GENERAL STATEMENT ON THE EFFECT OF VARIABILITY OF SUBGRADE ON PAVEMENT LIFE

By The
TPI GROUP

December 14, 1999

It is well known that subgrade strength has a predominant influence on the long-term performance of the pavement layers that are built upon it. By the same token, the variability of subgrade strength also effects the long-term performance of the pavement. For example, if one area of a subgrade has a lower stiffness than an adjacent area, it will be subject to larger deflections under heavy traffic loads. Since the area of lower subgrade stiffness allows more deflection in itself, this leads to varying deflection in the overlying pavement layers under traffic loads. The variation in the deflection along the pavement therefore leads to variations in the accumulation of damage along the pavement, both in the layers and at the pavement surface. The damage is manifest in terms of permanent deformation in any of the layers, in cracking of the pavement surface and eventually in terms of an uneven pavement surface. This uneven surface not only causes a rough ride for passengers and freight, but it also induces higher dynamic loading to the pavement from traffic, especially from the heavy freight vehicles. The higher dynamic loadings thus induce accelerated damage to the pavement in a cycle that is self-repeating.

Considerable effort is applied to the design roads that feature optimal combinations of the material properties of base, subgrade and pavement surface (as well as geometrical characteristics). However there far too often exists a discrepancy between the performance that is anticipated (predicted) by the design and the performance actually observed in practice. This discrepancy is largely believed to be due to a lack of compensation in the laboratory, and in the design models, for local variability that exists at a particular construction area. Although considerable effort is applied during construction to keep variability in compaction consistent within a percentage of a target design value, it is not known to what extent acceptable levels of this variability effect overall service lifetimes. Furthermore, a complete onsite compaction measurement of the base, subgrade and pavement is needed to obtain and accurate representation of variability along the entire road structure. Therefore, a nondestructive method of determining variability of all elements of the road structure is required to identify major uncertainties influencing pavement design and pavement life estimates.

The portable device, which is the subject of this study, is believed to be the solution to easily determine, not only the stiffness of the pavement layers, but also the variability of the stiffness of these layers along the roadway. While this device alone may not be capable of measuring stiffness to the depths needed for a full evaluation, it may be used in combination with other measurement devices, such as the falling weight deflectometer (FWD) or the heavy rolling load deflectometer (RLD).

Pavement layer deflection and stiffness data collected in this Pooled Fund Study through the use of various nondestructive testing (NDT) devices, will be used to calculate pavement strength structural variability and to furthermore determine the significance of these parameters to reflect remaining pavement life. The analysis will include different levels of subgrade strength and subgrade strength variability. Consideration will be given to varying environmental conditions throughout the pavement lifetime, varying traffic volumes, different axle configurations, suspensions, tires and dynamic loads. Pavement lifetimes can be estimated using available pavement performance models, vehicle dynamic models and economic cost models. Other related issues can be addressed in this study, given some additional information, to that developed above: (a) The separation of costs attributable to heavy vehicle associated damage from that due to damage from environmental effects only - this is essential to achieving the fair and equitable allocation of user charges for heavy trucks. (b) Development of a pavement structural variability procedure for use in pavement design.