.

4. If neither of these conditions exists, then the excavation must be sloped or benched in accordance with one of the following options:

   a) Option 1 – The excavation shall be sloped at an angle not steeper than one and a half (1-1/2 feet) horizontal to one (1 foot) vertical (34º).

   b) Option 2 – Excavations shall be sloped or benched in accordance with the results of visual and manual tests conducted on the excavation.

   c) Option 3 – Designs using other tabulated data. This option allows for the use of other tables, charts, and information which deals with soils and their properties. The sloping or benching must be approved by a registered professional engineer, and there are documentation requirements.

   d) Option 4 – Design by a registered professional engineer. This option is similar to #3. The difference is that the engineer must do the designing and not just approve a design. As with #3, there are documentation requirements.

   e) Note: Option 1, sloping at 1-1/2 feet horizontal to 1 foot vertical, should be the first choice as it will eliminate the visual and manual tests and engineering approval.

      a. So, what this means for example is that for a 5 foot deep trench, the soils should be benched back at least 7.5 feet.
3.0 Soil Classification

As mentioned earlier, soil conditions play a large part in how an excavation is made safe. In regard to excavations, soils have been classified into four types:

1. **Stable Rock**: Natural solid mineral material that can be excavated with vertical sides that will remain intact while exposed. It should be noted that unstable rock may be considered stable if the sides can be secured against cave in or movement by rock bolts, or by another protective system that has been designed by a registered professional engineer.

2. **Type A Soil**: Clay, silty clay, sandy clay, clay loam, and cemented soils such as hardpan or caliche (dense material which is difficult to excavate).

3. **Type B Soil**: Angular gravel (similar to crushed rock), silt, silt loam, and sandy loam.

4. **Type C Soil**: Gravel, sand, loamy sand, submerged soil, or soil from which water is freely seeping, submerged rock which is not stable. Once an excavation is open and before personnel can enter, the excavation must be classified as Stable Rock, Type A, Type B, or Type C. According to the regulation, “classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person.” Stable Rock obviously needs no additional analyses. Visual and manual tests explained in the following section.

4.0 Testing of Soils

1. **Visual Tests** – Visual tests are to determine whether the soil on the walls of the excavation and the soil removed is either cohesive or granular:

   a) Observe the walls and soil for particle size. Fine grained soil is cohesive and coarse-grained soil is granular.

   b) Look at the walls of the excavation and the surface adjacent to the excavation. Crack-like openings, such as tension cracks, could indicate fissures. If chunks spall off a vertical side, then the soil indicates fissures. Small spalls mean moving ground.

   c) Check the excavation and the adjacent area for existing utilities, other underground structures, and previously disturbed soil.

   d) Observe the open sides of the excavation for layered systems of soil.

   e) Look for surface water or water seeping from the side walls.

   f) Determine if sources of vibration will affect the excavation (vehicle traffic, pile driving, operations, demolition, etc.).
2. **Manual Tests** – Manual testing must be done to determine the properties of the soil to provide more information in order to classify the soil properly. Not all of the manual tests have to be done, but the type of soil will determine which test best applies.

   a) Plasticity test – mold a moist or wet sample of soil into a ball around one-eighth (1/8) inch diameter thread at least two inches long. If you can hold the tread aloft and it doesn’t tear, then the soil is cohesive.

   b) Dry strength test – if the soil is dry and crumbles on its own, or with moderate pressure into individual grains of fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay with any combination of gravel, sand, or silt. If the dry soil breaks into clumps which do not break into smaller clumps and which can only be broken with great difficulty and there is no visual indication the soil is fissured, the soil may be considered unfissured.

   c) Thumb penetration test – this test is used to determine unconfined cohesive strength of cohesive soils. Type A soils can be readily indented by the thumb; however, they can only be penetrated with great effort by the thumb. Type C soils can be easily penetrated several inches by the thumb and can be molded by light finger pressure.

   Thumb penetration tests should be conducted on an undisturbed soil sample, such as a large clump of soil, as soon as practicable after excavation so that the sun or rain doesn’t adversely change the sample.

