CS-219

EVALUATION METHOD OF DIAGNOSIS ON THE LOW COST MAINTENANCE OF CONVENTIONAL BRIDGES ALREADY CONSTRUCTED (part-1)

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1. INTRODUCTION

Bridges Structures exceeding thirty years after they had been built in Japan are by far in excess of 130,000 bridges nationwide including huge bridges that had been constructed in mass production at the time of construction rush in the 40s of Showa Era (1960s) through the lump generation of bridges. It has now surfaced as a grave problem how to maintain those bridges at low cost within the limited national budget that were primarily designed to have the total bridge-life of about eighty years or so.

It is feared that some degrading in functions or deterioration accompany those structures and routine check - ups are being conducted from the standpoint of maintenance and management in preventing the collapse of bridges from occurring attributable to these causes.

Check-ups of an earthquake disaster takes place once in five years across the nation. The method adopted will determine the deteriorated level and the necessity of repair of structured materials involved through qualitative judgment in accordance with the points of examination which corresponds to diagnosis on regular system uniformly across the country. However, it seems that there are some elements missing more or less that would help judge the importance of repair cost and particulars of structures.

This paper is to propose a effective maintenance method that would determine the weighing quantitatively toward each factor based on the basic data (clinical chart) such as bridge ledgers, etc. by using quantitative theory.[1] In order to enhance reliability of the result of diagnosis still more, fuzzy theory was introduced thereby imparting universality to judgment evaluation. Establishment of this analysis method thus made is considered to induce cost reduction since it enables to utilize limited maintenance and management expenses in an effective way.

2. EVALUATION OF SOUNDNESS (Bridge Diagnosis Evaluation)

As economical life among others are judged as corresponding to a case in which physical life exceeds that maintenance and repair expenses are considered to be swelling., this research is designed to have an integrated view wherein economical factor is dealt with under physical factor.

Based on the proposition as mentioned above, a study is to be made dividing into main classes between functional soundness (deterioration of materials) and physical soundness (deterioration due to lack of functions oriented load - proof strength).

(1) Evaluation of Functional Soundness

Taking factors influencing each item of functional soundness in common in traffic volume, evaluation will be made as to conformity toward traffic volume and other functional items. Using twelve - hour traffic volume as an index denoting traffic property, conformity will be judged. Moreover, choice was made selecting six items of ① lane width ② shoulder of a road ③ width of footpath ④ state of alignment ⑤ river improve plan and ⑥ crowded degree of traffic as relevant objects.

(2) Evaluation of Physical Soundness

According to "Gist of inspecting Bridges (Draft)" by the Civil Engineering Research Institute of the Ministry of Construction, it is considered that it is possible to determine the level of respective damages accurately and uniformly for the most part as items for physical inspection is classified under so many heads. There are twenty heads in all in bridge records that make up sectional materials with which bridges are constructed, while minute classification is made in two to ten heads depending on damaged patterns for each item.

However, not all of these are related to repairs and replacing relevant bridges. Thus, as far as items of vital structured materials such as main girders and slabs go, they had been further classified into three taking contents of damages into account. In addition, items involving cross girders, stringer girders, sway bracing, lateral bracing, etc. were arranged under one item as stiffness structures in a lump while accessories materials such as drainage equipment and sound proof walls and illuminations, etc. had been eliminated from the relevant item. Table 1 shows details of fourteen items selected in that manner.

3. ANALYSIS BY II CLASS OF QUANTITATIVE THEORY

An explanation is made in connection with an analysis result of evaluation on physical soundness. A number of inspection data on bridges are found at actual spots.

This research has again reviewed actual inspection data on bridges in A Prefecture involving 250 steel bridges, 250 concrete bridges with a total number of 500 bridges through data such as photos, etc. As a disposal method, a study had been made setting up four stage exterior criteria as shown in Table 2 depending on the state of bridges.

When evaluating its soundness, weight coefficient per axis, two axes and three axes was used with steel bridges and concrete bridges examined separately when considering importance of sectional materials.

