Mechanical Stabilization of Unsuitable Subgrade Soils During Interstate 95 Lane Widening

Presented to:
Geotechnical, Geophysical, and Geoenvironmental Technical Transfer Conference
April 9, 2019
Cary, NC

Bryan C. Gee, P.E.
Eric M. Klein, P.E., D.GE., F.ASCE
Gregory K. Goins, P.E.
William T. Maier
Project Background

• The Maryland Transportation Authority (MDTA) is responsible for constructing, managing, operating, and improving the State’s toll facilities

• MDTA currently has eight toll facilities: 2 turnpikes, two tunnels, and four bridges

• MDTA completed this project as part of a multi-year, multi-phase project to add Express Toll Lanes (ETLs) to Interstate 95, providing significant congestion relief in one of the most heavily-trafficked corridors in the United States

  • Two ETLs in each direction
  • Eight existing General Purpose Lanes maintained
  • For the subject phase of the project, ETLs and ETL exit ramps were located in the center of the right-of-way

• The northernmost design contract was for the Interstate 95 / MD 43 interchange
Project Location

[Map of Baltimore area with a red circle marking the project location]
Site Conditions

- Northbound ETLs were in the area of the northbound shoulder and embankment from the original construction in the 1960s

- In the project area, unsuitable material extended 1.8 m (6 ft) deep or more

- Extent of unsuitable subgrade soils was not initially known in design – problem was assumed to be isolated, which had been true during earlier phases of the project

- CBR values varied:
  - Laboratory CBR values were typically over 10
  - Much weaker areas, with measured CBRs of 0.1 to 0.5, were present along the entire project
  - In this area, CBR values were verified using a dynamic cone penetrometer (DCP)

- Contract documents allowed lime/fly ash treatment for larger areas of unsuitable soils – this had not been used to date on the project, and the project schedule could not accommodate this solution so close to completion

- Default solution was to remove and dispose of 1.8 – 2.5 m (6 - 8 ft) of unsuitable material and replace it with suitable fill
Issues and Constraints

- Construction area was between existing active General Purpose Lanes and ETL exit ramps in center of right-of-way
- Limited access points to remove and import material
- ETL exit ramps supported by Mechanically Stabilized Earth structures appx. 7.6 m (25 ft) tall
- Active travel lanes immediately adjacent to area to be excavated – depth would require excavation support
- Extremely limited room for excavation equipment
- Required construction sequence with complete undercutting would delay completion past scheduled opening date
- Increased cost
Solution Development

- Initial design was based on developing an effective section for the haul road into the site.

- Giroud-Han design methodology was used for initial design of subgrade stabilization section.

- Pavement section design was verified using AASHTO 1993 methodology via SpectraPave4-PRO software.

- Two test strips were built:
  - Two 305 mm (12 in) layers of graded aggregate base (GAB), two layers multi-axial geogrid.
  - One 610 mm (24 in) layer of No. 2 stone, choked with GAB at surface, one layer multi-axial geogrid.

- Second test section was used for haul road and results were used in final design.

- Design also considered variability in soil strength across the site, ground water, and drainage.
Final Design Approach

• Layer thicknesses, number of layers, and number of geogrid layers chosen to maintain full confinement of aggregate

• Geogrid aperture sizes matched to aggregate gradation

• Open graded aggregate used in lower layer to provide capillary break

• Non-woven geotextile used above the capillary break to maintain separation and prevent contamination of upper aggregate layer

• Drainage details modified to accommodate pavement section
Final Design Approach

Original Design

• 12 in. HMA
• 12 in. GAB
• 12 in. sand subbase with separation geotextile
• Excavate and replace all unsuitable soil

Final Design

• 12 in. HMA
• 12 in. GAB
• 24 in. MSL
• Remove soil only as needed
Final Design Section

- Choke #2 with GAB
- Large Aperture, Multi-axial Geogrid
- Standard Aperture, Multi-axial Geogrid
- Non-woven Geotextile where #57 contacts soil
- Non-woven Geotextile
- SUBGRADE

HMA
GAB
24" #2
6" #2
#57
Results

- MSL design successfully addressed unsuitable soil issues
- Project schedule was maintained
- Significant cost savings over conventional solution
- Pavement design was enhanced using MSL in compliance with AASHTO 1993 methodology
Acknowledgements

The authors gratefully acknowledge the cooperation and support of the project participants:

- Maryland Transportation Authority
- Tutor Perini
- RK&K Responsive People | Creative Solutions
- Tensar