Minnesota Department of Transportation
Engineering Services Division
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Technical Memorandum

To: **Electronic Distribution Recipients**

From: **Mark Gieseke, P.E.**
Assistant Commisioner (Acting), Engineering Services

Subject: Use of Geo-Synthetic Reinforced Soil- Integrated Bridge System (GRS-IBS) Abutments

Expiration

This Technical memorandum will expire on February 26, 2025 unless superseded prior to that date.

Implementation

Apply guidance contained herein on all new and ongoing Trunk Highway projects and State Aid projects. Local road authorities are encouraged to adopt similar guidelines. This guidance and its instructions are effective immediately.

Introduction

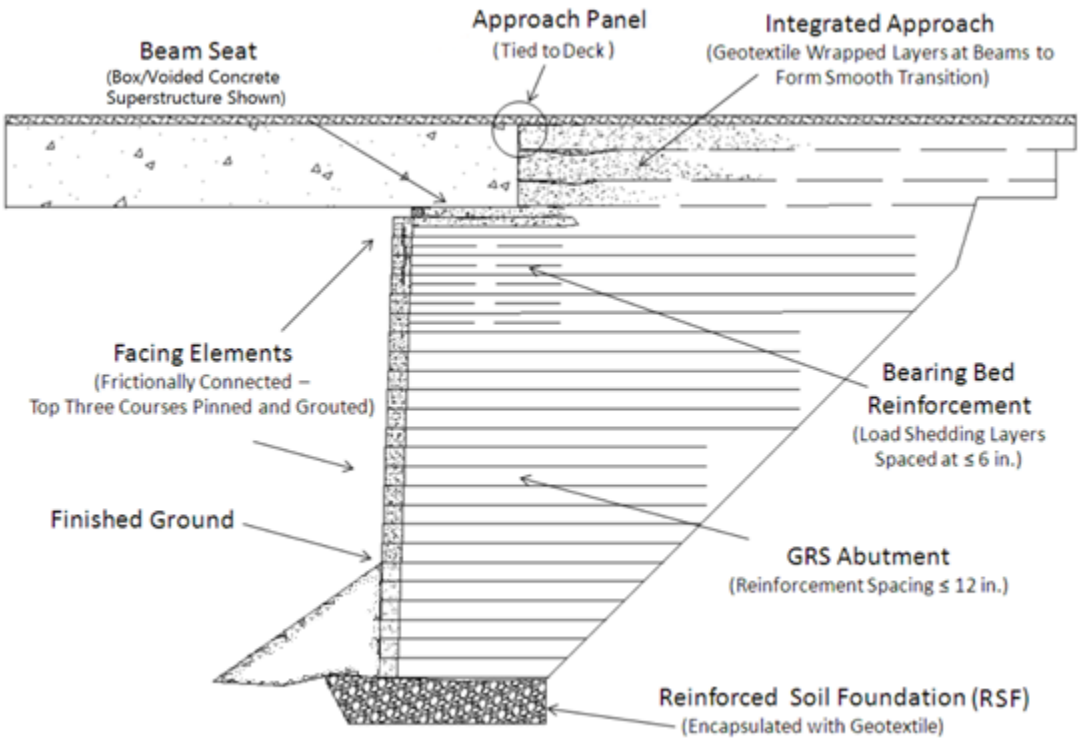

Figure 1: Typical GRS-IBS Cross Section

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GRS-IBS abutments are alternative foundation systems that may be used in lieu of conventional concrete abutments supported on spread footings. GRS-IBS abutments consist of closely spaced alternating layers of compacted fill and geosynthetic reinforcement to provide support for the bridge superstructure. Three main components make up the GRS-IBS: the reinforced soil foundation (RSF), the geosynthetic reinforced soil (GRS) abutment, and the integrated approach (See Figure 1). GRS-IBS technology was developed by the FHWA to help reduce bridge construction time and costs. Since 2010, over 200 bridges in 44 states have been constructed using GRS-IBS abutments. The best way to become familiar with GRS technology, design, and construction is to visit the following FHWA websites.

