Estimating Soil Pressure Against Unyielding Surfaces

FDOT GRIP Meeting

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August 17th, 2017

Topics Covered

- Introduction
- Background
- Objectives
- Tasks 1 – 6
- Wall configurations
- Project benefits

Introduction

- Mechanically Stabilized Earth (MSE) Walls are a cost effective option for earth retention systems.
  - Bridge abutments, highway separations, and when construction space is limited
- Reinforced strips or grids are placed between layers of compacted soil and mechanically attached to the wall facing.
- Lateral earth pressures exerted on the wall facing by granular backfill are opposed by frictional resistance developed along the surface of the reinforcement

Background

- In general design, the lateral earth pressure imposed on a retaining wall is approximately equal to the active lateral earth pressure
  - Conventional earth pressure theory
  - Reinforcement embedded in soil and free to move
- In certain cases, the reinforcement ties two walls together resulting in an unyielding condition.
  - Widening conditions (new wall tied to existing wall)
  - Acute corners
  - Back to back walls (bin-walls)
- The actual soil pressure that results behind an unyielding surface is not well defined

Background

- FHWA GEC #11 acknowledges that “much higher” tension develops in the reinforcement when walls are tied together
- Minor deformations that typically occur in conventional MSE walls are prevented
- While GEC #11 recognizes the problem, it does not provide a clear recommendation for estimating the pressure of compacted soils

Unyielding Condition

Objective

- Investigate the resulting earth pressure coefficients derived from approved MSE wall configurations in both a loosely and highly compacted soil scenario
- In both scenarios, two MSE wall configurations will be investigated simultaneously.
  - Configuration 1 – reinforcement attached to two walls where one wall is yielding and the other wall is unyielding
  - Configuration 2 – reinforcement attached to one yielding wall and embedded in soil near an unyielding surface
- The outcome can then be used to address design methodology and earth pressure coefficients for earthen fill compacted behind unyielding surfaces

Task Outline

1. Literature review and preliminary design
2. Final design, site prep, and materials purchasing
3. MSE wall trial 1 – loosely compacted soil
4. MSE wall trial 2 – highly compacted soil
5. Draft final report and closeout teleconference
6. Final report

Task 1

- Extensive literature review of current design practices and standards will be conducted
  - Ensure the MSE wall configurations adhere to the FDOT standard specifications for road and bridge construction
  - Comply with AASHTO design code.
- Construction and quality control procedures developed within the industry will also be investigated
  - Ensures proper construction and sequencing takes place
  - Provides structures that are representative of typical MSE wall construction

Task 2

- Soil testing:
  - Sieve analysis
  - Relative density
  - Consolidation
  - Compaction
  - Direct shear
  - Moisture content
  - Unit weight
  - Soil classification
- If permitted:
  - pH, resistivity, chloride, and sulfate testing

Task 2

- Preliminary designs will be drafted based on the results of the soil investigation
  - The Reinforced Earth Company (RECo) will work as a sub-consultant to UF
  - Offer guidance on construction operations and internal stability
    - Provide recommendations on number of reinforced strips required to maintain internal stability
- Final designs will be drafted and presented to FDOT for approval
  - FDOT approval must be gained before construction

Task 2

- Site prep
  - Soil box at UF's Coastal engineering lab will be used to conduct the research
    - Retrofit the control room to house the new instrumentation
    - Clear space to fit a crane for panel lifting and storage
- Instrumentation purchasing and calibration
  - Earth pressure cells (embedded in soil)
  - "Fatback" earth pressure cells (wall mounted)
  - Strain gauges placed on the top and bottom of the reinforced strips (compensate for bending)
  - String potentiometers to measure wall displacement
  - Vibrating wire readout box for spot checks during wall construction
  - Vibrating wire data logger to record and store measurements taken during the experiments

Task 3

- MSE wall trial 1 – loosely compacted soil
- Control experiment
- Investigate the developed earth pressure coefficients using a loosely compacted soil as the back fill
- FDOT project managers will define the degree of compaction

