

Development of BIM-based Design and Inspection Prototype Process for Temporary Works

C.H. Choi^a, C.H. Han^b and J. Lee^c

^aGraduate School, Kyung Hee University, Korea

^bDepartment of Architectural Engineering, Kyung Hee University, Korea

^cDepartment of Architectural Engineering, Kyung Hee University, Korea

E-mail: choich@khu.ac.kr, chhan@khu.ac.kr, leejb@khu.ac.kr

Abstract

Temporary work is about 10% of the total construction cost, and affects completeness of a building since it is directly related to the quality of building. However, BIM-based design of temporary work is used as a complement to the 2D design. Furthermore, the inspection and evaluation of temporary facility is carried out only at the self-evaluation of contractor which is so inefficient because the inspectors are spending a lot of time searching for the standards to check and a checklist for the check is also made manually. These are factors that make lower self-evaluation level of the contractor due to missing information or error.

The objective of this research is to develop prototype of temporary work based on BIM for improving the tasks of design and inspection. In this paper, the BIM-based design and inspection work process were defined. Then, the prototype which can design and inspect temporary work was developed based on the BIM library for one of the most typical item. By using the prototype, the BIM library can be used at the design stage to perform the BIM design for the temporary work, so that a high-quality BIM design is possible even if the BIM modeling expert is not present. By automating the generation of checklists, it is possible to prevent human errors that occur due to manual method.

Keywords –

BIM; Temporary work; Design; Inspection

1 Introduction

Installing temporary works in a construction project is about temporarily building and using structures for building the main structure, on the completion of which the temporary works are removed. Even though they are temporary facilities which are used only during the construction period and then removed, installing temporary works takes up about 10% of the total

construction cost[1]. And because the task is so important, directly related to construction cost and quality, that its technology decides whether a building project is complete or not, it requires systematic design and inspection. Despite such importance, however, the current BIM-based design of temporary works, which specifically serve to build the main structure, is done exclusively in such a way that after 2D design is completed first, its 3D rendering is used as an accessory tool[2]. Lately, various kinds of research are conducted with a view to applying BIM to the construction industry, but research done on temporary works remains insufficient. For this reason, we are running short of software and professionals specialized in the installation of temporary works, and temporary works design that plays by rule of thumb with 2D drawings causes conflicts among parts, thus leading to the redoing of the work. Therefore, we urgently need to draw up reasonable and scientific temporary work design and management plan[3, 4]. In this light, the ultimate goal of this study is to develop a system that can implement the design and inspection of temporary works and which directly engages in the BIM library-based installation of temporary works. To fulfill the ultimate goal of the study, this paper aims to develop a prototype for the BIM library-based temporary works design and inspection system.

2 Classification of temporary works

Matters related to the technical standard for the temporary works installation in a construction project are specified in the Standard Integrated Construction Codes established by Ministry of Land, Infrastructure & Transport (MOLIT)[5]. The MOLIT Standard Integrated Construction Codes was created in 2016 for efficient management of construction standards. As the past classification standards varied and their details overlapped and clashed for the specifications, the Standard Specification of Building Projects and the Standard Specification of Temporary Works Installation

Table 1. Temporary Works Installation Classification according to Korea Construction Specifications (KCS)

Code Number	Code Name	Code Number	Code Name
21	Temporary works installation	05	Generals on formwork and temporary shoring
10	Generals on Temporary works installation	10	Formwork and temporary shoring for construction of high-rises and high towers
20	Common temporary works installation	15	Formwork and temporary shoring for exposed aggregate concrete
05	On-site temporary works	20	Formwork and temporary shoring for other types of concrete
10	Construction support equipment	60	Scaffold installation
15	Environmental management facilities	05	Generals on scaffold installation
30	Temporary earth retaining work	10	Scaffoldings
40	Cofferdam, construction road, construction access road, temporary stream crossing, bypass	15	Bar grating stair treads and walkway
45	Temporary bridge and road deck panel	70	Safety facilities installation
05	Temporary bridge	05	Generals on safety facilities installation
10	Road deck panel	10	Fall hazard prevention facilities
50	Formwork and temporary shoring	15	Falling objects prevention facilities

were integrated. The Standard Integrated Construction Codes divides into Korean Design Standard (KDS) and Korea Construction Specifications (KCS), each categorizing into Commons, Facilities, and Projects.

The specifications for the temporary works installation are defined in the Facilities of Korea Construction Specifications (KCS) and are managed with Korea Construction Specifications (KCS) as shown in Table 1. KCS is composed of the category of temporary works installation with the code of “21 00 00”, the 8 sub-categories, and 15 sub-sub-categories. The temporary work installation is specified into the different sub-categories of Generals, Materials, and Installation, thus providing installation inspection and measurement information. Therefore, this study taps into the temporary work classification of KCS which quality control construction engineers should use to conduct on-site checks.

