PAVEMENT CRACKING PATTERNS AS AFFECTED BY TRAFFIC LOADING

Kyushu University ○ David A. Mfinanga
Hidetoshi Ochiai
Noriyuki Yasufuku
Miyazaki University Hiroshi Yokota

1. INTRODUCTION

Pavement cracking is one of the main distresses that reflect on the pavement structural strength. Cracks allow water ingress which weakens the pavement and rapidly quickens its deterioration. The development of pavement cracking is mainly due to traffic loading, environmental effects, or an interaction of both depending on the type of cracking. This paper explores how pavement cracking patterns are affected solely by traffic loading. Understanding the effect of purely one factor, e.g. traffic loading, will lead to a better understanding of the cracking process, shed light on the proper preventive and maintenance strategies, better designs, and eventually improve modeling process.

2. GENERAL APPROACH

Because of the exposure to climatic cycles i.e. temperature change and water, pavements suffer deterioration over a period of time. Pavement age is here used to represent the cyclic effect of environmental forces contributing to pavement deterioration. For age to actually represent environmental forces, analysis had to be done on data from areas with same climatic conditions. Pavement cracking data of freeways in Kyushu whose different areas showed no significant climatic differences were used. To obtain the effect of traffic loading only, elimination of environmental effect was achieved by analyzing data of road sections with same age but different traffic loading. Fig. 1 shows an illustration for obtaining such data from different road sections. To eliminate the influence of pavement structural strength, analysis was done on data from road sections with similar structural strengths. All pavements were divided into four groups of structural strengths according to equivalent pavement thickness, T_A, and subgrade CBR as shown in Table 1 and analysis was done within age groups.

Table 1: Pavement Structural Groups

GROUP	T_A (cm)	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. PAVEMENT CRACKING DATA

Cracking data used here were obtained by JH which classifies pavement cracks into 3 types, network (alligator, block, map etc.) cracking, longitudinal cracking, and transverse cracking. The system involves surveying 100 m sections and rating cracking in ranks of 1, 2, or 3. Rank 1 represents a case where a number of localized cracks begin to appear. Rank 2 represents numerous cracks starting to branch off for longitudinal cracks, covering half width for transverse cracks, and covering a wide area in the case of network cracking. Rank 3 represents a case of extensive coverage of section area with even wider cracks.

For 100 m road sections with same pavement structure, same age and traffic loading at the survey time, a representative average crack rank was calculated which was then used in the analysis. Each data point in the analysis, therefore, represents an average crack rank of more than 100 sections with

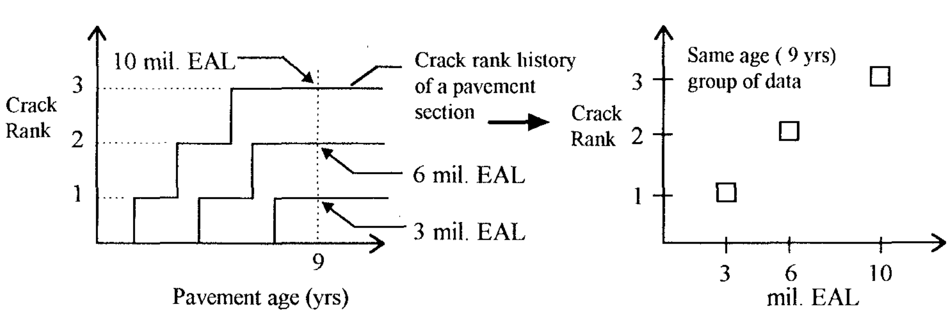

Fig. 1 Illustration of Formation of a Group of Data for Traffic Loading Effect Analysis

similar characteristics.

