OSC 12
Ohio Safety Congress & Expo

WELL AT HOME. SAFE AT WORK.

151 Earth Retention Systems: Understand What's Holding it Back

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Wednesday, March 28, 8 to 9 a.m.

Ohio Bureau of Workers' Compensation

Earth Retention Systems

IGEL Since 1911

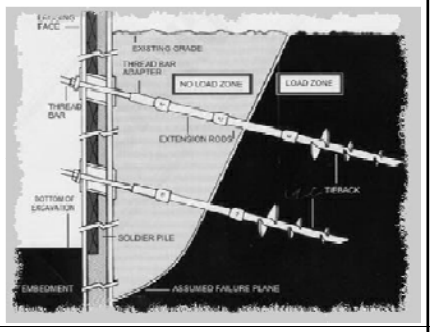
Course Outline

- Overview of Earth Retention Systems
  - Nomenclature
  - Soil principles
- Safety
  - Regulations
  - Factors to Consider
- Best Practices for Construction
  - Things to Consider
- Wrap-up Questions/Feedback

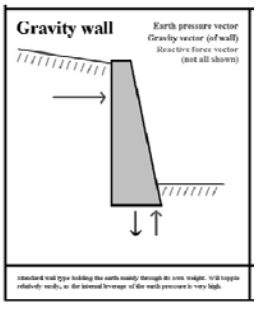
Overview of Earth Retention Systems

Intent is to hold back the earth

- Failure plane (OSHA sloping)
- Soil classifications

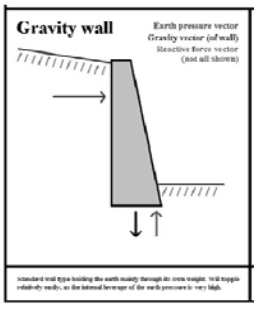


Overview of Earth Retention Systems



Gabion Wall (*gravity wall*)

Overview of Earth Retention Systems

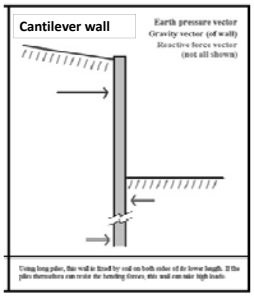


Other Types of Gravity Walls

Cast-in place concrete wall
- T-wall
- Mass wall

Landscape segmental wall (*keystone wall*)

Overview of Earth Retention Systems



H-Pile Lagging – Cantilever Wall

Earth Retention Systems

Overview of Earth Retention Systems

Lagging Installation

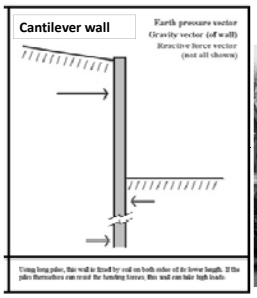
Behind the flange
(*as shown at right*)

Welded studs and plates
(*as shown below*)

Install per engineered drawings

Earth Retention Systems

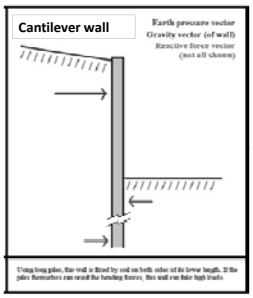
Overview of Earth Retention Systems



Sheet Pile – Cantilever Wall

Earth Retention Systems

Overview of Earth Retention Systems



Other Types of Walls

Caissons (*tangential*)

Auger-cast piles

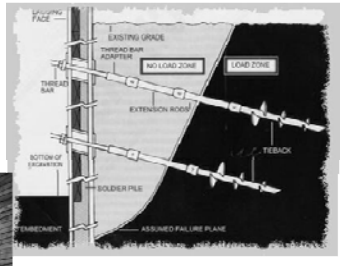
Slurry wall

Earth Retention Systems

Overview of Earth Retention Systems

Anchors

Tie-backs



Earth Retention Systems

Overview of Earth Retention Systems

Anchors

Deadman
(*and rod*)

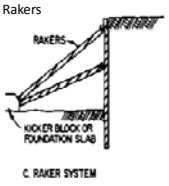
Earth Retention Systems

Overview of Earth Retention Systems

Bracing

Struts

Rakers



C. RAKER SYSTEM

Construction and Safety of Earth Retention Systems

H-Pile and Lagging with Struts (*aka Soldier Pile Lagging*)

OSHA's Distinction between a "Trench" and "Excavation"

- **Excavation:** any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal
- **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.* 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 or less, the excavation is also considered to be a trench.

