Performance Testing of GRS Test Piers Constructed with Florida Aggregates – Axial Load Deformation Relationships

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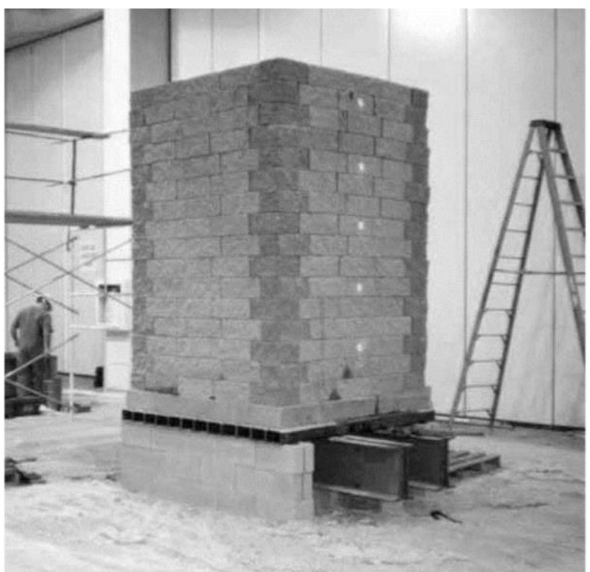

(Nicks et al., 2013)

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BACKGROUND

- Geosynthetic Reinforced Soil (GRS) structures similar to conventional stabilized earth structures (e.g., Mechanically Stabilized Earth Walls)
- Primary difference in the reinforcement spacing
  - GRS vertical spacing (S_v) between reinforcement < 12 inches AASHTO
  - Close spacing forms a Geosynthetic-Aggregate-Geosynthetic composite capable of carrying load
- Are in service as abutments to highway and railway overpasses
- Observed lower failure (service and strength) than MSEW
- Aggregates are used as backfill
- Internal stability (reinforcement rupture) controls GRS structures
- Has the following advantages:
  - Decreased cost (25-60%)
  - Accelerated construction
  - Decreased dependence on specialized equipment
  - Flexible design that can be adjusted
  - Decreased maintenance
- GRS piers are an experimental method to evaluate performance of GRS for abutments

RESEARCH MOTIVATION

- NCHRP 24-41 "Defining the Boundary Conditions for Composite Behavior of Geosynthetic-Reinforced Soil Structures" was a comprehensive study of GRS structures past performance, pier tests, centrifuge tests and numerical studies
  - Re-analyzed all experimental data
  - Calibrated numerical models for composite behavior analysis
  - Concluded S_v and strain behavior around reinforcement as the characteristics most important to stability
  - Made recommendations for how existing design methods could be revised and implemented in AASHTO LRFD Bridge Design Specifications
- Guidance on GRS structures in FDOT SDG (2019)
  - Graded aggregate base (GAB) and course aggregates (#57 and #67 stone) as GRS backfill (#57 more commonly used)
  - Minimum mechanical properties based on tests at SMO
  - Biaxial geogrid and woven geosynthetic ultimate tensile strength >4,800 lbs/ft
  - Segmental blocks permitted
  - $S_{v\,max}$ = lessor of height of block or 8 inches

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RESEARCH QUESTIONS

- What is the performance of GRS piers with aggregates used throughout Florida?
  - How does composite of crushed concrete GAB (CCGAB) and reinforcement perform?
- What is the axial load deformation behavior ?
- For S_v < 8 inches, what is the load capacity within service limits?

PROPOSED PROJECT OBJECTIVES AND TASKS

OBJECTIVES

Measure axial-load deformation behavior of GRS piers through full scale testing to identify their performance when constructed with aggregates used in Florida and typical reinforcement types at different vertical spacing.

TASKS

Task-1: Review previous studies on GRS, design methods, material, and construction practices

