Research Summary

Geosynthetic Reinforced Soil for Bridge Approach Slab Support

WHAT WAS THE RESEARCH NEED?

The United States (US) has approximately 600,000 bridges among which 25% (~150,000) suffer from bumps at their ends and costs about $100 million/year for the US Departments of Transportation (DOTs) to repair (Briaud, 1997). Identifying the causes of these bumps and feasible solutions is a very challenging task because of the many factors involved in the problem, such as soil embankment properties, bridge-to-highway joints, type of bridge abutment, compaction methods, and type of highway pavement. The approach slab is prone to an inevitable amount of differential settlement since the bridge abutment is usually constructed using deep foundation systems that exhibit negligible settlement, while the compacted layers of highway embankment would settle.

WHAT WERE THE RESEARCH OBJECTIVES?

This project took a comprehensive design method to increase the rigidity of the approach slab coupled with soil/backfill material reinforcement to increase soil/backfill material bearing capacity in a target support area to spread the load and minimize the settlement. The project also addressed retrofitting current bridges where a robust construction using precast slabs is the favorite choice due to fast-track execution of construction to minimize impact on traffic.

WHAT WAS THE RESEARCH APPROACH?

The following tasks took place:

Project Number:
RES 2019-22

TDOT Lead Staff:
Kathleen McLaughlin

Principal Investigator(s):
Dr. Khalid Alshibli | PI
University of Tennessee
Knoxville

Project Term:
December 2018 to February 2022
1. Reviewed TDOT requirements for acceptable backfill materials and guidelines for bridge abutments and approach embankments.
2. Performed a comprehensive 3D Finite Element (FE) analysis to better understand the interaction between the approach slab and the supporting backfill material.
3. Developed detailed engineering drawings for the design of approach slab, backfill material, joints, drainage, erosion control, and soil reinforcement for different types of embankments used.

WHAT WERE THE FINDINGS?

- The effective depth of geogrid reinforcement reaches 2×B below the sleeper slab, where B is the width of the sleeper slab.
- Tensile strain along the geogrid layers is significant within a distance of 2×B surrounding the sleeper slab in the traffic direction.
- The geogrid manifests a peak tensile strain underneath the center of the sleeper slab when it is placed between a depth of 0.75 and 1.5×B below the sleeper slab, whereas two peak strains occur toward the sleeper slab sides when the layer is placed below 1.5×B or above 0.75×B.
- An optimum design would require reinforcing the effective depth (2×B) with five layers of geogrid equally-spaced at 0.33×B.
- The benefits of geogrid inclusion become less significant when B increases.
- The Ultimate Bearing Stress of the Sleeper Slab (UBSS) of a preliminary design proposed by the TDOT can be improved by 30% when rearranging the geogrid reinforcement in a way that includes one additional layer but extending the reinforced depth of soil to be at least 1.25×B.
- The settlement at both sides of the H/S joint was almost the same under service loads for the TDOT retrofit and recommended designs, which suggests no sudden change in elevation (bump) for crossing motorists.

IMPLEMENTATION AT TDOT

Figure 2-13 in the report body presents the adopted design which is easy to implement for new construction and for repairing approach slabs for bridges in service. The proposed design suggests replacing soil embankment underneath the approach slab with 4 biaxial geogrid layers (Tensar Biaxial BX1200 or equivalent) between 9-inch-thick lifts of openly-graded aggregate and a layer of woven polypropylene geotextile (Propex GEOTEX-315ST or equivalent) to separate the embankment clay from the reinforced aggregate fill. The geogrid layers are equally-spaced within a depth of 2×B below the strip footing, where B is the width of the footing.

MORE INFORMATION