An Application of Pavement Deterioration Model for Pavement Maintenance Planning
− A Case Study on Route 8 in Hokuriku Region −

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1. INTRODUCTION

Pavement management system (PMS) is a comprehensive and coordinated process used to assist decision makers in finding cost effective strategies in pavements. The utilization of PMS is to determine what maintenance works should be applied in what locations at what times. In PMS, pavement deterioration models (PDM) are used to determine future maintenance needs of pavement sections, economic analyses and life cycle analyses. The purpose of this study is to discuss some applications of the PDM ,which was developed from the database of Route 8 in Hokuriku Region.

2. METHODOLODY

Markov probabilistic model is used to develop the PDM in this study. One of the major elements that have great influence on the accuracy of PDM is transition probability matrix (TPM). TPM that developed in this study is built on the long-term pavement performance data of Hokuriku Region. The database contains: location and length, pavement material, age, condition data, rehabilitation records, traffic data. According to the pavement material types, pavement maintenance actions and traffic volume (one-way daily traffic volume of heavy vehicles is over 3000), the pavement sections are classified into 4 pavement families as shown in **Table 1**.When the TPM is established, by using the following equations, the future condition of the pavement at any time can be predicted.

$$p'(1) = p'(0) \times P ;$$
$$p'(2) = p'(1) \times P = p'(0) \times P^2 ;$$
$$\ldots\ldots;$$
$$p'(t) = p'(t-1) \times P = p'(0) \times P^t;$$
$$E[X(t,p)] = p'(0) \times P^n \times E;$$

Where, E : Expected state vector, which defined by the mean MCI values of each state.
N : Number of duty cycles
P : Transition probability matrix (TPM).
p'(0): Initial state vector. If the pavement is new, it becomes (1, 0, 0, 0, 0, 0, 0, 0,0,0)
E [X(t,p)] : Expected value at a duty cycle t.

Table 1 Pavement families in the study.

Family	Base material	Action applied
1	Bitumen stabilized base	Overlay
2	Bitumen stabilized base	Reconstruction
3	Granular base	Overlay
4	Granular base	Reconstruction

3. RESULTS AND ANALYSES

(1) Pavement Deterioration Models

Fig.1 shows the typical PDM of pavement family 1. The condition of pavement is assessed by Maintenance Control Index (MCI). MCI values decrease smoothly with time, which means pavements deteriorate with age. From the figure, pavement with different current performance condition deteriorates with different deterioration change.

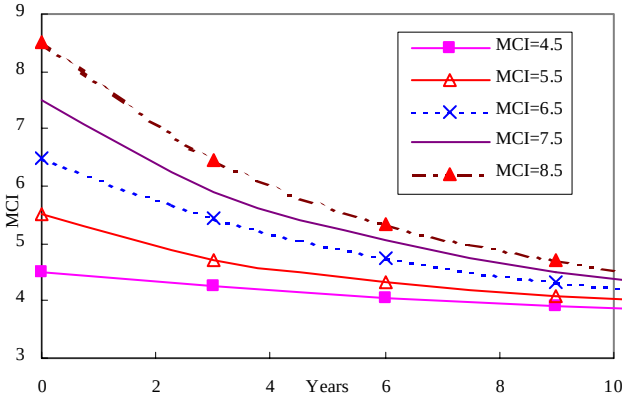

Fig.1 Pavement Deterioration Models

Key words: PDM, Markov Probabilistic model, rehabilitation, Hokuriku Region, location
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(2) Pavement Section Needs Year

By using the PDM, the expected remaining life of the pavement can be predicted. According to the experts, when the MCI of a pavement decreases to 4.0, it is supposed to do maintenance work, such as existing pavement rehabilitation or reconstruction. The time that a pavement section reaches 4.0 is called “needs year”. **Fig.2** and **Fig.3** show the summary distribution of needs year in different areas. For example in **Fig.2**, in 2013, there are about 35 pavement sections whose total length is around 3 km need to be done with proper rehabilitation. From the figures, it can be seen that the budget planning for maintenance of each year should be different.

