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Preparation of FMMS Improvement Measures through the Application of BIM in Transport Safety Inspection Work

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Abstract. BIM has received attention of late as a technology for improving construction productivity, and BIM project delivery has become a hot topic. In accordance with such changes, it is necessary to suggest ways of remodeling the current construction project operation framework, such as the institution, guidelines, and information system for BIM project delivery. This paper suggests an improvement plan of the facility maintenance management system through the BIM application of bridge safety inspection. To do this, the following procedures were carried out. First of all, the current situation of FMMS-based bridge inspection was analyzed. Second, the improvement requirements were defined, and the current system solution was deduced through BIM application. Finally, the BIM requirements for realizing such improvement plan were suggested.

Keywords: BIM (Building Information Modelling), CALS(continuous acquisition & lifecycle support), Road Projects, Bridge, Safety Inspection, FMMS(facility maintenance management system)

1 Introduction

The Ministry of Land, Infrastructure, and Transport (MOLIT) announced a plan to apply building information modelling (BIM) to 20% of the infrastructure projects in South Korea by 2020 for the purpose of enhancing the productivity and safety of the construction industry. With the road engineering works opening for ordering BIM projects, ordering agencies need to reform their construction project systems or newly develop one, including their standards for work and information systems. Against such backdrop, this study examined the local construction and management administrations' basic measures for responding to the operation of the BIM ordering system from the viewpoint of information systems.

Infrastructures have become dilapidated and old of late, increasing their maintenance cost. Also, the maintenance stage of the construction life cycle involves the largest time and cost. Thus, applying BIM to the maintenance stage will certainly create big ripple effects.

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This study thus selected the Facility Maintenance Management System (FMMS) of the construction project informatization system (CALS) as the target of BIM. Taking into account the increasing need for social safety, this study focused on bridge safety inspection.

This study was conducted according to the following procedure. First, the status of the bridge safety inspection based on the facility maintenance management system (FMMS) was analysed. Second, the improvement requirements of the current system were defined, and BIM solutions were derived. Third, requirements for such solutions were offered.

2 Analysis if the FMMS-based Bridge Safety Inspection Status

2.1 FMMS Outline

FMMS supports the maintenance of road facilities, such as bridges, tunnels, and underground roadways, which are being managed by the national land management offices. It is currently applied to some 7,700 facilities. The FMMS functions consist of the management of the facility specifications, inspection and diagnosis, maintenance reinforcement plan and history, and statistics

2.2 Bridge Inspection and Diagnosis Work Procedure

The national land management offices conduct safety work in accordance with the Special Act on Facility Safety Management and the regulation on national land maintenance and repair operation. Such work consists of the offices own bi-annual regular inspection and special inspection as well as of contracted precision inspection and precision safety inspection. Of these, precision safety diagnosis, whose work procedures and diagnosis items are the most segmented, is conducted in the following order: (1) planning inspection and diagnosis; (2) visual-appearance and onsite investigation through testing; (3) status evaluation; (4) safety evaluation; (5) comprehensive safety class evaluation and designation; (6) provision of maintenance reinforcement methods; and (7) writing of reports.

2.2 Analysis of Cases of FMMS-based Bridge Inspection and Analysis

FMMS's inspection and diagnosis menu consists of planning in line with the above workflow, management of the inspection history, inquiry about the damage photos by member and about the maps of damages by visual inspection, internal approval, and confirmation of the inspection book. Fig. 1 shows cases of the history of inspection and diagnosis.

