Huang, Wen-Chao, Ph.D., Purdue University, August 2007. Numerical modeling and probabilistic analysis of subgrade improvement using geosynthetic reinforcement.
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During a recent survey on geotechnical problems that create difficulty for roadway engineers, the issue of soft/wet subgrades was mentioned in every response provided by construction and maintenance units. Currently, common methods used in projects to address wet and soft subgrade conditions include excavation-substitution, soil improvement with chemical additives, and mechanical reinforcement with geosynthetics. The study in this research focuses on mechanical reinforcement with geosynthetics, especially with geogrid reinforcement.

The methodology in this research employs numerical analysis for obtaining the model responses. The base numerical model is verified through several previous studies. A number of parameters with an applicable range of values are used in the parametric studies in order to cover practical and realistic system response. The subgrade soil properties were found to be the most critical parameter in the whole system. The equivalent subgrade CBR concept was therefore adopted for the main design recommendations in this research. With geogrid reinforcement and aggregate as the fill material, the overall subgrade strength increased and thus an equivalent enhanced subgrade CBR was obtained. This design recommendation could be integrated into traditional design approaches.

Due to the uncertainties of the undrained shear strength of subgrade, as the undrained strength gets smaller beyond critical values, failure may occur. In this research, probabilistic methods were applied to the design recommendations suggested in this research, as well as two other design approaches, the Giroud and Han method and the Milligan method for comparison in terms of reliability assessment. Since the variation of subgrade undrained shear strength along a roadway axis can also alter the performance of roadways, spatial variability could be considered by using an auto-correlation distance. Having an auto-correlation distance allows the assumption that the behavior beyond the auto-correlation distance is independent, and by using mathematical equations, the reliability assessment with spatial variability therefore could be evaluated.