

Tech Brief

Resilient Modulus Properties of New Jersey Subgrade Soils

FHWA-NJ-2000-001-TB

September 2000

HERE'S THE PROBLEM

It is necessary to effectively and economically design pavement systems through subgrade response. However, previous methods for testing the characteristics and behavior of subgrade soils have not effectively modeled the types of stresses experienced by the subgrade.

AND, HERE IS THE SOLUTION...

To evaluate subgrade response to various loading conditions through use of mechanistic design methods for flexible pavements which require the specification of subgrade resilient modulus.

BUT, HOW CAN IT BE DONE?

By developing a laboratory testing program to determine the resilient modulus of typical New Jersey subgrade soils.

THESE ARE OBJECTIVES OF THE STUDY...

- To determine the resilient properties of subgrade soils specific to combined residual/transported soils of New Jersey, and determine the proper predictive procedures for determining their value.
- To evaluate the effect of varying moisture content on the resilient modulus properties of New Jersey subgrade soils.
- To provide a statistical model to predict the resilient modulus of different soil types under varying confining pressure and deviatoric stress schemes and moisture contents.

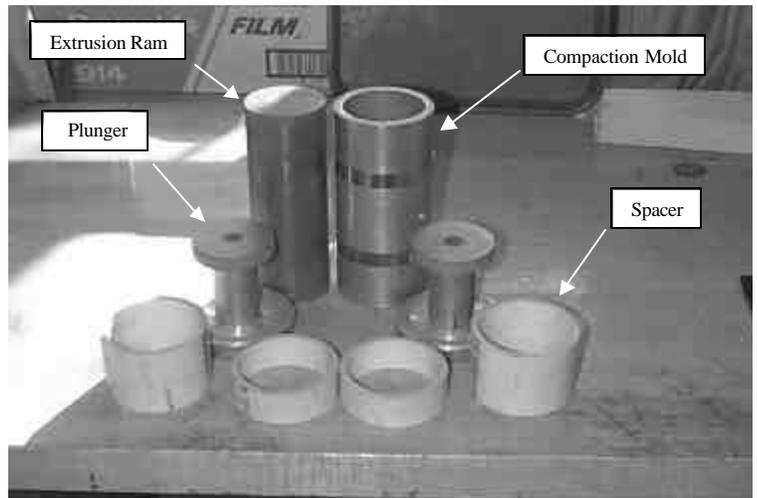


AND, HERE'S WHAT WE DID...

The first activity of this project was a comprehensive literature search and understanding of the current resilient modulus test.

Six soils were chosen for testing in the experimental program. They were divided into two types- coarse and fine grained.

This project involved laboratory testing to determine the effect of moisture content on the compaction of granular and cohesive subgrade soils. The change in water content on fine-grained soils changes the effective stresses as a result of changes in soil suction, which accompany changes in soil water content in unsaturated soils. When the water content was decreased, the suction, along with the effective stress and soil stiffness generally increased until very low water contents were reached.



A sensitivity analysis was conducted via two different pavement section schemes; a full-depth asphalt pavement and a conventional pavement section. The analysis was conducted to determine if the resilient modulus of the subgrade had a dramatic effect on the asphalt layer thickness, so the pavement reach 2 million loading repetitions from an 18 kip axle vehicle before fatigue loading would begin. The subgrade was found to have a more pronounced effect on the asphalt layer thickness when the subgrade modulus was lower.

A statistical model was adopted to develop soil parameters for each material tested. This model reflected that resilient properties of a residual subgrade soils were determined with respect to changes in parameters that most influenced stiffness characteristics of the soils. These were found to be confining pressure, deviatoric stress and initial or compacted water content.

The statistical model was verified by predicting the resilient modulus with similar properties as determined by peers.

A database was compiled to provide resilient modulus values for use in New Jersey mechanistic pavement design. The sensitivity analysis concluded that the design engineer should exercise extra caution when designing pavement sections that have a subgrade resilient modulus less than 10,000 psi.

CONCLUSION...

The changes in resilient values were more pronounced for coarse, granular type soils under varying confining pressures as compared to the fine material soils tested. Changes in confining pressure are more influential on the intergranular stress distribution of coarse cohesionless materials than fine materials. Coarse soils assumed a very rigid structure at the dry side of the optimum with a resulting increase in resilient properties compared to the finer soils.

A comprehensive statistical, predictive model was identified for estimation of resilient modulus values of tested soils. The calibrated model accurately predicted the resilient properties of a specific material type at any given depth.

A design procedure provided a guideline for pavement designers on how to determine the design, effective roadside resilient modulus for subgrade soils.

WHAT IS THE NEXT STEP?

Additional work is needed to better understand the phenomena of resilient properties accompanied by permanent deformation under the given American Association of State Highway Transportation Officials (AASHTO) loading regime. A modification to the resilient modulus test specification should be considered to evaluate the effect of pore pressure on the resilient modulus properties of soils. In addition, work in the area of correlating the resilient properties of soils to nondestructive field evaluation of subgrade stiffness, using the Seismic Pavement Analyzer (SPA) or Falling Weight Deflectometer (FWD) would be beneficial in determining subgrade properties under vehicular loads.

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A final report is available online at <http://www.state.nj.us/transportation/research/research.html>

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NJDOT Research Report No: FHWA-NJ-2000-001