3 The BIM-based temporary works design and inspection process

In general, the work system for BIM-based temporary works design is as shown in Figure 1. By acquiring required drawings such as floor plan, elevation drawing, site plan, and section drawing, one figures out what different lines on drawings represent, performs the modeling of parts by eliminating as many unnecessary elements including centerline, dimension line, and text as possible, and arrange on drawings entered attribute data.

The above series of processes can be efficiently handled in a short period of time by BIM design professionals but problematically requires large workforce and much time for SMEs or single-specialty construction companies. By creating and using a BIM library for temporary works and thereby reducing the workforce and time that are put into the BIM modeling, one can lower the barrier to the BIM adoption.

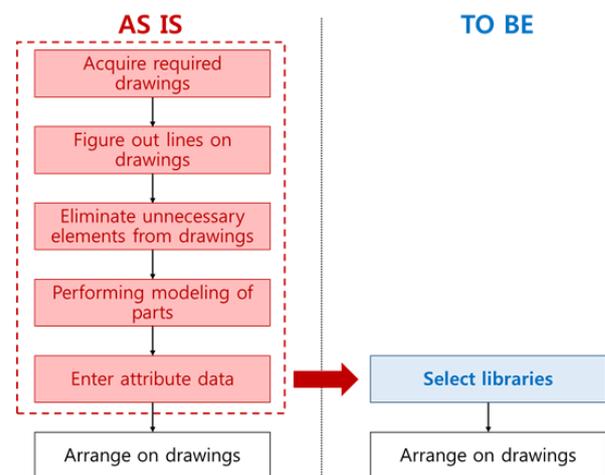


Figure 1. As-Is and To-Be for the work system for BIM-based temporary works design

In general, the builder's work system for temporary

works inspection is divided into the inspection preparation stage and the inspection results processing stage. The work process in the inspection preparation stage involves preparing documents needed for inspection by checking the criteria for the objects of inspection and creating an inspection chart as shown in Figure 2. As it has to extensively search and check various related documents to verify the criteria for the object of inspection, the builder's implementation of the tasks of the inspection preparation stage is inefficient. Furthermore, since the inspection chart for checking its own evaluation is manually prepared, human errors may intervene. This also explains how inefficient work makes the builder work perfunctorily, which downgrades the inspection standards and lowers the quality of facilities. Therefore, to solve the problem, BIM should be used to automatically extract the criteria for temporary works and automatically generate an inspection chart.

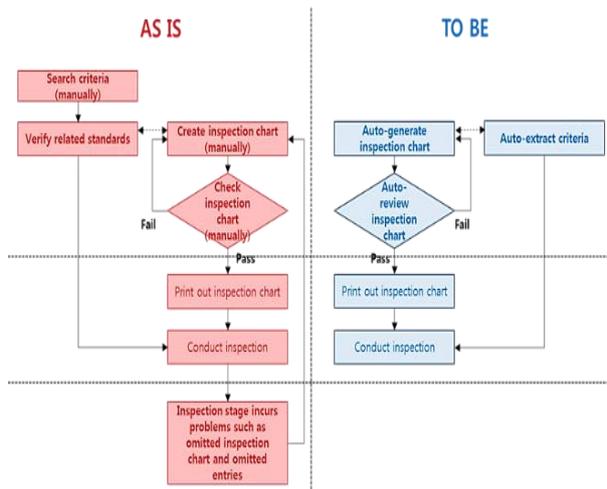


Figure 2. As-Is and To-Be for the Temporary Works Inspection Preparation Stage

Additionally, the work process for the inspection results processing stage involves creating and reviewing the inspection results and therewith creating inspection report, as shown in Figure 3. In processing the inspection results, the builder has to perform all the related tasks manually, which should be automated to minimize data errors and increase work efficiency.