- FHWA Every Day Counts (EDC)-3: Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS): https://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/grs-ibs.cfm
- FHWA GRS-IBS FAQs: https://www.fhwa.dot.gov/innovation/everydaycounts/edc-3/grs-ibs_faq/
- FHWA GRS-IBS Interim Implementation Guide: https://www.fhwa.dot.gov/publications/research/infrastructure/structures/11026/11026.pdf
- Sample Guide Specifications for Construction of GRS-IBS: https://www.fhwa.dot.gov/publications/research/infrastructure/structures/12051/12051.pdf
- GRS-IBS Synthesis Report: https://www.fhwa.dot.gov/publications/research/infrastructure/structures/11027/11027.pdf

Purpose

The purpose of this document is to provide information and guidance to evaluate the applicability of GRS-IBS abutments for Trunk Highway and State Aid bridge projects.

Guidelines

GRS-IBS abutments may be considered for Trunk Highway and State Aid bridge projects with prior approval from the State Bridge Design Engineer. Prior to seeking approval from the State Bridge Design Engineer, evaluate the bridge site for GRS-IBS abutments by ensuring that the site limitations listed below are satisfied.

The list is based on the review of several other state DOTs that have successfully established their own GRS-IBS abutment selection criteria, Minnesota's past GRS-IBS experience, and FHWA national experience with GRS-IBS abutments.

GRS-IBS Site Limits:

Consider the use of GRS-IBS abutments only for bridges:

1. That carry a maximum of 2 lanes of low-volume vehicular traffic on a local roadway **OR** carry only bike and pedestrian traffic. Low-volume vehicular traffic is defined as an AADT of less than 400 vehicles/day using the 20 year forecast volume;
2. Over local roadways or TH routes, standing water (velocity = 0 fps), or bike and pedestrian paths;

3. With skews less than or equal to 20 degrees;
4. With single spans less than or equal to 100 feet in length;
5. With abutments heights less than or equal to 20 feet measured from top of finished ground to top of beam seat;
6. Where the ground slope in front of the abutment is no steeper than 1V:2H;
7. At sites with an in-place soil pH of 5 to 9; and
8. The foundation report has been issued by or reviewed by the MnDOT Foundations Unit and has been approved as a site where GRS-IBS may be considered.

GRS-IBS Design Limits:

1. Place the bottom of the GRS abutment to assure a minimum of 3 feet soil cover above the top of the reinforced soil foundation (RSF);
2. If bedrock is encountered, key RSF into bedrock 6"-12" based on rock quality and erodibility;
3. When the bridge is located over standing water, ensure the bottom of the facing element of the GRS abutment is above the 100 year flood plain;
4. Ensure the abutment width to height ratio is not less than 1.1. Width is measured from outside face of wingwall to outside face of wingwall along the front face of abutment and height is measured from the bottom of facing element to top of roadway;
5. Orient the front face of abutment to front face of wingwall angle so that it is not less than 70 degrees (See Figure 2);

