PREDICTION OF HIGHWAY PAVEMENT PERFORMANCE USING HISTORICAL DATA.

Mfinanga, D.A. Yokota, H. Deguchi, C. Miyazaki University.

1. Preface:

A good Pavement Management System (PMS) requires an accurate and efficient pavement performance and prediction model. Knowledge of the performance trend of the pavement is critical to efficient and economical management of pavements. A procedure has been developed to estimate the service life of a flexible pavement based on FWD data and the AASHO Road test performance models(1) modified to Japanese situation. The use of deflection data stems from the fact that deflection of a given pavement under a particular load serves as a better measure of the pavement's ability to survive than mere knowledge of pavement structure design since deflection reflects the strength of the embankment soil and the pavement structure as they were actually constructed regardless of how they may have been specified.

2. Prediction of pavement performance using FWD data.

2.1. Development of performance curves using AASHO results:

Pavement performance curves and equations relating benkelman beam deflection and axle load applications for different axle loads for PSI value to fall to 2.5 and 1.5 were developed by the AASHO Road Test(1). In Japan, the equivalent single-axle load (ESAL) is 5t(11 Kip), so the curves were converted to 11 Kip single-axle load curves by changing the load variable in the model. Both the American PSI and the Japanese MCI (Maintenance Condition Index) depends basically on three types of pavement distresses, rutting, cracking, and longitudinal profile. Though having different formulae, they can be regarded as representing same pavement qualities with MCI(ranging between 0 and 10) having twice the numerical value of PSI(ranging between 0 and 5). Furthermore, maintenance regulations with respect to MCI specifies that with MCI values less than 5.0, maintenance is necessary while with values less than 3.0, rehabilitation or reconstruction is of utmost importance(2), proportional to PSI values of 2.5 and 1.5 respectively. A correlation between MCI and PSI could therefore be established. Fig. 1(a)&(b) show the obtained performance curves relating 5t(11 Kip) single-axle load applications to fall and spring benkelman beam deflections respectively.

2.2. Establishing FWD-Benkelman beam deflections ratio:

While the performance curves require Benkelman beam deflection data, our method employs FWD data. A relationship had therefore to be established. The Dynamic Slab-Ground Theory, DSGT(3), developed by one of the authors, is used in calculating FWD and Benkelman beam deflections in order to find the ratio between the two. DSGT divides a pavement into two parts with a periodic load acting as shown in fig. 2. Table 1 shows the characteristic differences between FWD and Benkelman beam testing which were taken into account. DSGT calculates deflection as a function of loading frequency, temperature, Modulus of elasticity of the elastic half-space, and thickness of the slab (upper layer). Fig. 3 shows the obtained FWD-Benkelman beam deflection ratios, η, for different thicknesses, T_0 and modulus of elasticity, E_0. The values of T_0 and E_0 are automatically obtained by DSGT once the FWD deflection is known. The following equation is used to change η to 5t axle-load deflection ratio, $\acute{\eta}$:

$$\acute{\eta} = \eta(P_F/5) \quad (1)$$

where P_F is the load (in tons) used in the FWD test.

$$W_{BB} = W_{FWD}/\acute{\eta} \quad (2)$$

where W_{BB} and W_{FWD} are Benkelman beam and FWD deflections respectively.

W_{BB} is then used in figs. 1 to predict performance.

3. Conclusion:

A method has been developed to predict the performance of flexible pavements using FWD data. From FWD data, equivalent Benkelman beam data can be derived, and using performance curves or equations the performance of the pavement can be predicted. This is expected to lead into better management of pavements by planning more precisely and by optimally allocating resources at the right time and to the right pavement sections.

* We would like to extend our sincere thanks to Mr. Norio Shimomi, a fourth year student, for his part in carrying out calculations and drawing graphs.

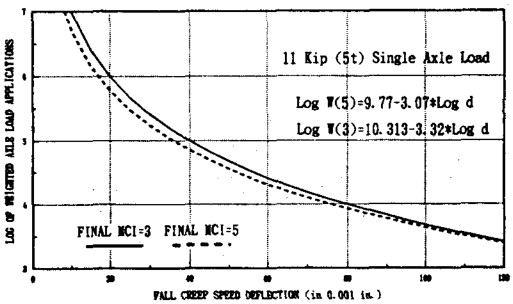

Fig. 1(a). Relationship between performance and fall Benkelman beam deflections.

Table 1. Differences between FWD and Benkelman beam testing parameters.

Testing device	Frequency (Hz)	Radius of load area (cm)
FWD	22	15.24
Benkelman beam	0.5	7

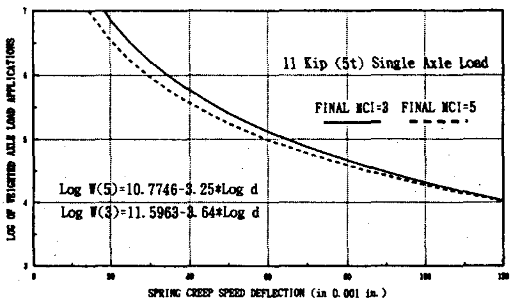

Fig. 1(b). Relationship between performance and spring Benkelman beam deflections.

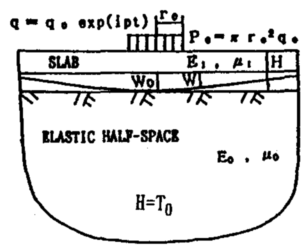

Fig. 2. Dynamic Slab-Ground Theory (DSGT) model.

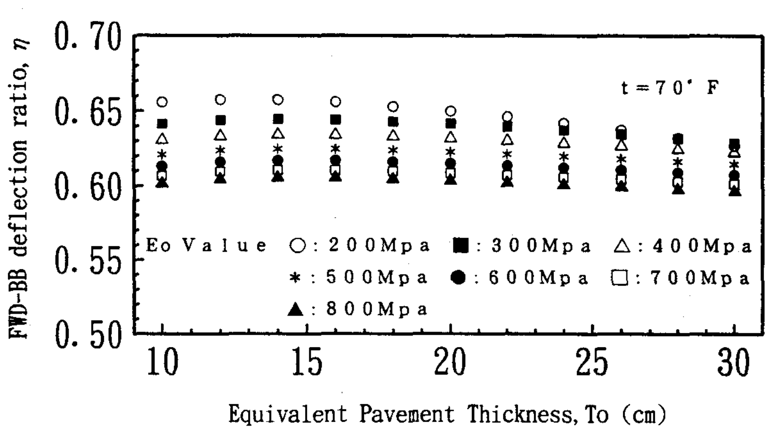

Fig. 3. FWD-Benkelman beam deflection ratios, η.

References:

1. AASHO Road Test-Report 61E. HRB, National Research Council, Washington, D.C., 1962.

2．菊川滋，猪股和義．舗装の長期修繕計画システムの開発．土木技術資料　２９－１（１９８７）

3. H. Yokota and H. Fujimoto. Dynamic Analysis of an Infinite slab on an Elastic Half-Space and its Application to Dynamic Overlay Analysis. Memoirs of Faculty of Engineering, Miyazaki University, No. 16, February, 1986.