Theoretical Analysis of Structural Behavior of Road Test Flexible Pavements*

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ABRIDGMENT

•THE MAIN objective of this study is to present a rational, mechanistic interpretation of measurements and observations made on flexible pavements in the AASHO Road Test and other similar experimental investigations. The analysis is centered around stresses and deflections of the pavement system, with due attention to the mechanisms of pavement failure and associated phenomena. The paper is divided into five chapters.

Chapter 1 consists of a comprehensive critical review of the existing theories of structural behavior of flexible pavements. For the purpose of discussion all the theoretical methods of pavement design are divided into two major groups: (a) ultimate strength methods, and (b) elasticity methods. Advantages and shortcomings of both groups as well as of individual better-known methods of each group are discussed in detail.

Chapter 2 contains selected data on the structural behavior of the AASHO Road Test flexible pavements. The data are assembled in accordance with the three major objects of analysis, namely: (a) stress distribution in the pavement system, (b) resilient pavement deflections, and (c) cumulative plastic deflections and structural failure of pavements.

Chapter 3 presents available data on index properties, strength and deformation characteristics of the pavement materials and the subgrade. Chapter 4 is an analysis of all the assembled data, subdivided in a manner similar to that used in Chapter 2. Major conclusions are outlined in Chapter 5.

Vertical stress distribution data show that stresses vary with pavement temperature and degree of saturation of the subgrade, as well as with vehicle speed. Generally, the stresses are lower at lower temperatures, at lower degrees of saturation, and at higher vehicle speeds. At creeping vehicle speeds, and over the major part of the year, excepting frost periods, vertical stresses follow the patterns predicted by the Boussinesq theory for a homogeneous solid. Under loads they are considerably higher than those predicted by the Burmister theory of a layered solid.

Deflection data indicate that the deflection basins have a very limited extension and are not at all comparable in size to those predicted by the layered solid theories. This finding is in agreement with previous observations as well as with the stress measurement results. It is indicative of a limited load-spreading ability and a limited slab action of conventional bases and subbases.

Structural failure data are analyzed with emphasis on the mechanics of rutting. It is found that the rutting of AASHO Road Test flexible pavements was caused primarily by distortion within the pavement structure, as long as the subgrade stress remained below a critical level. This finding justifies the selection of the limiting subgrade stress as a design criterion.

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It was further concluded that the phenomenon of structural failure of flexible pavements is governed by the relative resilience or compressibility of the subgrade soil with respect to the shear strength of the pavement structure. Depending on the thickness and strength of that structure with respect to the subgrade, punching shear failure or general shear failure may occur in extreme cases.

In the remainder of Chapter 5 implications of the findings of this study with respect to existing design procedures are discussed and recommendations for future research are given. The need for more fundamental research in the area of mechanics of flexible pavements is stressed. It is suggested that a general design method for flexible pavements must include consideration of both elastic and plastic phenomena.