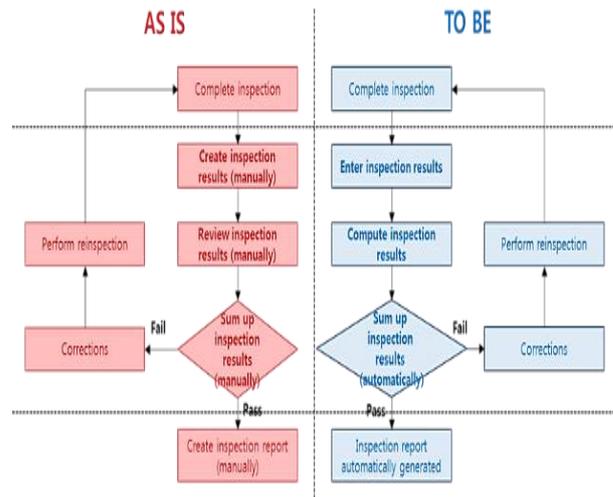


Figure 3. As-Is and To-Be for the Temporary Works Inspection Results Processing Stage

4 A prototype for the BIM-based temporary works design and inspection system

For this paper, I have developed the prototype for the BIM-based temporary works design and inspection system based on Excel by selecting scaffoldings, which are most frequently used and take up the largest cut of the construction budget for the temporary works installation. The algorithm for the BIM library-based temporary work design is as shown in Figure 4.

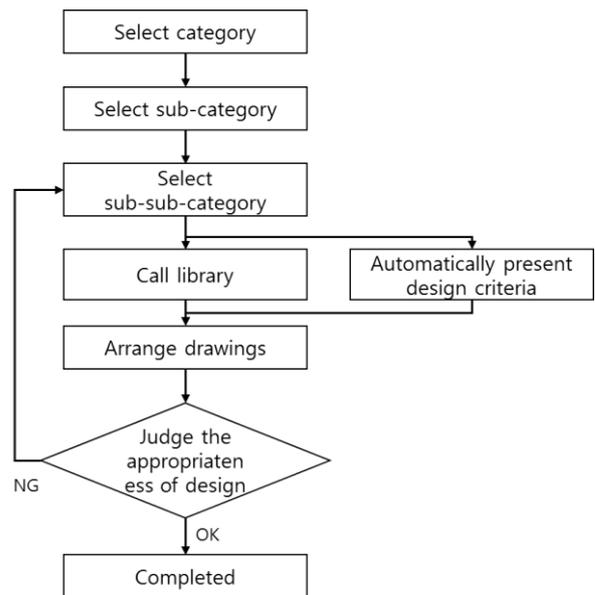


Figure 4. Algorithm for the BIM-Based Temporary Works Design

According to the temporary works classification as described in Table 1, the conditions are selected in categories, sub-categories, and sub-sub-categories to call the library. When the library is called, the criteria that should be applied in designing the current temporary works are automatically presented to minimize design errors and thereby enable the design of the temporary works. Then, the type, structure, and specifications of the designed temporary works are examined to decide if their design is appropriate, and unless something inappropriate is found with them, the design is completed. The prototype for the temporary work design that has been developed based on the algorithm as shown in Figure 4 is as seen in Figure 5.

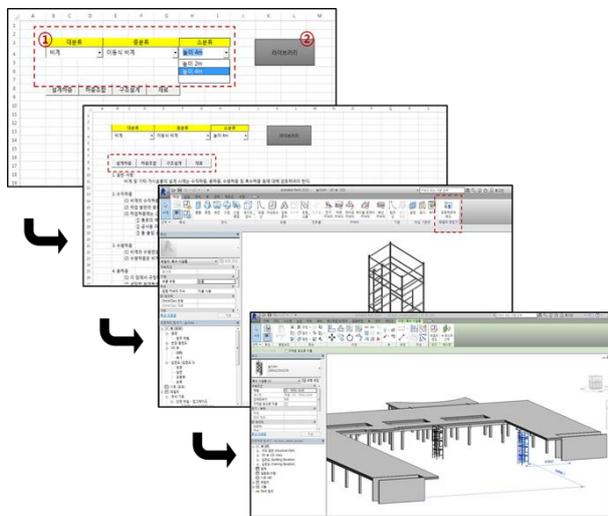


Figure 5. The Prototype for the BIM-Based Temporary Works Design

In this study, the algorithm for the BIM-based temporary works inspection is as shown in Figure 6. The BIM model for the temporary works which is designed based on the BIM library designates and exports attribute data, which is called by the inspection module.