Task-2: Design experimental plan for performance tests

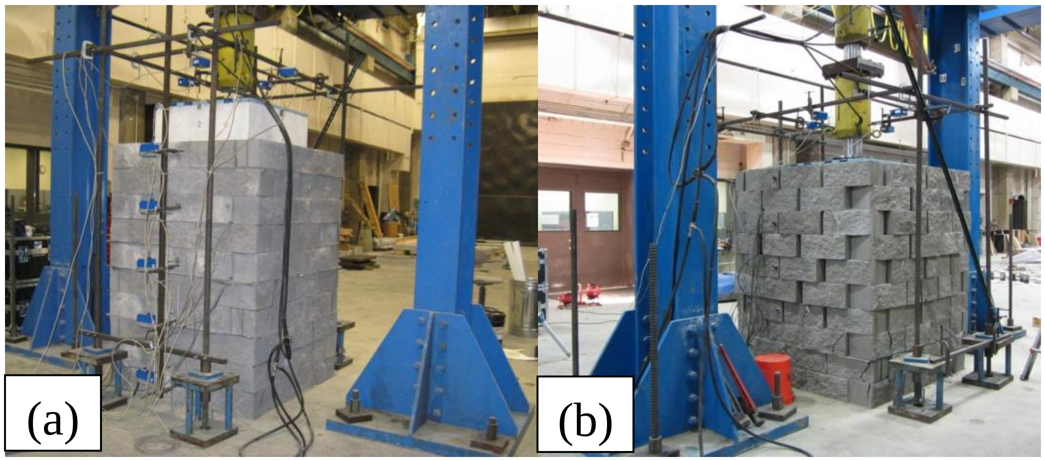
Task-3: Performance tests – Axial load-deformation tests on multiple GRS piers

Task-4: Compare performance test results with previous results and predictions and make recommendations for GRS design in Florida

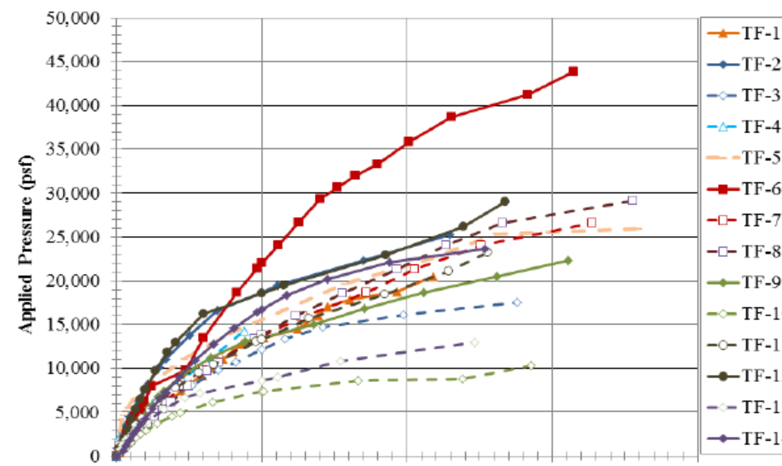
Tasks-5 and 6: Final reports and closeout teleconference

PREVIOUS EXPERIMENTAL STUDIES

FHWA conducted 19 tests for influence of pier characteristics LRFD Bridge Design Specifications



FHWA performance test of GRS pier
(a) pre-test (b) post-test (Nicks et al., 2013)



(Nicks et al., 2013)

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PROPOSED TESTS

Tests to be conducted at Marcus H. Ansley Structures Research Center

Aggregates	Geosynthetic	S_v, Vertical Reinforcement Spacing	Facing	B, Width	H, Height
3	2	2	1	1	1
GAB and #57 stone, CCGAB	biaxial geogrid or woven geotextile	8 inch 4 inch	segmental blocks	3.5 ft	8 ft (H/B > 2 for 6 in deep facing)

Measurements:

- Applied axial load
- Vertical deformation and changes in profile with linear potentiometers
- Tensile load distribution with strain gauges on reinforcement layers
- Aggregate pressure distribution with horizontal and vertical pressure cells

REFERENCES

- FDOT. (2019). Structures Manual: Volume 1 – Structures Design Guidelines.
- Nicks, J.E., Adams, M.T., Ooi, P.S.K., and Stabile, T. (2013). Geosynthetic Reinforced Soil Performance Testing – Axial Load Deformation Relationships, Publication No. *FHWA-HRT-13-066*, Turner-Fairbank Highway Research Center, McLean, VA.
- Zornberg, J.G., Morsy, A.M., Kouchaki, B.M., Christopher, B., Leshchinsky, D., Han, J., Tanyu, B.F., Gebermariam, F.T., Shen, P., and Jiang, Y. (2018). Defining the Boundary Conditions for Composite Behavior of Geosynthetic-Reinforced Soil Structures. Project No. 24-41, National Cooperative Highway Research Program (NCHRP) Transportation Research Board, National Academies of Sciences, Engineering, and Medicine.

Thank You