A Simple Method to Evaluate Subgrade Resilient Modulus for Pavement Overlay Design using FWD Parameters

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Abstract

Subgrade soil characterization expressed in terms of resilient modulus (M_R) is one of the most important parameters in pavement overlay design with Falling Weight Deflectometer (FWD) data. The subgrade M_R can be determined by several methods such as laboratory testing, back calculation with FWD data or estimation from correlation studies. In order to obtain M_R from laboratory testing, a dynamic triaxial testing equipment is required. But in Sri Lanka, only static triaxial testing apparatus is available, hence we cannot obtain M_R from laboratory testing. Empirical relationships with California Bearing Ratio (CBR) is the most widely used method to estimate subgrade M_R, since CBR is not an expensive and easy to obtain parameter. Although it is convenient to obtain M_R from these simple empirical relationships, these relationships are not tested for the soil condition in Sri Lanka, hence the results obtained may not be accurate.

AASHTO 1993 guide provides an equation to calculate resilient modulus from FWD data, however it not widely used because Engineers always prefer to use simple CBR-M_R empirical relationships to obtain subgrade M_R. It is very important to analyse FWD deflection data obtained from all the sensors, since it provides valuable information of the pavement subgrade condition. But one of the problems in the AASHTO equation is, it only uses one deflection sensor (D300 or D450), to calculate M_R in order to satisfy the minimum distance criteria. Hence the non-linearity characteristics of subgrade is not identified in AASHTO method.

Hoak and Emery (7) reported that in the deflection basin obtained from FWD data, at relatively large distances (generally more than 600 mm up to 900mm) from the loading plate, all compressive strain will occur only in the subgrade. Also they have reported that deflections obtained from sensors D300 to D900 will represent the combined effect of both subbase layer and subgrade.

When the pavements are selected for rehabilitation work, from the test pit investigation, it can be observed that it is difficult to distinguish between subbase material and subgrade of those aged pavements. So that it is not unreasonable to consider deflections obtained from sensors D300 to D900 in order to calculate a representative M_R for the aged pavement sections. Two factors, central deflection (D0) and subgrade non-linearity characteristics are considered, to decide a one M_R from D300 to D900 as the representative value.

Measured central deflection (D0) also provides an indication of the condition of the subgrade. Hoak and Emery (7) reported that of all structural layers of the pavement, contribution of subgrade to the central deflection (D0) is about 70%. M_R is calculated from the equations proposed by Boussinesq and the method proposed in Transit New Zealand Report No. 117 (6) is used obtain non-linearity characteristics of calculated M_R.

This study proposes an improved method to calculate subgrade resilient modulus (M_R) while analysing condition of the subgrade and its non-linearity characteristics. The results are compared with the resilient modulus obtained from AASHTO method.

Key words: FWD, Subgrade, Resilient Modulus

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