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Road Bridge Brief Inspection and Input System with Tablet Computer

Kou IBAYASHI*[1], Yasushi TANAKA[2], Osamu YOUDA[3] and Kyuichi MARUYAMA[4]

*[1]*Nagaoka National College of Technology, 888 Nishikatakai-machi Nagaoka-City JAPAN, ibayashi@nagaoka-ct.ac.jp*
[2] *Nagaoka University of Technology, JAPAN, yasuxi@vos.nagaokaut.ac.jp*
[3] *Ohishigumi Co. Ltd., JAPAN, os-youda@oishigumi.co.jp*
[4] *Nagaoka University of Technology, JAPAN, kmaru@vos.nagaokaut.ac.jp*

ABSTRACT

Brief inspection system for road bridge, composed by three components, that is, brief bridge inspection manual, inspection data input system with tablet computer, discussion committee of deteriorated bridge, is proposed. Brief inspection manual is simplified from already used inspection paper manual in local municipalities. Inspection data input system is composed by tablet computer, server computer and mobile communication internet. Inspector inputs data by touching the screen of tablet computer with questions and answers system, and take photos by built-in camera of tablet computer, at site. Inspector needs no special knowledge and experience of inspecting bridge. Collected inspection data are analysed by inspection system administrator. If deteriorated bridge is detected, inspection reports discussion committee consisted of relevant knowledge and experience people treats these problems, and selects answers, for example, detail inspection, repair, renewal and options. This inspection system will reduce bridge inspection cost in future.

Keywords. Bridge Brief Inspection, Tablet Computer, Database,

INTRODUCTION

600 thousands road bridges over two meter length exist in Japan, and the age of thousands bridges become over 50 years within next decade. More than half of all bridges belong to local municipalities in Japan, however they are now under financial pressure due to aging of population and economic recession. In present, bridge inspection spends many cost and manpower, and there is no money to use current inspection method in future.

Bridge brief inspection system is executed instead of detail inspection for all existing bridges. All bridges are classified one with no damage or serious damages. Bridges with serious damage is needed detail re-inspection.

BRIDGE INSPECTION ORGANIZATION

Bridge inspection organization is shown in Figure 1. “Inspector” is consisted with government worker or smaller construction company worker and others, who are not always a bridge inspection specialist. “Inspection administrator” is a bridge inspection specialist

with experience. “Person of relevant knowledge and experience” is a university professors and distinguished inspection specialists.

“Inspector” checks bridge with proposed brief inspection input and database system. “Inspection administrator” re-evaluates results of inspection, and judges serious damage or not from inputted various data and photos. “Person of relevant knowledge and experience” can discuss critical or incurable damage bridges and selects answers, that is, needed detail inspection, repair, renewal or other options.

Therefore, this organization system needs fewer inspection specialists than conventional method, and will reduce inspection costs in future.

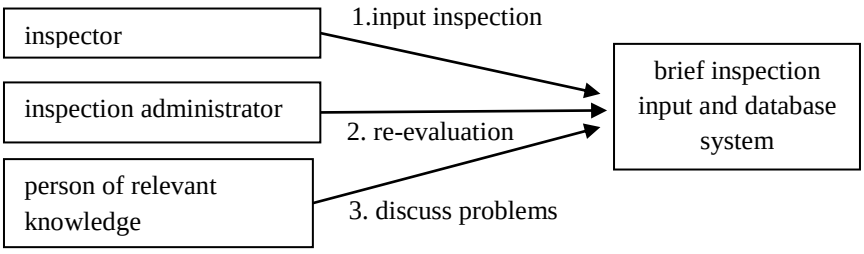

Figure 1. Bridge inspection organization

BRIDGE BRIEF INSPECTION MANUAL

Bridge brief inspection manual is based on “Niigata prefecture bridge regular inspection manual – simple version -”. This manual is used in Niigata Prefecture in Japan, but similar type of manual is used in each district in Japan. This inspection manual is named “simple version”, but needs many inspection points, many charts and photos of damaged part at bridges and special knowledge and experience.

Conventional inspection manual in Niigata prefecture is shown in Figure 2, and proposed brief manual is shown in Figure 3. Comparing the former and the latter, the latter is more simply than the former.

Brief inspection manual leads to rough range inspection data than conventional manual, but it is no major problem to use this manual because of scooping no damage bridges.In addition, conventional inspection needs record of many part of each member in one bridge, and needs five rank evaluation to each inspection part with special knowledge and experience of inspector. However, brief inspection needs minimum inspection point of bridge, and two rank evaluation (Yes / No) . Therefore, brief inspection needs no special knowledge and experience, and can save inspection time.

