Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 14 (2011) 2160–2163

Procedia Engineering

www.elsevier.com/locate/procedia

The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction

Analysis and Design of Reinforced Concrete Bridge Column Based on BIM

H. M. SHIN[1a], H. M. LEE [2b], S. J. OH[3] and J. H. CHEN [3]

[1]*Department of Civil Engineering, Sung Kyun Kwan University, Korea*
[2]*Department of Civil Engineering, Sung Kyun Kwan University, Korea*
[3]*Department of Civil Engineering, Sung Kyun Kwan University, Korea*

Abstract

The production of structures in construction field is beyond the other industrial efficiency. This seems to be problem in construction field to solve. The introduction of PLM (Project Lifecycle Management) to construction industry can be the solution for the problem. There are various tasks and steps in the construction industry, and PLM is a system that can unify and control them. Under PLM system, analysis and design is the most important issue, and recently BIM (Building Information Modeling) is clue to solve for the issue. BIM is a 3D based modeling method that includes information on consecutive work processes; planning, design, construction, and maintenance. In this study, the system of analysis and design acceptable to PLM and BIM was proposed and this system was applied to a typical civil structure, RC bridge column.

Keywords: CPLM(Construction Product Lifecycle Management); BIM(Building Information Management); 3D information model; RC bridge column; Finite element Analysis

1. INTRODUCTION

A new management system, Project Life-cycle Management (PLM) that performs integrated management of each process for product manufacture, as part of innovative strategy for product development and manufacture has been employed in other industries such as automobile and shipbuilding. Based on 3D space and design information, the efforts to build the system (Construction Product Life-cycle Management or CPLM) with which the project participants efficiently create, share and manage the information over the life-cycle of the project have been made in a bid to enhance the competitiveness. So

[a] Corresponding author: Email: hmshin@skku.edu
[b] Presenter: Email: pantene@skku.edu

doi:10.1016/j.proeng.2011.07.271

this study was intended to develop the materialization of parametric modeling of 3D object model, considering design characteristics of RC bridge column and data use, for the purpose of developing the civil structure design system, and furthermore, the study was conducted focusing on BIM-base structure analysis using 3D object model and developing the design process that will produce the structure calculation which will meet the requirements of current design laws, after implementing structure analysis and design using 3D object model.

2. 3D INFORMATION MODELING IN CONSIDERATION OF FEM ANALYSIS

2.1. (PBS)Product Breakdown System

The part model at the lowest level to create the whole models is developed to the model with product breakdown system (PBS). The reason for modeling is not only for design change, reuse or using as communication tool but also for using the model over the entire life-cycle of the structure. It is the required condition for the project participants in the area of planning, designing, construction and maintenance to communicate and exchange the data through the model.

2.2. Use of model library

Viewing the shape of actual bridge, they have similar shape of structure but the dimension and material are somewhat different depending on topographic condition. It must be inefficient to produce new model whenever implementing the new project, when producing 3D object model, and thus it is necessary to seek the way of using existing model. Most of 3D CAD programs provide the environment to allow to construct the library with part model by classifying the dimension into the parameters. With such a function, producing the object model of the structure using 3D object model library would be the way to improve the productivity of the model, eliminating the inefficient element.

2.3. Determination of parameters of 3D object model section for FEA modeling

To set the ratio of longitudinal reinforcement and hoop steel as design parameter, other elements such as thickness and width of pier and footing, shall be constrained by shape and dimensional constraint conditions. Joint necessary for finite modeling varies depending on shape of section(rectangular or circular) and the design shall determine the conditions to be given to the joint, considering cost efficiency and safety.

3. BIM BASED ANALYSIS AND DESIGN

The classical design process has various drawbacks. The error of engineer can be occurred easily and the efficiency of works is influenced by the error. As a result, time loss is occurred, which spreads to economy loss. In this study, the weak point of classical design process was made up and the process of analysis and design based on 3D-information model was constructed. For this, various modules and data bases is need. Indeed interface program to unify individual module is needed, too. The process of analysis and design based on 3D-information model is given in Fig. 1.