5.0 **Requirements**

There are several other requirements which must be followed to meet compliance:

1. **Make certain underground utilities are located before digging.** If there is any suspicion as to the possibility of encountering a utility, then a call to Dig-Safe is required. In Maine, Massachusetts, Rhode Island, Vermont, or New Hampshire, call 1-888-344-7233. USM/FM utility references are also to be checked.
   a) **OSHA Construction Standard - 1926.651(b)(1)**
      i. The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.
2. Once the visual and manual tests have been done, the maximum allowable slope must be determined. This is done by referring to Appendix C of this document. For simple slopes, simple benches, multiple benches, vertical sided lower portions or excavations made in layered soils, refer to the appropriate diagram.

3. A stairway, ladder, or ramp must be located no more than twenty-five (25) feet from any employee who must work within the excavation. However, this is not required if the excavation is (4) feet or less in depth. **Note:** Step ladders are not to be used. Ladders must extend 3 feet above the excavation.

4. Employees must keep a safe distance from digging equipment while in operation and trucks when being loaded.

5. Any excavations should be considered a confined space. Excavations which have been left open overnight and are of sufficient depth to have restricted air movement should be tested before employees are allowed to enter. If an excavation is oxygen deficient or contains a hazardous atmosphere, then confined space entry procedures apply including planning for a providing necessary emergency rescue equipment.

6. Employees shall not work in excavations where water has accumulated or is accumulating unless effective means of dewatering are undertaken. It is important to remember that accumulating water means changing soil conditions.

7. The stability of adjacent structures (buildings, foundations, retaining walls, etc.) must be considered if they are in close proximity. If a hazard can be reasonably expected, then employees can’t enter the excavation unless:
   
   a) The excavation is in stable rock, or  
   b) An adequate protective system is provided, or  
   c) A registered professional engineer determines that any structure in question is not close enough to affect or be affected by the excavation.

8. Employees must be protected from loose rock and soil. Materials and equipment must be kept at least two feet from the excavation’s edge. Employees shall not be permitted to work on the faces of sloped or benched excavations at least above other employees unless employees below are protected from falling objects.
9. Each employee in an excavation shall be protected from cave-ins by an adequate protective system unless:
   a) Excavations are made entirely in stable rock, or
   b) Excavations are less than 5 feet (1.52 m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

10. Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

6.0 Personal Protective Equipment/Confined Space Equipment

1. Personal protective equipment (PPE) listing:
   a) Hardhat
   b) Gloves
   c) Safety glasses/goggles
   d) Safety shoes

2. Confined space equipment listing:
   a) Air monitoring devise (MSA Optima)
   b) Harness and retrieval equipment

7.0 USM/FM Competent Persons and Emergency Phone Number

a. The below personnel are designated to act as Competent Persons during any project involving excavation and trenching.

b. Note: Competent person - "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."
c. Also, the Competent Person shall ensure that all facets of the Excavation/ Trenching program are being applied and utilized during the project and necessary documentation and follow-up is taken care of.

1. Competent persons for Gorham campus:
   a) Assistant Director for Maintenance and Operations
   b) Assistant Director for Grounds and Grounds Services

2. Competent persons for Portland campus:
   a) Assistant Director for Maintenance and Operations
   b) Assistant Director for Grounds and Grounds Services

3. Emergency phone number for both Portland and Gorham campuses:
   a) USM Police – 911

**8.0 Training**

1. Orientation training – All regular FM grounds and trades personnel working on excavation projects must complete this scheduled training before working on any USM excavation project, no exceptions will be allowed.

2. Refresher training – Annual reviews of yearly projects will be conducted by the University Environmental Health & Safety Office and if needed refresher training will be conducted.

3. Sub-contractors – Any sub-contractor doing work on USM campuses will have their respective safety and health programs available upon request.
Appendix A: Supervisory Checklist – Excavation Projects

Planning Considerations:

a) Identify and assign a competent person to each jobsite that engages in excavation and trenching activities. (Experience, education, and authority).
b) Do the current OSHA standards for evacuation apply to this activity?
c) Are soil conditions known? (Soil analysis, previous excavations, etc.).
d) Are building plans and utilities available? (Dimensions of excavation, roads, sidewalks, existing buildings, and structures).
e) Weather considerations for the duration of activities?
f) Overhead, surface, or underground electrical or other utility considerations. (Dig Safe at 888-344-7233).
g) Surface water or high ground water table?
h) Protective systems needs? (Sloping, trench boxes, timber or hydraulic shoring, sheeting, etc.).
i) Emergency procedures are in place (must be communicated to every employee prior to any work activities)? Emergency radio communication is on site.
j) Will a professional engineer be required? (Yes, if excavation cannot be sloped to 1 - 1½ and current OSHA standards apply to this activity).