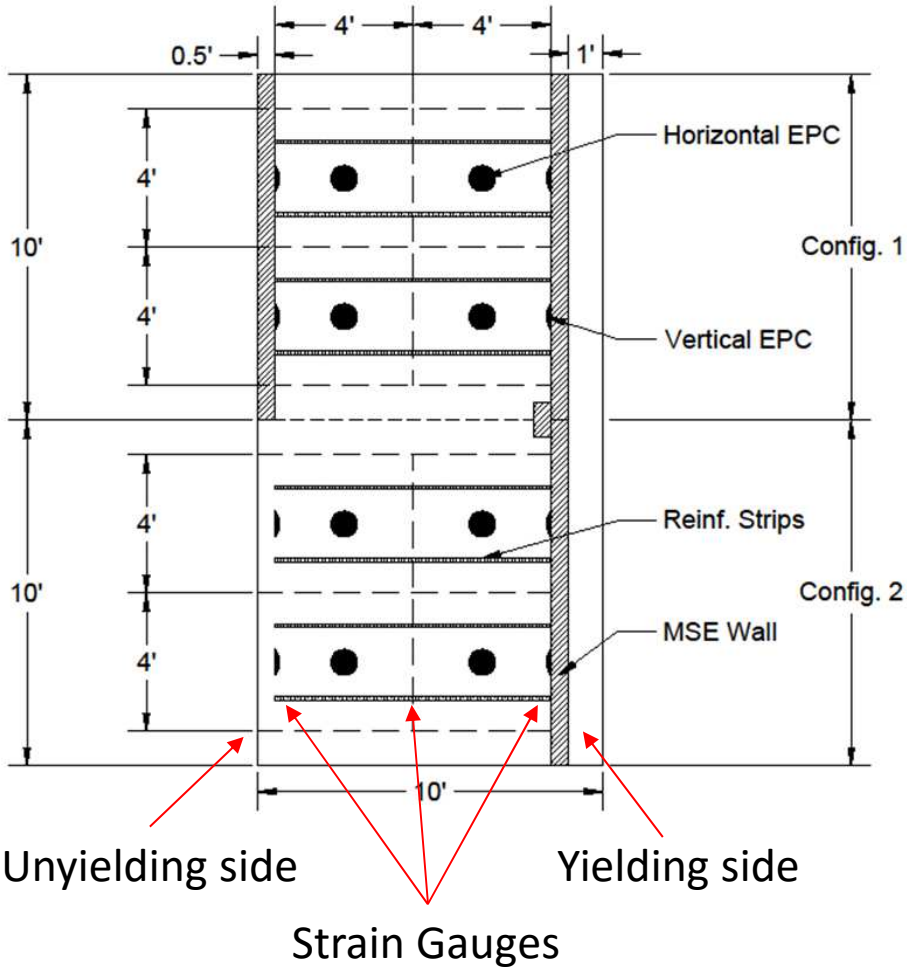
Task 4

- MSE wall trial 2 – Highly compacted soil
- Investigate the developed earth pressure coefficients using a highly compacted soil as the back fill
- FDOT project managers will define the degree of compaction
- Results from Trials 1 and 2 will be compared
- Conclusions will be drawn on the effects of compaction for both wall configurations

UF’s Soil Box

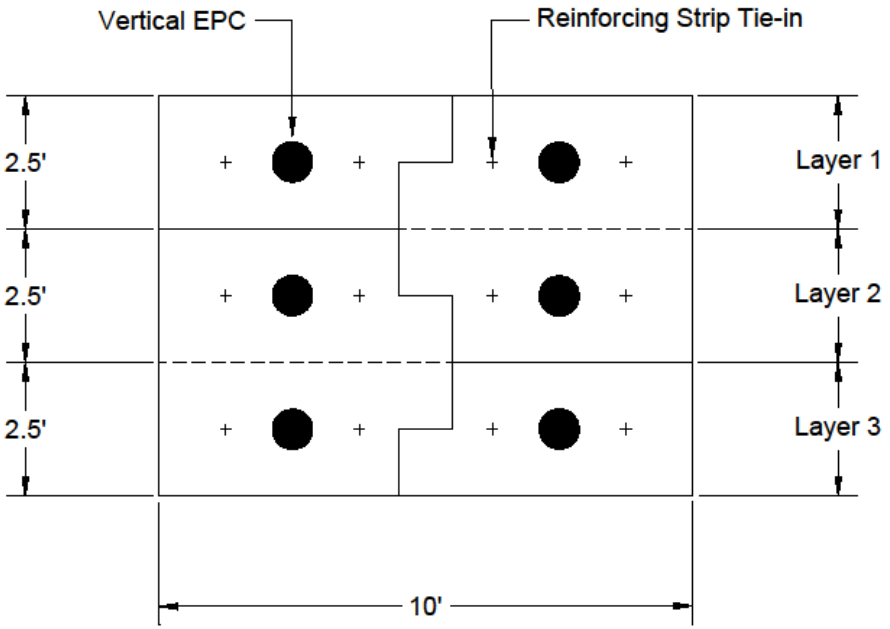
Wall Configurations – Plan View

- Configuration 1 – reinforcement attached to two walls where one wall is yielding and the other wall is unyielding
- Configuration 2 – reinforcement attached to one yielding wall and embedded in soil near an unyielding surface
- Large 4’ x 4’ x 1’ concrete blocks will provide surcharge loading
  - Length of time for the sustained loading will be decided by FDOT and the PI based on the data collected



Wall Configuration – Profile View

- Square/rectangular panels will be used based on surveying approved FDOT vendors
  - Cruciform panels displayed to the right
  - Number of reinforcing strips will be determined in Task 2
    - 4 are shown per layer
    - Current plan is to use 6 per layer
- Tributary wall area is used to check internal stability
  - ½ panel tall and 2 panels wide
- Instrumentation is placed within each layer of the tributary wall area
  - Provides 24 different zones that will be investigated simultaneously.
  - 12 zones per wall configuration



Tasks 5 and 6

- Task 5
  - Draft final report
  - Closeout meeting
- Task 6
  - Final Report

Project Benefits

- The empirical results and numerical methods developed from this effort will allow for increased accuracy in geotechnical design.
  - Reduce unnecessary strength requirements such as additional reinforcement layers and stronger connections
- Can be applied to the following MSE walls:
  - New walls tied to an existing wall (widening conditions)
  - Back to back walls (bin-walls)
  - Acute corners
  - Other scenarios where fill would be placed and compacted against an unyielding surface.

Questions?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