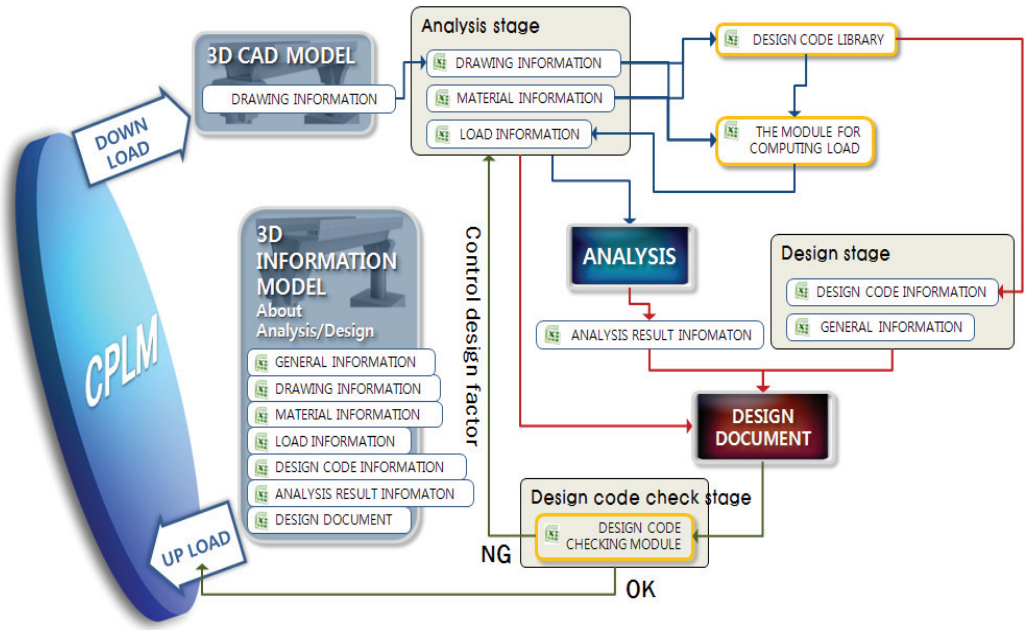

Figure 1: The process for analysis and design based on BIM

3.1. Classification of 3D-information model

3D-information model is made up of diverse information. Those are general information, drawing information, material information, load information, design code information. Description of each item is given in table 1.

Table 1: An example of table style

	Information	List
3D CAD	drawing	guardrail height = 0.4m (H1=0.25m, H2=0.35m, H3=0.3m, H4=0.05m …)
	drawing	wind-load width = 0.7m, applied height of car crash load to guardrail = 1.15m
Analysis BIM	material	Concrete ; fck = 30MPa, Reinforcement; fy = 400MPa ; etc...
	load	A rear wheel load = 96kN design velocity = 80km/h, wind velocity = 40m/sec,
Design BIM	drawing	bridge length = 160m, bridge width = 33.8m tangent length = infinity, etc...
	material	type of structural steel ; eg. arch rib = SM520 , etc...
	general	name of bridge = S-bridge, apply construction method = FCM method bridge,
	design code	ACI code, EURO code etc...

3.2. Modules and library that make the process

3.2.1. The module for computing load

For the analysis of structure the module for computing load was established. Dead load is computed with the drawing information and the material information. Live load is defined with the general information and the design code information. The data computed by the module for computing load assigned to appropriate position of a design document.

3.2.2. The library of design code

Various design code is required for the formation and type of structures. In this study the library of design code is established to design PSC box structure. This library is used to write design code information.

4. CONCLUSIONS

In this study, 3D object model which incorporates parametric modeling mechanism was adopted as information model for structure analysis and design process under CPLM environment, thereby recommending the approach to efficiently deal with the design change. 3D information model provides the process to store the information used during analysis and design process in 3D model which results in reducing the error or missing of information, thereby allowing the efficient design process. Results of this study will provide basic information that can develop unified automation system about design process of civil structure.

ACKNOWLEDGMENTS

This research was supported by a grant (code#06-E01) from Virtual Construction Research Center Program funded by Ministry of Construction & Transportation of Korean government.

REFERENCES

[1] Cho, S.H., Park, J.G., Lee, H.M., and Shin, H.M., (2008), A study of virtual object model on the superstructure of PSC box girder bridge. Korean Society of Civil Engineers Conference, pp. 837-840.

[2] Eastman. C. (2004). New Methods of Architecture and building. ACADIA 2004 Conference. pp. 1-11

[3] Park, J.G., Kim, M.H., Lee K.M., Choi J.H., and Shin, H.M. (2008) Design of Interface between 3D Object Model and Structure Analysis Program, Computational Structural Engineering Institute of Korea collection of dissertations, Vol.21 No.03, pp. 247-252 (in Korean).

[4] Sacks, R., and Barak, R. (2007), Impact of three-dimensional parametric modeling of buildings on productivity in structural engineering practice, Automation in Construction 17, pp. 439-449.

[5] Shim, C.S., Kim Y.H., Jeon, S.M., and Kwak, T.Y., (2007) Investigation on the 3-D design guidelines of structures, Computational Structural Engineering Institute of Korea conference, pp.301-306 (in Korean)

[6] Lee, M.S, (2008) A proposal about apply of integration design process based on BIM, CAD & Graphics Vol.7, CAD & Graphics, pp. 126-131.