土木学会西部支部研究発表会(1996.3)

TRAFFIC LOADING EFFECTS ON PAVEMENT RUTTING

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1. INTRODUCTION

Good pavement management requires a reliable method of predicting pavement performance. Many people in the field of pavement performance have stated that the largest deficiency is the absence of good relationships between pavement distress and pavement performance. This research was initiated on the conviction that lack of understanding of the interacting effects of traffic loading and environment or age on pavement deterioration has hampered progress. It is acknowledged that pavements deteriorate with traffic, time, and environment. The aim is to model pavement deterioration as a combined process of the separate effects of traffic loading and environment. This paper introduces a small portion of the overall research.

2. METHODOLOGY

Because of the exposure to climatic cycles, pavements suffer deterioration over a period of time. Pavement age is assumed to represent the cyclic effect of environmental forces contributing to pavement deterioration. To achieve this, analysis has to be done on data from areas with same climatic conditions. Climatic data from Kyushu area, whose freeways data were used, shows that there is no significant climatic differences. By fixing age and observing traffic axle loading, the equivalent axle loads (EAL) can be assumed to represent the pure effect of traffic loading because the environmental effects have been removed. Likewise, to eliminate the effect of pavement structural strength, analysis was done on data with similar structural strengths. Pavements were divided into 4 groups of structural strengths according to equivalent pavement thickness, T_A and subgrade CBR as shown in Table 1. All credible pavement rutting data of all expressways in Kyushu for about 20 years were used.

Table 1: Pavement Structural Groups

GROUP	T_A	CBR
A	21.0 - 24.5	8.0 - 10.0
B	21.0 - 24.5	10.5 - 15.0
C	24.5 - 27.0	7.0 - 10.0
D	28.0 - 31.0	4.0 - 8.0

3. RESULTS

Since rutting has an irregular trend and since each structural group had around 2,000 data for analysis, all the data were plotted for each group and age category and the mean rut depths ($\bar{X}$, see fig. 1) for each traffic load (EAL) point were used in the analysis. The following results were observed:

(1) Fig. 1 shows a typical plot from individual road sections data for a structural group and a fixed age. There are about 30 such plots for each category and straight line regression was used to show whether rutting increases with traffic loading (EAL). In 80% of the cases rutting increased with traffic loading. This is an important outcome since it shows the effect of traffic loading alone without other factors.

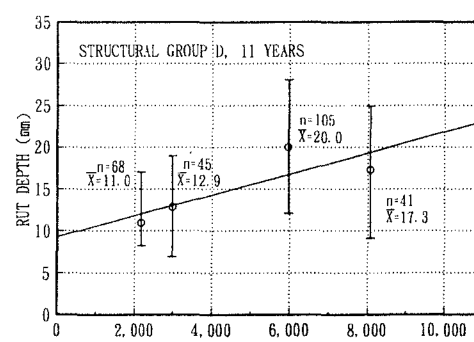


Fig. 1 Typical traffic loading vs rutting plot.

(2) Fig. 2 shows results using representative mean values. It shows that the pure effect of traffic loading, in general, follows a power function in influencing rutting;

$$RUT = a(EAL)^b \qquad (1)$$

where RUT is the rut depth and EAL is the total cumulative traffic axle loads. The power function gave the best results, r^2=0.7 on average in all categories. b is an exponent that controls the degree of curvature of the curve and has been found to strongly be correlated to pavement age and CBR. Rutting increases more in pavements in initial stages of traffic loading than in those with large cumulative traffic loading. For the same traffic loading, there is more rutting on older and weaker pavements. The effect of age (environment) and structural strength is further discussed in (3) and (4).

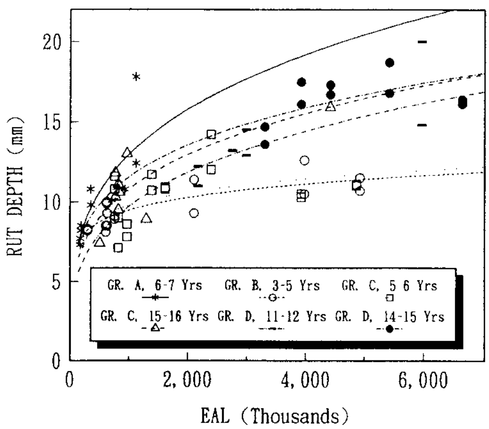


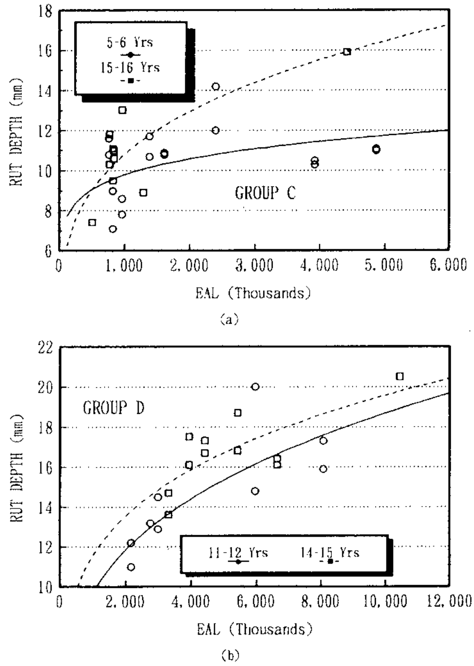
Fig. 2 Trend of the effect of traffic loading on rutting.

(3) Looking at figs. 3 (a) and (b), by comparing the two curves for pavements with different ages, it is clear that older pavements have more rutting, indicating environmental influence.

(4) From results, it is conceived that both the effects of traffic loading and environment are larger on weaker pavements (thinner pavements with weaker subgrades) than in stronger pavements. Fig. 4 shows one of the few available cases. In this case, looking at pavements in groups B and C, it is not clear as to which is more affected. This is because as seen in Table 1, one has stronger pavement and one a stronger subgrade and the overall strength in resisting rutting cannot be judged.

4. CONCLUSION

Using a vast pool of data from different roads, the following conclusion can be made concerning the effect of pure traffic loading; that rutting increases with traffic loading, and the increase is less with more cumulative loading; that environment, assessed as age, affects rutting with older pavements having more rutting; and that weaker pavements experience more rutting.



Figs. 3 Influence of environment

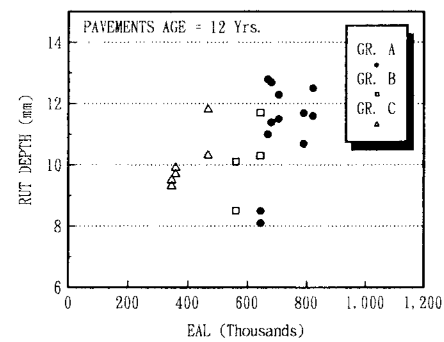


Fig. 4 Influence of pavement structural strength

5. REFERENCES

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George K.P., Rajagopal A.S., and Lim L.K. Models for Predicting Pavement Deterioration. Transportation Research Record 1215, Washington D.C., 1989.