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GOVERNOR

OFFICE OF THE
SECRETARY

STRUCTURES DESIGN BULLETIN C11-05

Date: April 15, 2011

To: District Directors of Operations, District Directors of Production, District Design Engineers, District Construction Engineers, District Geotechnical Engineers, District Structures Design Engineers

FROM: Robert V. Robertson, P. E., State Structures Design Engineer

COPIES: Brian Blanchard, David Sadler, David O'Hagan, Larry Jones, Andre Pavlov, Charles Boyd, Tom Andres, Sam Fallaha, Dennis Golabek, Tom Waits, Jonathan Van Hook, Garry Roufa, Peter Lai, Rodrigo Herrera, Rudy Powell, Chris Richter (FHWA), Jeffrey Ger (FHWA), Bob Burleson (FTBA)

SUBJECT: Mandatory Evaluation of Suitability of Geosynthetic Reinforced Soil (GRS) Abutments for Single Span Bridges

DESIGN REQUIREMENTS

1. Section 3.12 of the **January 2011 Structures Design Guidelines** is expanded as follows:

   3.12.12 Geosynthetic Reinforced Soil (GRS) Walls and Abutments

   A. GRS abutments are a shallow foundation and retaining wall option that may significantly reduce the construction time and cost of single span bridges.
   B. GRS walls and abutments, like MSE walls, are very adaptable to both cut and fill conditions and can tolerate a greater degree of differential settlement than CIP walls. GRS walls, however, are also not appropriate for all sites.
   C. GRS walls and abutments are constructed with coarse aggregate or Graded Aggregate Base (GAB) backfill and geosynthetic soil reinforcement. However, site space limitations may preclude the use of GRS walls and abutments because of the inability to place the soil reinforcement.
   D. When excessive scour or settlements are anticipated, countermeasures, deep foundations and/or other wall types may be required.

2. Section 3.13.2 of the **January 2011 Structures Design Guidelines** is expanded as follows:

   P. GRS Walls and Abutments

   Commentary: **FHWA Publication No. FHWA-HRT-11-026 "Geosynthetic Reinforced Soil Integrated Bridge System Interim Implementation Guide"** (GRS Guide) contains background information and design steps for GRS walls and abutments. (Refer to this guide for Figures referenced below)

1. GRS Abutments may be used to support single span bridges which are not at risk of movement due to sliding, uplift, etc.
2. Design the GRS abutment in accordance with the LRFD methodology contained in Appendix C of the GRS Guide, except as otherwise described in this section.
3. Coordinate with the Drainage/Hydraulics Engineer to determine the design scour depth at the abutment with respect to the distance between abutments.
4. Utilize a Reinforced Soil Foundation (RSF) in lieu of the concrete leveling course utilized for MSE walls. (See Figure 30 and Section 7.4 of the GRS Guide)
5. Detail the bottom layer of reinforcement for the GRS abutment to bear on top of the RSF at the design scour elevation or 6 inches below the finished ground surface, whichever is deeper.
6. Ensure the minimum length of reinforcement, B (bottom layer of reinforcement) is not less than 6 feet.
7. Ensure the thickness of the RSF is 18 inches or 0.25B, whichever is greater.
8. Extend the RSF a distance of at least 18 inches or 0.25B, whichever is greater, in front of the wall facing.
9. Use a maximum vertical reinforcement spacing of 8 inches. (In the bearing reinforcement zone the reinforcement spacing is reduced by 50%.)
10. GRS Walls are designed as GRS Abutments but without a “Bearing Reinforcement Zone.”
11. GRS Walls and Abutments are constructed in accordance with Developmental Specification 549 using the following materials:
    a. Index 501 Geogrid or Woven Geotextile reinforcement with both:
        i. Approved Application Usage 1 or 3, and
        ii. An ultimate tensile strength exceeding the ultimate strength requirements computed for the project, or an ultimate tensile strength of 4,800 lbs per foot in both the machine and cross directions, whichever is greater.
    b. Graded Aggregate Base (GAB) backfill meeting the requirements of Specification 204.
    c. 8”x8”x16” Concrete Masonry Units meeting the requirements of Specification 949-3.
    d. Non-epoxy-coated rebar
12. Testing by the State Materials Office indicates the following GAB backfill design values should be assumed for design: γ_{NAT} = 144 pcf, φ_f = 42 deg, C = 0

COMMENTARY

GRS Abutments and Walls are part of FHWA’s Every Day Counts (EDC) initiative to reduce bridge construction time and cost. A limited number of small bridge projects have been constructed in other parts of the country using this technology in combination with precast bridge components. These projects were considered cost effective, are performing well, and the lessons learned during those projects led to the GRS Guide. Earlier this year the FHWA sponsored a series of regional summits to share this technology with state departments of transportation. The presented information may be viewed at the following website:
http://www.fhwa.dot.gov/everydaycounts/summit/grs_ibs.cfm
The GRS Guide may be downloaded from:
http://www.fhwa.dot.gov/publications/research/infrastructure/structures/11026/11026.pdf

BACKGROUND

The following background information is excerpted from FHWA-HRT-11-026:

> Based on constructed demonstration projects, GRS-IBS is more cost-effective than traditional bridge construction, utilizes common materials and construction techniques, and provides a safer work environment for personnel in work zones. GRS-IBS bridges can be built in less time (in weeks, rather than months), which translates into less congestion; fewer road closures, disruptions, and shutdowns around work zones; and lower materials and labor costs. The method of construction is such that the abutments are built from the inside out, reducing the exposure of personnel to potential roadside hazards. In addition, the technology is environmentally sensitive and results in minimal environmental impacts. The technology produces a reduced construction and carbon footprint, eliminates the need for installation of a deep foundation or CIP concrete, and can be adapted to fit the site-specific environmental needs.
>
> The cost to build a GRS-IBS bridge is potentially 25–60 percent less than traditional methods, depending on the standard of construction. The savings is attributable to the simplicity and flexibility of the design, speed of construction (which is less dependent on weather conditions than CIP abutments), use of readily available materials and equipment, and elimination of the deep foundation and other construction details associated with the approach way to the bridge. Furthermore, this method has the potential for reduced maintenance costs because it eliminates the bump at the end of the bridge, creating a smoother and safer transition. Also, the application of GRS technology in other facets of earthwork (e.g., walls, culverts, foundations, slope stability, rock fall barriers, etc.) has the potential to result in significant cost savings and more effective use of transportation funding.
>
> In summary, the benefits of GRS-IBS include the following:
>
> - Reduced construction time.
> - 25–30 percent lower cost than standard pile cap abutments on deep foundations with 2:1 slopes for off-system bridges.
> - 50–60 percent lower cost than standard department of transportation bridges.
> - Construction that is less dependent on weather conditions.
> - Flexible design that is easily field-modified for unforeseen site conditions.
> - Easier maintenance due to fewer parts.
> - Construction with common equipment and materials.
> - Better quality control.

DESIGN IMPLEMENTATION

The revisions to the SDG contained herein are effective for all single span bridge design projects with a "Notice to Proceed" after June 1, 2011.The districts are encouraged to investigate the feasibility of implementing these requirements on other projects already in progress.

Preferred details for inclusion in project plans are under development and will be ready by September 1, 2011.

Developmental Specification 549 will address the background, materials construction requirements and developmental pay items specific to GRS walls and abutments which are not addressed in Specification 548. Developmental Specification 549 will be ready for inclusion in project Specification Package by July 1, 2011.

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