(3) Needs Year Map

Another application of the PDM is shown in **Fig.4**.The map is convenient to be used for the rehabilitation planning. It shows the time when pavement sections in different locations should be done with rehabilitation in the near future.

4. CONCLUSION

Pavement deterioration models on Route 8 are developed. Using the PDM, pavement section needs year is calculated. From the pavement needs year, budget planning, inspection scheduling and work planning can be estimated. The map which is useful for maintenance is also developed in the study.

REFERENCES

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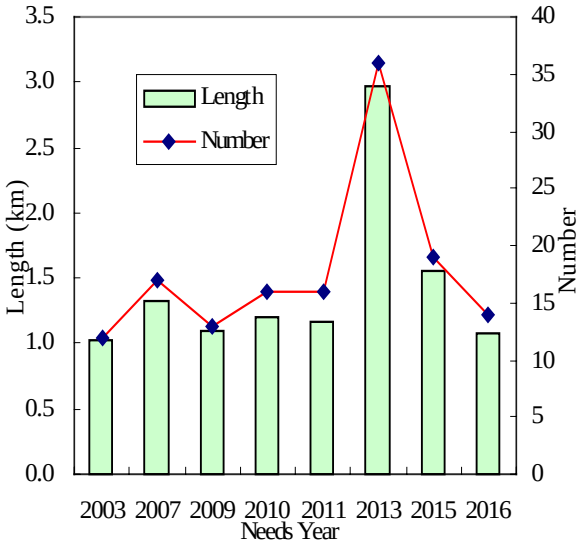

Fig.2 Summary distribution of needs year for Nagaoka.

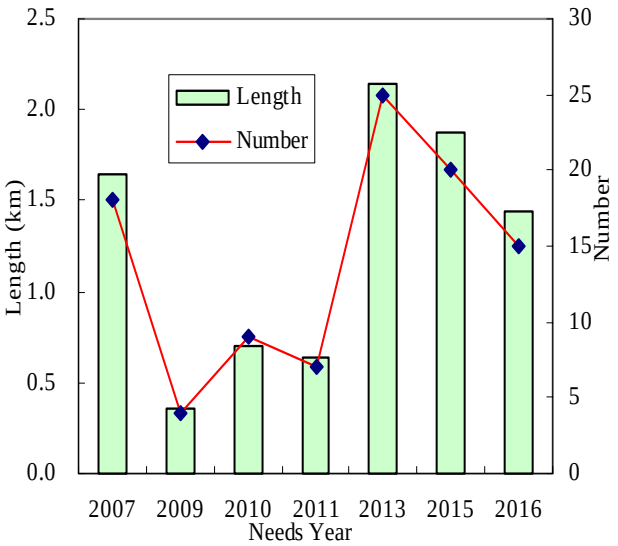

Fig.3 Summary distribution of needs year for Niigata

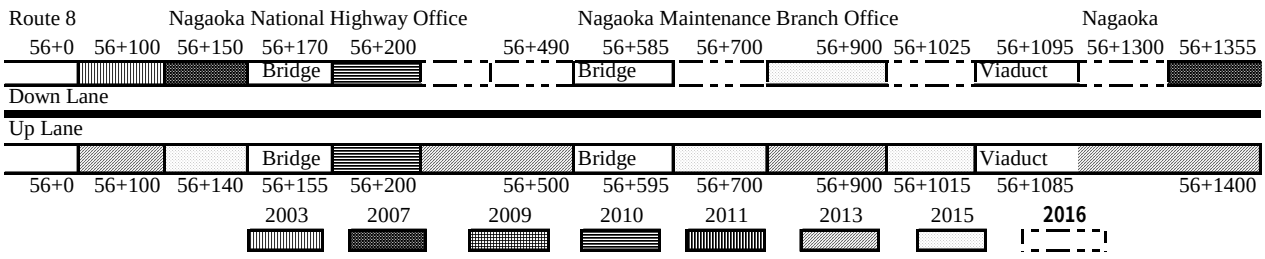

Fig.4 A needs year map (in Nagaoka)