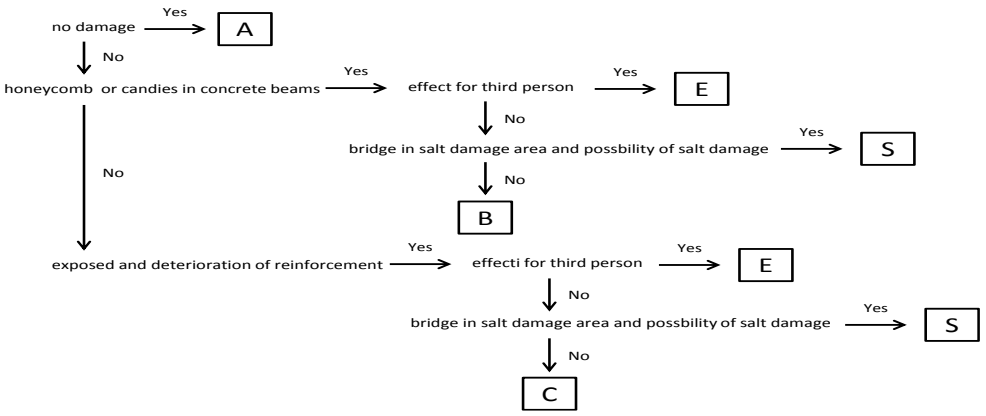

Figure 2. Local municipal manual (exposed and deteriorated bar section)

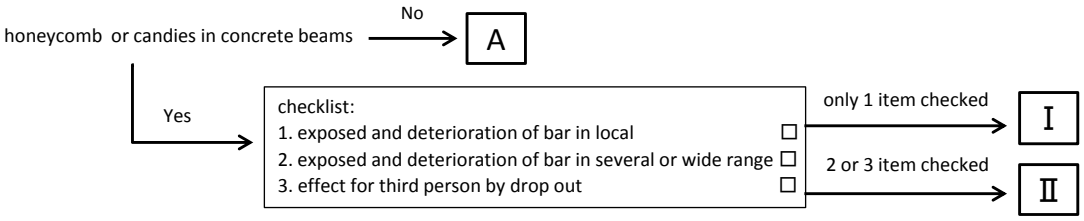

Figure 3. Proposed brief manual (exposed and deteriorated bar section)

For example, checkpoint example of brief inspection manual is shown in Figure 3. This section leads to evaluation of "exposed and deteriorated bar", from answered one question and three checkboxes. System suggests inspector to taking photo as necessary. Results of this section indicates three rank of evaluation, "A", "I", "II". "A" rank has no damage or a few damages with no necessity of repair. "I" rank has recognised some damage, and inspector reports this evaluation to road administrator. "II" rank has progressing deteriorated damage or damage great effect to structure, and inspector reports necessity of detail inspection to road administrator.

INSPECTION DATA INPUT SYSTEM

Proposed inspection data input system composed of tablet computer client and database server, shown in Figure 4. Tablet computer is "iPad", and installed software (iPad App) is "FileMaker Go". Server computer is Macintosh computer with "Mac OS X server" and "FileMaker" software series. Computers for database server management are several PCs with "Windows" series and "FileMaker Pro"

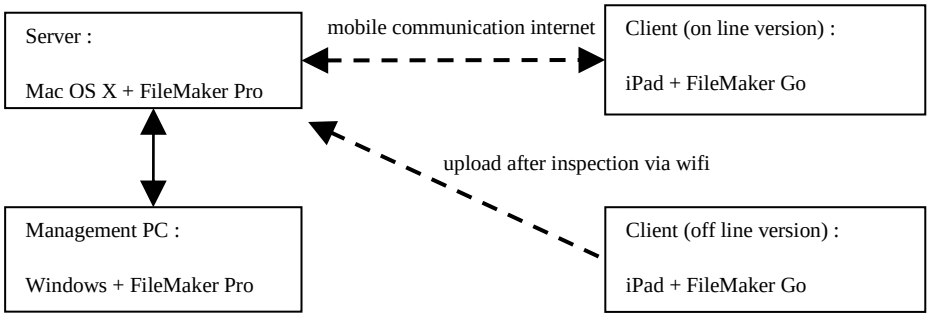

Figure 4. Bridge inspection system component

Tablet computer connects server via both “on line” and “off line”. On line version can be real time data input and output, but operations are slowly and cannot use in out of mobile communication internet area. Off line version needs upload data after inspection, but operations are more quickly and can use out of mobile communication service area.