29 CFR, Part 1926.650 "Scope and Application"

Applicable Regulations

- "*Additional requirement for shield systems used in trench excavations.* Excavation of earth material to a level not greater than 2 feet below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications that while a trench is open of a possible loss of soil from behind or below the bottom of the shield."

29 CFR, Part 1926.652(g)(2) "Requirements for Protective Systems"

- "Support systems, shield systems, and other protective systems not utilizing Option 1 [Appendices in the CFR], Option 2 [Manufacturer's Tab Data Sheets], or Option 3 [Other tabulated data], above, shall be approved by a registered professional engineer."

29 CFR, Part 1926.652(c)(4)(i) "Requirements for Protective Systems"

- "Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

Section 5(a)(1) of the Occupational Safety and Health Act

Applicable Regulations

- "Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection."

29 CFR, Part 1926.651(j)(1) "Specific Excavation Requirements"

Appropriate Reference

- "After installation of the soldier beams, the soil in front of the wall is excavated in lifts, followed by installation of lagging. Excavation for lagging installation is commonly performed in 1.2 m [approx. 3' 11"] to 1.5 m [approx. 4' 11"] lifts, however, smaller lift thicknesses may be required in ground that has limited "stand-up" time. Lagging should be placed from the top-down as soon as possible after excavation to minimize erosion of materials into the excavation."

Geotechnical Engineering Circular No. 4 Ground Anchors and Anchored Systems. Section 2.3.2.3 Lagging, pg. 14. July 1999

Registered Professional Engineer

OSHA's Stance (*courtesy of Region V's technical director*)

- Stamped, engineered drawings are suitable as a protective system only when the installation is complete.
- The depth of a trench is measured from the bottom soil floor to the top of the ground, not from the bottom soil floor to the first lagging board.
- The tables in Appendix C of the Subpart relate only to the use of timber trench shoring (lagging) in depths to no greater than 20 feet.
- The tables in Appendix C of the Subpart do not indicate the means and methods to which installation should occur.

Factors to Consider for Competent Person

Determine which regulation(s) apply.

Trench: Two feet is the maximum allowable unprotected depth. Lagging boards should be installed in two foot increments.

Excavation: There is no clear "depth" that is permissible to dig down before installing lagging boards. (*Best practice would be less than five feet)*

These are *minimum* guidelines. Other considerations should be examined for employee protection.

Factors to Consider for Competent Person

Other Considerations/Common Sense (competent person should make call):

- Cohesive strength of the soil
- Water
- Proximity to busy roadways
- Existence of utilities
- Vibrations of heavy equipment
- Fissures
- Cracks
- Slough off
- Super-imposed loads (materials, equipment, etc.)
- Body position of the employees needing to perform work

Other Safety Factors (non-excavation) to Consider

- **Welding operations** – FR-rated jacket, FR-rated reflective vest, welding hood, welding gloves, fire watch, fire extinguisher, screens for flash protection, and proximity to combustibles
- **Access** – Stairway, ladder, ramp or other safe means *29 CFR, Part 1926.621(l)*
- **Fall protection** – catwalks, guardrails, anchorage points for tie-off, harnesses, lanyards (appropriate for fall distance and minimizing the pendulum effect) *29 CFR, Part 1926.621(l)*
- **Existing utilities** – Proper notification and safe and prudent digging to expose utilities, adequate rigging/protective measures to support throughout duration of excavation
- **Soil settlement** – after installation (to protect against overhead hazards)
- **Cutting** – face shields, safety goggles, and gloves
- **Air Quality /Confined Space** – 4-gas detectors and rescue procedures
- **Housekeeping** – removal of excess material

Best Construction Practices

- <u>Lagging board spacing</u>
  - Put a gap between the boards to relieve ground water pressure
  - Allow water, but not the soil
- <u>Void behind lagging boards</u>
  - Minimize space as much as possible
  - Backfill as you go
- <u>Surface water control</u>
  - Keep lag boards backfilled
  - Divert surface water at top

Best Construction Practices

- <u>Adjacent to structures</u>
  - Excavate with caution (two feet minimum?) to prevent disturbance of existing structures
- <u>Beam square (plumb)</u>
  - Beams are designed to carry the earth load against the flange
- <u>Don't dig beyond designed cantilever depth</u>
  - Don't dig past tie-back depth.
  - Determine depth (*ask P.E.*) before strut needs to be installed

Best Construction Practices

- Check with P.E. before altering engineered system
  - Beam obstruction/relocation
  - Strut/waler locations (*clearances*)
- Changes in Soil/Field
  - Contact P.E. when excavation reveals a change in soil or field conditions.

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