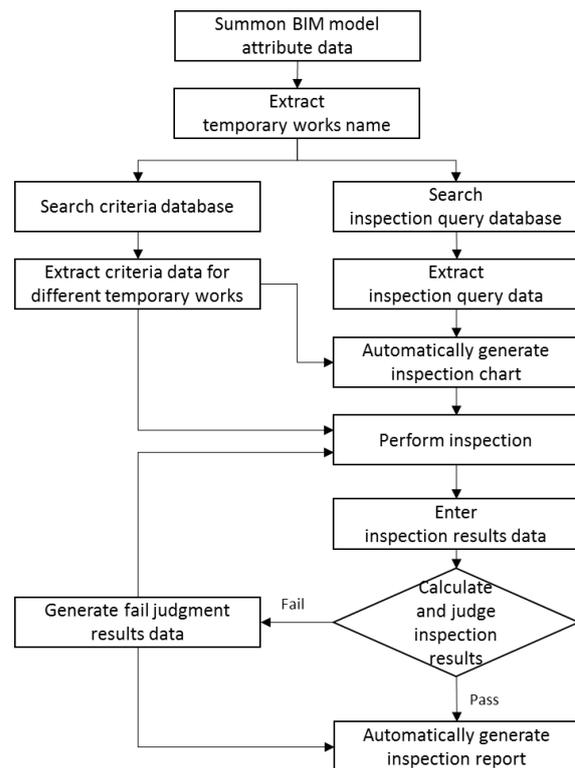


Figure 6. The Algorithm for the BIM-Based Temporary Works Inspection

The criteria database or the inspection query database for generating inspection chart is searched by extracting only the data on the temporary works name from among the summoned attribute data. The criteria shall be extracted for different temporary works through the searched criteria database, while the inspection chart shall be automatically generated by putting into the inspection chart form the temporary work inspection criteria that are extracted from the inspection query database. Also, the results of the inspection for different criteria shall be automatically calculated and judged by putting into the inspection module the inspection results data which are generated after inspection is implemented. By generating the failed criteria with the judgment results, data needed for reinspection is provided, and finally, the inspection report is created.

The prototype for the temporary works inspection system that has been developed based on the algorithm as shown in Figure 6 is as shown in Figure 7.

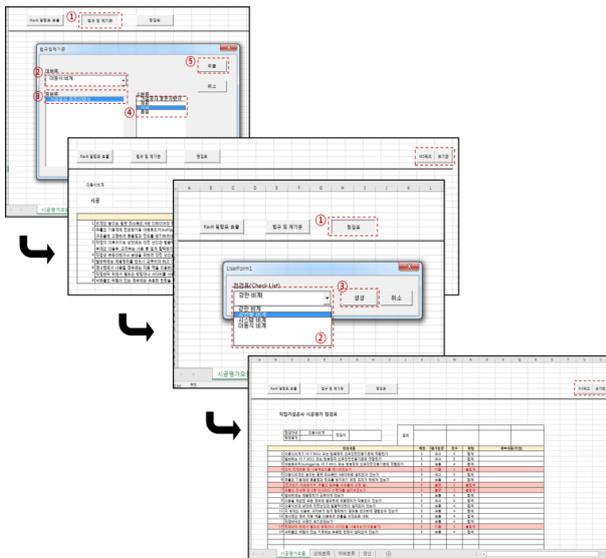


Figure 7. The Prototype for the BIM-Based Temporary Works Inspection

5 Conclusion

As the tasks of designing and inspecting temporary works are manually implemented in an inefficient manner, there has been concern about human errors and perfunctory operation. Therefore, the study has been conducted for the purpose of increasing the efficiency involved in the construction engineer's design and inspection of the temporary works installation. And looking to improvement, I have presented a prototype for the BIM-based temporary works design and inspection system.

First of all, to accomplish the goal of the study, I have identified the temporary works classification from earlier studies and established the work process for the BIM-based temporary works design and inspection. On this basis, I have developed the algorithm for the BIM-based temporary works design and inspection and the prototype for the system. The BIM-based temporary works design and inspection system as described in this study will greatly reduce the time required for work and automate what is otherwise manual operation, thus preventing human errors and improving the operational convenience.

This study is significant in that as basic research, it has developed a prototype with a view to developing the BIM-based temporary works design and inspection system. However, it has its limitations in that it has failed to complete a system that has perfect functions with regard to its system. Therefore, further research will be carried out to develop a system that can support the design and inspection of the entire temporary works by upgrading and adding functions for a future system

References

- [1] Park JM, 2012. Improvement Plan of Work Process Model for Analyzing Productivity in Construction Temporary Work. Chungbuk University, Chungbuk, Korea.
- [2] Lee JK, Min YG, Lee SH, 2014. A Study on the BIM based Architectural Design Process in Housing, Journal of The Korean Digital Architectural Interior Association, 1: 61-70
- [3] Lee EB, 2011. A study on standardization of BIM library for classification system and property information. Sejong University, Seoul, Korea.
- [4] Park JY, 2015. A study on Developing BIM Library for Architectural Documents. University of Seoul, Seoul, Korea.
- [5] Kim MJ, 2012. Development of Breakdown Structure of Temporary Work in Housing Project. Chungbuk University, Chungbuk, Korea.