General Considerations:

a) Surface encumbrances: signs, utility poles, etc. (Located, removed, or supported).
b) Access and egress (“exits”). Structural ramps not too steep, ladders every 25 feet, etc. (Refer to safety plan).
c) Exposure to vehicular traffic. Barricades, cones, lighting, reflective vests, traffic control needs (flag persons, electronic controls, etc.).
d) Safety considerations for mechanized equipment. (Working under loads, outriggers, barricades, backup alarms, other rigging and digging considerations).
e) Hazardous atmospheres. Confined entry considerations? (Testing and monitoring equipment, respirators, emergency procedures, etc.). Definition of confined space: A tank, vessel, silo, vault, pit, open topped space more than four feet (1.2 m) deep, pipeline, duct, sewer, tunnel, having limited means of egress and has one or more of the following characteristics:
i. Less than 19.5% oxygen.
ii. Flammable/combustible/explosive atmospheres present or able to be generated or enter into the area.
iii. Toxic atmospheres present or able to be generated or enter into the area.
iv. Areas not protected against entry of water, gas, sand, gravel, ore, grain, coal, biological, radiation, corrosive chemicals, or any other substance which could possibly trap, suffocate, or harm a person.
v. Poor natural ventilation.
vi. Restricts entry for rescue purposes.

f) Fall prevention measures.
g) Water accumulation. (Pumps, diversion ditches, dikes, etc.).
h) Stability of adjacent structures. (Support systems, bracing, underpinning, P.E.)
i) Inspections. (Daily and whenever conditions change, always document inspections).
j) Personal protective equipment is being used.

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<tr>
<th>Employees Working on Project:</th>
<th>Supervisor’s Signature:</th>
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<th>Daily Follow-Ups as Needed for the Same Job Location</th>
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<tr>
<td>Date: S.I.                                  Date: S.I.</td>
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<td>Date: S.I.                                  Date: S.I.</td>
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Supervisors: File this checklist in the appropriate documentation folder in your FM office, random audits will be conducted.
Appendix B: Definitions

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum hydraulic shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

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

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person - "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 braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or sides mean the vertical of inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means 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.

Kickout means the accidental release or failure of a cross brace.
Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either pre-manufactured or job-built in accordance with 1926.652 (c) (3) or (c) (4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of oil or rocks are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.
Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.
Appendix C: MAXIMUM ALLOWABLE SLOPES

<table>
<thead>
<tr>
<th>SOIL OR ROCK TYPE</th>
<th>MAXIMUM ALLOWABLE SLOPES (H:V)(1) FOR EXCAVATIONS LESS THAN 20 FEET DEEP(3)</th>
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<tr>
<td>STABLE ROCK</td>
<td>VERTICAL (90º)</td>
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<td>TYPE A (2)</td>
<td>3/4:1 (53º)</td>
</tr>
<tr>
<td>TYPE B</td>
<td>1:1 (45º)</td>
</tr>
<tr>
<td>TYPE C</td>
<td>1 ½:1 (34º)</td>
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</table>

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

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

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

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.
SIMPLE SLOPE -- GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

SIMPLE SLOPE -- SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 3/4 to 1 and maximum bench dimensions as follows:
3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.

UNSUPPORTED VERTICALLY SIDED LOWER PORTION -- MAXIMUM 8 FEET IN DEPTH)

All excavations more than 8 feet but not more than 12 feet in depth with unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.
UNSUPPORTED VERTICALLY SIDED LOWER PORTION -- MAXIMUM 12 FEET IN DEPTH

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of $\frac{3}{4}:1$. The support or shield system must extend at least 18 inches above the top of the vertical side.

SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under CFR 1926.652(b).

Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.
SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

![Diagram of Simple Slope]

SINGLE BENCH

![Diagram of Single Bench]

MULTIPLE BENCH

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.
VERTICALLY SIDED LOWER PORTION

4. All other sloped excavations shall be in accordance with the other options permitted in CFR 1926.652(b).

Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.

SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.
3. All other sloped excavations shall be in accordance with the other options permitted in CFR 1926.652(b).

**Excavations Made in Layered Soils**

1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.
2. All other sloped excavations shall be in accordance with the other options permitted in CFR 1926.652(b).