4. RESULTS

Due to lack of enough data to create enough categories for detailed analysis, the analysis of cracking trend is limited to general observations. As seen in figs. 2-4, the trends were mainly observed in the case of pavements in structural groups C and D which had extensive data covering wide ranges of EAL values. Most data in groups A and B (not shown) was clustered on same values of EAL which made it difficult to observe any trend. Thus, regression lines drawn to indicate the increasing or decreasing trends appear only in cases with sufficiently wide ranges of EAL values.

(i) Network Cracking: Although network cracking is mainly alligator cracking, this category also included map, block, and even irregular cracking. Fig. 2 shows that traffic loading has no effect on network cracking. Narrowing network cracking to mainly alligator cracking, the results can be concluded as that the number of axle loads determines only the onset of fatigue cracking where fracture failure is thought to have occurred but does not have any defined relationship thereafter. That is, traffic loading may determine the onset of fatigue cracking but is of secondary importance thereafter and in other forms of network cracking.

(ii) Longitudinal Cracking: Fig. 3 shows no trendy relationship between longitudinal cracking, which are believed to be caused by construction defects, and traffic loading.

(iii) Transverse Cracking: Fig. 4 shows that transverse cracking increases with EAL i.e. there is some influence due to traffic loading. Although most transverse cracking are documented to be related to low-temperature cracking, these results show that traffic loading alone can increase or initiate transverse cracking. These finding calls for further technical research.

5. CONCLUSIONS

(1) Results on network cracking which mainly includes alligator cracking show no defined relationship between axle load repetitions and alligator (fatigue) cracking. In line with technical experiments which have proved a strong relationship, it is concluded that traffic loading determines the onset of fatigue cracking but does not have a defined relationship afterwards. (2) Longitudinal cracking is not influenced by the cumulative effect of traffic loading. (3) Results show that traffic loading has an effect on transverse cracking.

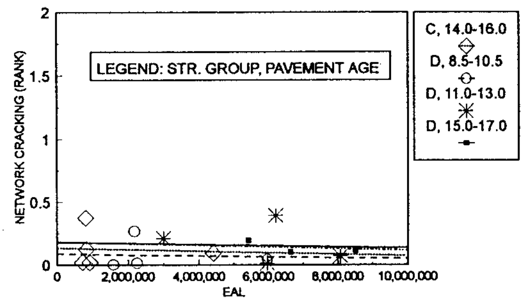

Fig. 2 Network cracking rank vs Traffic Loading

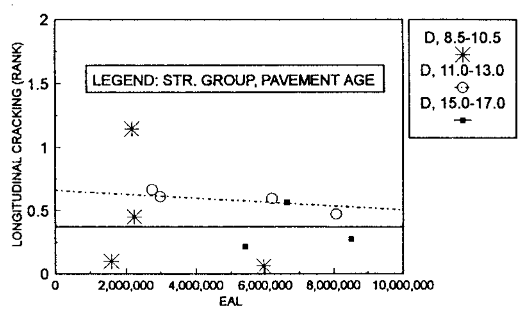

Fig. 3 Longitudinal Cracking Rank vs Traffic Loading

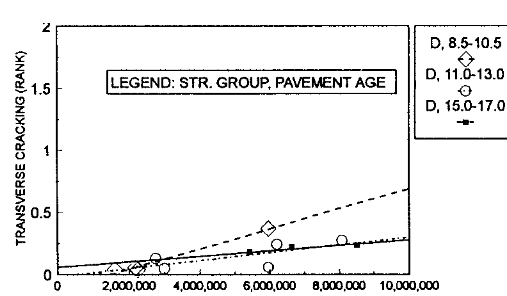

Fig. 4 Transverse Cracking Rank vs Traffic Loading

REFERENCES

Day, R.W. Pavement Deterioration: Case Study. *Journal of Performance of Constructed Facilities*. Vol. 9 No. 4, ASCE. Nov.,1995, p. 311.

Paterson, W.D.O., and Chesher A.D. On Predicting Pavement Surface Distress with Empirical Models of Failure Times. *Transportation Research Record 1095*, 1986. p. 45.