Database data composed two major data table, “bridge data” and “inspection data”. Bridge data consists of bridge name, bridge ID, bridge length, width and others. Inspection data consists of bridge ID, inspection results, photos, and overview evaluation. Bridge data and inspection data is with relationship via bridge ID. Because inspection data increases by inspection, one bridge data relate to several inspection data.

Cover page of the system is shown Figure 5.(a). This page is changed next page when “Start Brief Inspection” button tapped, and system obtains location information by GPS. System searches already inputted bridge specifications by location information. Inspector starts inspection after confirming bridge location and specification (shown in Figure 5.(b)).

Figure 5. (a) Cover page of system (b) select bridges by location information

Inspector checks bridge in order, pavement, superstructure, slab, shoe, pier and abutment in the system. Each input data screens of system are simple layouts shown in Figure 6.(a), inspector touch screen by questions and answers system. Inspection system needs choice of main beam made by “steel” or “concrete” in superstructure screen part. When system needs

taking photos, inspector can take photo choosing “camera” by tapping square of object field in the screen (shown in Figure 6.(b)).

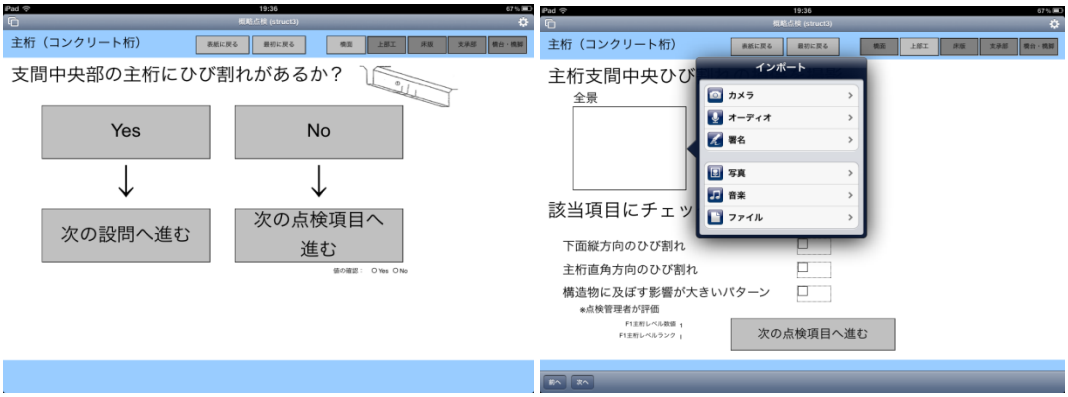

Figure 6. (a) Select choices (cracks appear or not in center of main beams) (b) take photo example

After answered all questions by inspector, system shows general score of the bridge, example shown in Figure 7.(a). If general score is “A”, no problems occurred in the bridge. However, the score “I” or “II” means re-evaluation by inspection administrator. “Re-evaluation” screen mode is shown in Figure 7.(b).

Figure xx. (a) Screen of general scores of bridge (b) re-evaluation screen

FIELD PRACTICE

This system is nearly completed by several field tests. In present, this system is examined in local city at Niigata prefecture Chuetsu area, and the availabilities and problems of this system are being examined. This city has 163 bridges, and the length of most bridges is under 10 meter. Bridges made by RC, PC, steel, RC box culvert and others. Field practice scene examples are shown in Figure 8. After brief inspection is completed, to verify availabilities and problems, results will be compared with past detail inspection results. This system will be used in other cities as more field test.

Figure 8. Field practice scene example

CONCLUSIONS

- Brief inspection system is proposed, composed by three components, that is, brief bridge inspection manual simplified from already used inspection paper manual in local municipalities, inspection data input system with tablet computer, and discussion committee of deteriorated bridge

- Inspection data input system, composed with tablet computer, server computer and mobile communication internet, is proposed. Inspector inputs data by touching the screen of tablet computer in the system of questions and answers, and take photos by built-in camera of tablet computer, at site. Inspector needs no special knowledge and experience of inspecting bridge.

- Collected inspection data are analysed by inspection system administrator. If deteriorated bridge is detected, inspection reports discussion committee consisted of relevant knowledge and experience people treats these problems, and selects answers, including the detail inspection, repair, renewal or other options.

- In present, this system is used in local city at Niigata prefecture Chuetsu area, and the availabilities and problems of this system are being examined. This system will be used in other cities.

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