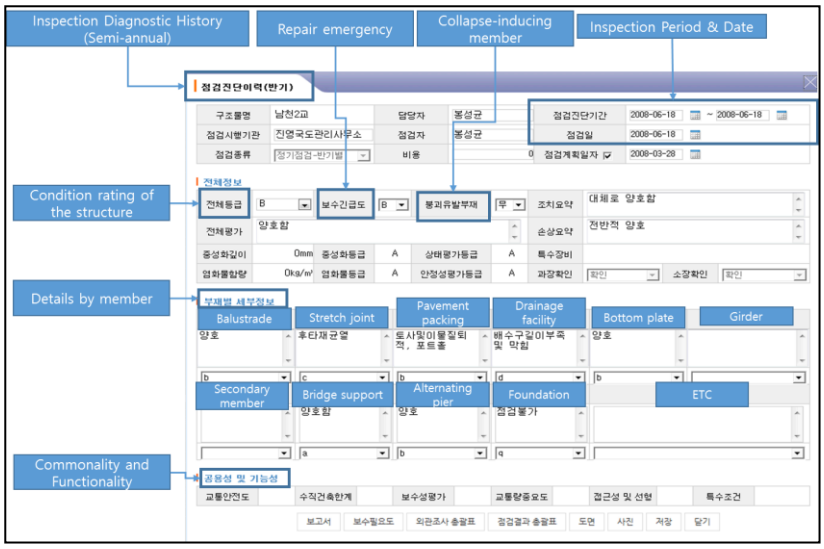

Fig. 1. Example of inspection and diagnosis history

The searched information is the results of onsite investigations, allowing one to confirm investigation results by member and status evaluation class. The inspection staffer conducts onsite appearance investigation and inputs the results using the contracted inspection program. As shown in Fig. 2, the map of damages by visual inspection can be drawn after selecting the span that had been damaged under the tree structure by member, created based on the information on the specifications.

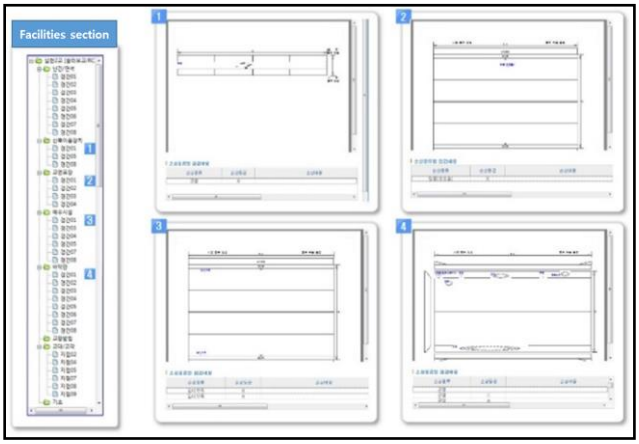

Fig. 2. Bridge appearance investigation diagram

3 FMMS Improvement Measures and BIM Application Requirements

The major concept of BIM-based bridge safety inspection is the integration of inspection data centring on BIM objects, and the visualization of the object-based data. Thus, from this viewpoint, the FMMS-based bridge safety inspection status was analysed, and the improvement measures discussed below were derived.

First, FMMS uses completion drawings such as structural drawings and various detailed drawings not directly for inspection but only for reference when identifying the onsite status. Also, FMMS involves repeatedly inputting detailed specification information (which is already included in the completion maps) when registering new facilities. This is because the completion documents have the information necessary for maintenance, distributed in various drawings and reports, with the information provided not in a form necessary for work. Thus, measures for using the completion BIM model are offered for registering facilities with FMMS, and for inspection work. The BIM model cannot replace drawings separately made by section, span, and member.

To do this, the local construction and management administrations' future guidelines for the writing and delivery of BIM should specify the following BIM model requirements for writing BIM in a form usable for maintenance work.

