JOINT TRANSPORTATION RESEARCH PROGRAM

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Quality Assessment of Geogrids Used for Subgrade Treatment

Introduction

The Indiana Department of Transportation (INDOT) has been using geogrid reinforcement for improving weak subgrades because in many cases use of geogrids and replacement of a portion of the weak soil with aggregates is a faster and more effective solution than chemical treatment. Geogrids provide reinforcement by laterally restraining the subbase, thereby improving the bearing capacity of the pavement system and decreasing the shear stresses on the subgrade soil. However, INDOT engineers have reported that contractors tend to choose the cheapest geogrids available on the market, barely meeting the few requirements included in INDOT specifications.

In section 918 of the INDOT standard specifications (Soil Fabrics), the requirements specified for geogrid material properties are the minimum ultimate tensile strength, tensile modulus, aperture size and open area of geogrids. The required tensile modulus and tensile strength of geogrids lie within very broad ranges. Unlike other DOTs (such as those in Kansas, Ohio, West Virginia, and Kentucky), INDOT does not specify minimum junction strength values for geogrids. Geogrid junction strength is an important factor that influences the long-term performance of pavement subjected to repeated traffic loads, and therefore minimum requirements for it should be included in specifications.

In this study, large-scale direct shear tests were performed to evaluate the efficiency of geogrid reinforcement placed between an aggregate layer (#53 aggregate; classified as poorly graded gravel) and a subgrade soil layer (glacial till; classified as clay loam). Based on the test results, correlations between a geogrid reinforcement efficiency parameter and properties of geogrids were investigated.

Findings

Large-scale direct shear tests were performed on soil-geogrid-aggregate samples. The aggregate and subgrade soil layers were compacted at their optimum moisture contents (OMC) to relative compaction values of 93–98%. ($R_{\text{soil}} = 94\text{--}98\%$ and $R_{\text{aggregate}} = 93\text{--}96\%$). Eight brands of biaxial geogrids were selected and tested in this study. Values of the average peak interface shear strength coefficient α_{peak} varied from 0.96 to 1.48, depending on the brand of geogrid tested.

Correlations between average α_{peak} and properties of the geogrids tested were explored. The optimum aperture area was found to be 825 mm² (1.28 in²), while the optimum normalized aperture area, defined as the ratio of the square root of the geogrid aperture area to the D_{50} of the aggregate, was equal to 4.7. The average peak interface shear strength coefficient increased with increases in the junction strength of the geogrids. However, no significant correlation was found between the geogrid tensile strength at 2% strain and average α_{peak} values. Thus, based on the large-scale direct shear tests results, the geogrid aperture area and junction strength are the parameters that determine the efficiency of the soil-geogrid-aggregate system.

The relationship between the average peak interface shear strength coefficient and geogrid property requirements of the specifications of Indiana, West Virginia, and Kentucky DOTs were also compared. With respect to the aperture area, INDOT requires a much smaller aperture area than the other DOTs, with the requirements of the other DOTs being closer to the optimum aperture area determined in this study. The tensile strength values of the tested geogrids satisfy the requirements of all DOTs. The geogrid junction strength and the average peak interface shear strength coefficient show a strong correlation.

However, currently, INDOT specifications do not have a requirement for geogrid junction strength.

Based on the correlation found in this study, an aperture area requirement of 825 mm² (1.28 in²) and a junction strength requirement of 11.5 kN/m (788 lb/ft) were suggested as preliminary guidelines to be implemented by INDOT. The recommendation is restricted to the use of geogrid for subgrade reinforcement (Type IV of INDOT specifications 207.04) with No. 53 aggregate.

Large-scale direct shear tests were also performed at moisture contents 2% and 4% higher than the OMC on samples compacted to relative compaction values of 94–96% ($R_{\text{soil}} = 95\text{--}96\%$ and $R_{\text{aggregate}} = 94\text{--}95\%$). The peak interface shear strength coefficient for tests performed at a moisture content 2% above the OMC was 1.49, while for tests performed at a moisture content 4% above the OMC, α_{peak} was equal to 1.99.

Implementation

This research found that the aperture area and junction strength of geogrids influence the efficiency of subgrade reinforcement systems. Based on the results of large-scale direct shear tests performed in this study, we proposed an aperture area requirement of 825 mm² (1.28 in²) and a junction strength requirement of 11.5 kN/m (788 lb/ft). The recommendation is restricted to the use of geogrid for subgrade reinforcement (Type IV of INDOT specification 207.04) with No. 53 aggregate. For the geogrids tested, no correlations were observed between the average peak interface shear strength coefficient and other geogrid properties, such as tensile strength at 2% strain, tensile modulus, and ultimate strength. The effects of the aggregate and geogrid type and density and moisture content of the subgrade soil were also investigated in this study. An implementation project would provide valuable insights on the pullout resistance of geogrids in the field.

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