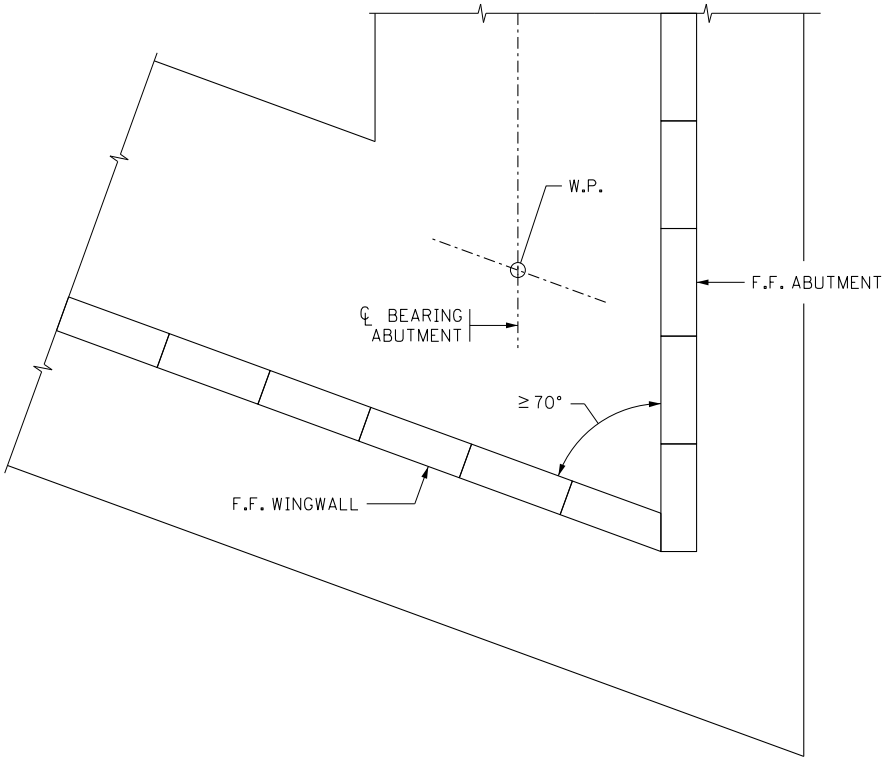

Figure 2: Abutment to Wingwall Angle

6. Use Precast Modular Blocks (PMBs) for facing elements, found on the MnDOT Approved/Qualified Products lists titled "Prefabricated Modular Block Walls" or "Prefabricated Modular Gravity Block Walls" (See https://www.dot.state.mn.us/products/walls/index.html for more information);
7. Require virgin backfill soil and granular materials that have a pH of 5 to 9;
8. Limit the vertical strain in the GRS abutment to 0.5% and the maximum lateral strain to 1.0%. Refer to the FHWA GRS-IBS Interim Implementation Guide for further information on how to calculate the vertical and lateral strain;
9. Ensure angular distortion between abutments is less than 0.008 radians (angular distortion equals difference in total settlements between abutments over the span length). Total settlement for each abutment should be listed in the foundation report. Calculate the angular distortion for each abutment by assuming that the abutment has settled completely and that the opposite abutment has no settlement;
10. Limit the Service I bearing stress on the beam seat to less than or equal to 4,000 psf;
11. Design and construct GRS-IBS abutments in accordance with the FHWA GRS-IBS Interim Implementation Guide, except as noted in this memorandum;
12. Design GRS-IBS abutments using Load and Resistance Factor Design (LRFD) methodology with latest LRFD resistance factors published by the FHWA;
13. Follow the requirements for utilities near MSE walls found in the MnDOT LRFD Bridge Design Manual except that no utilities are permitted within Zone 5 without approval from the State Bridge Design Engineer; and
14. Include a courtesy technical review of the GRS-IBS abutment designs and plan details by the FHWA. For more information on the FHWA technical review process, visit the FHWA website at https://www.fhwa.dot.gov/resourcecenter/technical-assistance.cfm .

Wingwall alignment can be parallel, flared or perpendicular to roadway. Parallel wing walls allow the reinforcement to run continuous from wing wall to wing wall, and are therefore preferred.

Questions

Any questions regarding the technical provisions of this Technical Memorandum can be addressed to the following:

Joseph Black, Structural Wall Engineer, MnDOT Bridge Office, Contact Number: **(651) 366-4485**

Any questions regarding publication of this Technical Memorandum should be referred to the Design Standards Unit, DesignStandards.DOT@state.mn.us. A link to all active and historical Technical Memoranda can be found at http://techmemos.dot.state.mn.us/techmemo.aspx.

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