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PREDICTION OF FLEXIBLE PAVEMENT PERFORMANCE USING FWD DATA

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1. INTRODUCTION

Performance prediction models are the most essential part of a Pavement Management System. In this paper, the prediction model was developed using AASHO Road Test data. The Dynamic Slab-Ground Theory (DSGT), developed by one of the authors, was used to convert Benkelman beam deflections to FWD deflections for the single axle load of 10tf(22Kip) used in Japan. The final curves provide a reasonable method of predicting pavement performance by relating FWD deflection and the number of axle load repetitions to Maintenance Condition Index (MCI).

2. DEVELOPMENT OF PREDICTION MODEL

The AASHO Road Test (1958-1960) established the deflection-performance relationships through a series of factorial experiments. Fig. 1 shows one of the curves for 22.4Kip single axle load. To make use of the results DSGT was used to convert Benkelman beam deflections in AASHO test into FWD deflections.

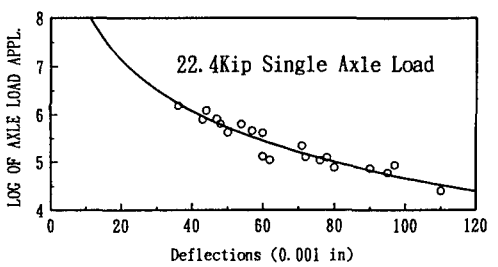

Fig. 1. Relationship between axle-load applications to PSI=2.5 and Benkelman beam deflection (AASHO).

DSGT is an analytical solution of a slab on the ground, on the surface of which a periodic load $q=q_0 exp(ipt)$ acts as shown in fig. 2. Timoschenko-type slab theory was used in developing the theory and the slab deflection, W, is calculated using the elastic modulus values of the slab and the half-space, E_1 and E_0 respectively together with the slab thickness, H. DSGT is applied to pavement

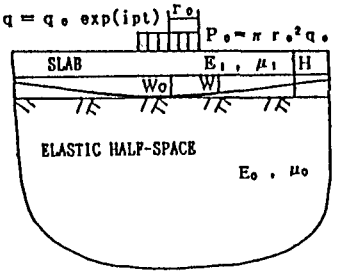

Fig. 2. Model of Dynamic Slab-Ground Theory (DSGT).

problems using the idea of a full-depth asphalt concrete pavement. In this case, pavement structures in the AASHO Road Test were converted to full-depth asphalt concrete pavements using equivalent thickness coefficients for base and subbase courses. DSGT was then used to calculate the FWD - Benkelman beam deflection ratio. To do this, DSGT program calculated FWD deflections using a loading frequency of 21.7Hz and radius of load area of 15.24cm. The values for the Benkelman beam were 0.5Hz and 7cm respectively. Fig. 3 shows the obtained η (FWD - Benkelman beam deflection ratio) against T_0 (full-depth AC thickness) for different values of E_0.

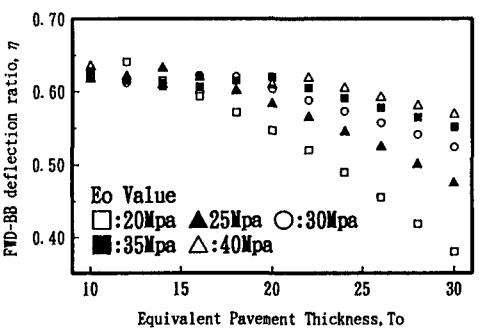

Fig. 3. FWD-Benkelman beam deflection ratios, η.

Deflection data and axle-load repetitions data to different values of PSI for the 22.4 Kip single axle load lane in the AASHO Road Test were used. The Benkelman beam deflection data was converted to FWD data using the ratio η obtained by DSGT. Very good agreement was obtained from the regression of FWD deflection and Log of load repetitions. Fig. 4, which is an equivalent of fig. 1 including other values of PSI and converted to FWD deflection, shows the obtained regression curves.

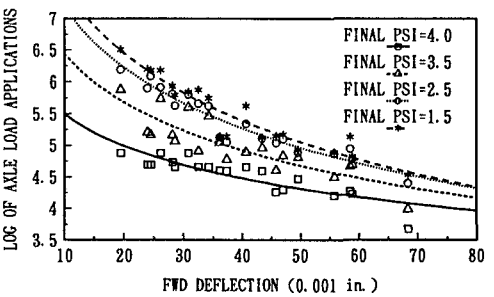

Fig. 4. Relationship between axle-load applications and FWD deflections.

The top of fig. 5 which shows the performance trend of pavements for different values of FWD deflection is obtained by tracing different FWD deflection data from a rotated fig. 4 (bottom part of fig. 5) for different values of PSI.

3. HOW TO USE THE MODEL

The performance of a pavement can therefore be estimated from fig. 5 using FWD deflection and therefore rehabilitation and reconstruction can be well fore-planned. Since an axle load of 10tf(22Kip) is used, the tire load is therefore 5tf(11Kip). All FWD deflection data obtained through other loadings should be converted to equivalent values for 5tf load before using the performance curves as follows:

$$w^* = w \times \frac{5}{P_F} \qquad (1)$$

where P_F is the load in tons used in FWD test and w is the deflection under P_F.

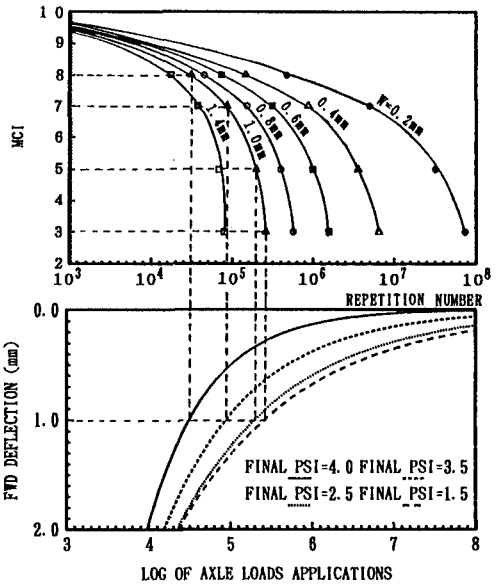

Fig. 5. Relationship between pavement performance trend and FWD deflection.

4. CONCLUSION

This paper has described a procedure to predict pavement performance using FWD deflection data as part of a Pavement Management System. Japanese pavement maintenance procedures requires that rehabilitation be carried out when the pavement MCI reaches 5.0 and reconstruction if less than 3.0. The prediction procedure can be used to predict the time when rehabilitation will be required and to estimate the overall life of the pavement which will in turn improve long-term management planning.

5. REFERENCES

National Research Council. *The AASHO Road Test Report 5*; HRB, Washington, D.C., 1962

Yokota H. and Fujimoto H.. Dynamic Analysis of an Infinite Slab on an Elastic Half-Space and its Application to Dynamic Overlay Analysis; Memoirs, Miyazaki University, No. 16, Feb. 1986