- Modelling unit: Division of upstream and downstream directions, and division by span unit
- Target of modelling: Must include the members subject to inspection

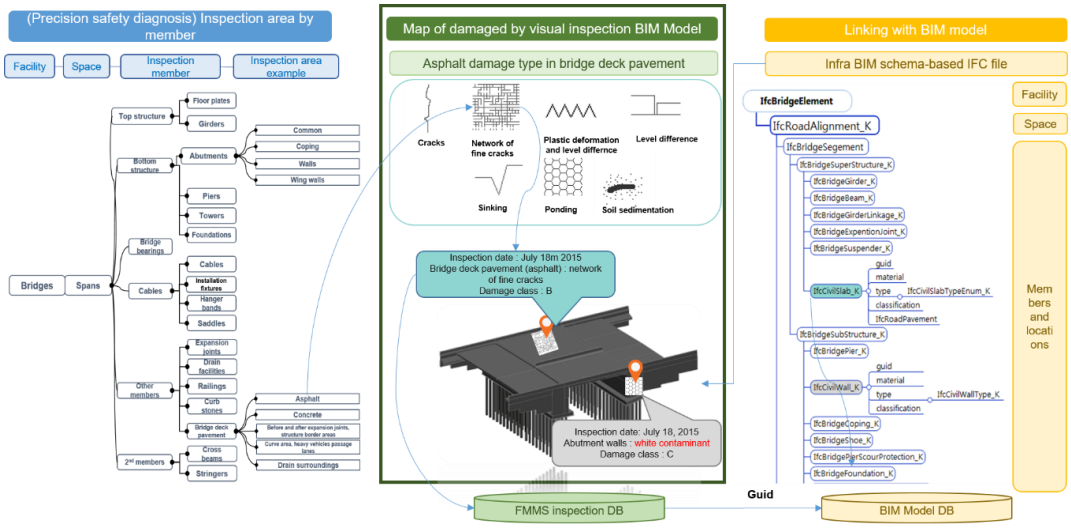

Fig. 3. BIM application conceptual diagram of bridge safety inspection

· Top structures (floor plates, girders), bottom structures (abutments, piers, towers, foundations), bridge bearings, other structural members (expansion joints, drain facilities, railings, curb stones, and bridge deck pavement), 2nd structural members (crossbeam and stringers)
- Input attributes: BIM should be delivered either by directly inputting the attribute set for FMMS specification management and management codes into the BIM model or by writing the external file involving inputting BIM objects-interoperable attributes (it is necessary to provide FMMS IFC Pset or a COBie concept file).

Second, the production of the map of damages by visual inspection is duplicated when inspecting the same bridge, and the information is distributed and accumulated by member and span. Thus, it is difficult to trace the inspection history for the same facilities and members, and it is impossible to provide the integrated damage information viewer for bridges. It is thus proposed that the map of damages by visual inspection be replaced by the BIM model, and that the BIM objects be interoperated with inspection data. FMMS should be changed such that completion BIM model databases by bridge should be constructed, and inspection databases should be interoperated with BIM objects. Also, a BIM viewer equipped with the abilities of mark-up and data inputting should be loaded in the system for tagging damage information by BIM member, and for inputting the safety class, damage type code, etc. Fig. 3 shows a conceptual diagram of the crafting of the map of damages by visual inspection targeting the bridge deck pavement, using the delivered IFC file, which is crafted according to KICT's Infra BIM schema currently under development.

4 Conclusions

This study analyzed the status of the bridge safety inspection based on the facility maintenance management system(FMMS), defined the improvement requirement items in the current system, and derived building information modelling(BIM) technology solutions. The requirements for such solutions were also presented.

Through the proposed measures, when BIM-based inspection data are accumulated in FMMS, diverse statistical data can be acquired by facility, structural type, member, material, class, etc. The inspection and maintenance costs by member can be totalled, and as such, it is expected that such data can be used as the lifecycle-cost-based maintenance data. Also, an integrated viewer and a monitoring viewer for the inspection history can be provided, boosting the efficiency of decision making.

This study focused on writing and using inspection data through the appearance inspection of bridges but did not take into account the application of BIM to maintenance reinforcement and other works. Further research is required regarding the application of BIM to the overall FMMS-based work. This study targeted new bridges, for which the BIM models were secured with the implementation of BIM orders. As such, the future studies plan to research on BIM model construction measures and measures for interoperating BIM objects and FMMS data targeting existing bridges in FMMS.

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