STURACUTURE PARTS

Super Structure	Main Girder	
	Main 1	(Corrsion･Abrasion･Exposure･of Reinforcing Rod)
	Main 2	(Crack･Fracture etc.)
	Main 3	(Free lime･Abnormal oscillation)
	Secondary Structure	(Stringer,Cross Beam,Stiffnes Structure etc.)
	Slab	
	Floor 1	(Abrasion･Exposure of Reinforcing Rod.)
	Floor 2	(Crack on Slabs)
	Floor 3	(Free lime･Slip.etc.)
Sub Structure	Pier Abutments	
	Fundamental Structures	
Others	Shoe	
	Balustrade	
	Earth Covering	
	Pavement	
	Expansion System	

Table-1. Pysical Items

DAMAGE LEVEL　　FLOW OF REPAIR DECISION

Items for repair level	Dtermination of Evaluation		
	1st axis(x-axis)	2nd axis(y-axis)	3rd axis(z-axis)
OK: Meintenance of the status quo	Smaller figures	Smaller figures	Smaller figures
Ⅳ: Riquiring Minner Repairs	than boundary	than boundary	Upper figures
Ⅲ: Requiring Major Repairs	figures	Upper figures	
Ⅱ: Going with replacement of constraction rather than repairs	Upper figures than boundary		

Table-2 Exterior criterion

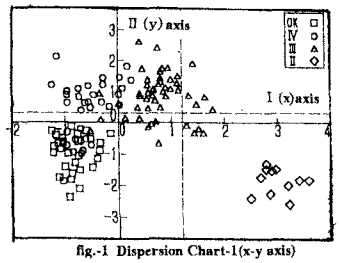

fig.-1 Dispersion Chart-1(x-y axis)

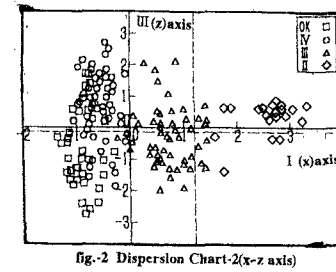

fig.-2 Dispersion Chart-2(x-z axis)

By 1st axis, 2nd axis and 3rd axis here, they mean a boundary line of a coordinate axis obtained from a calculation of quantitative theory and great and small sizes of the value given to 1st axis (x axis) will distinguish (OK, IV, III) and (classification of II). Furthermore, 2nd axis (y axis) will determine (OK, IV) and (classification of II), while 3rd axis (classification of III) will do (OK) and (classification of IV). As such.

4. OVERALL EVALUATION ON INSPECTING THE BRIDGES

While the reduction of cost is being clamored loudly, this study has proposed an evaluation method quantitatively capable of grading means of maintenance and repairs of existing bridge structures at minimum cost and maximum effect in an effective way. In doing so, I have employed a method based on basic data involving 250 bridges under an investigation for inspection which included current bridges to examine a level of judgment out of data of respective structures under the subject whether respective sectional materials of the relevant bridges are sound or not while conducting diagnosis of soundness of relevant bridges of which sectional materials were damaged and deteriorated.

Depending on the weight coefficient for the result of inspection covering fourteen items as shown in Table - 3, damage ranking of respective items may be multiplied by each weight of an axis (x axis), 2 axis (y axis), and 3 axis(z axis) , thus seeking sample scores, total value of each axis. Then, based on it, the damaged level may be judged using criterion value mentioned in the previous clause by adapting fuzzy quantitative theory to the calculation of quantitative theory.

References

1) Hayashi, Komazawa : Quantitative Theory and Data Management (Asakura Bookstore)
2) Civil Engineering Institute of the Ministry of Construction : The Gist of Inspecting Bridges (Draft), Civil Engineering Institute Data No. 2651, 1988
3) Evaluation on Diagnosis of Soundness of Bridges by Fuzzy Quantitative Theory
The 26th Civil Engineering Academy, Kanto Branch
Summary of Lectures on Reading Papers on Technology