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Collaboration of Architects and Engineers in Structural System Configuration Through the IdeCAD Platform

A Case Study

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Abstract: This paper reports the findings of a multidisciplinary design workshop with the aim of improving the collaboration between architects and civil engineers in choosing an appropriate structural system configuration for a design project. The workshop was conducted with the participation of undergraduate students of architecture and civil engineering at the Istanbul Kultur University who were asked to work together in selecting an appropriate structural system configuration of a simple reinforced concrete residential dwelling. The participants were asked to experiment with various design options and to evaluate the implications of their design decisions on the overall cost and constructability of the design project. IdeCAD Structural for structural design and IdeCAD Architectural for architectural design, were selected as the software for design collaboration due to the ease of exchanging information, the ability of checking designs according to Turkish design codes and the similarities in the user interfaces.

1. INTRODUCTION

Structural system configuration is perhaps the most important area of collaboration between the architects and the civil engineers, particularly in Turkey where over 90% of the population lives in seismically active regions. Both the architects and engineers need to understand the restrictions imposed by design codes, safety regulations, functional requirements, aesthetic concerns as well as the needs of the client in the design of the structural system of a design project.

In the conventional practice, the architects prepare the architectural layout of the structure and pass it to the structural engineers along with the preferred locations and dimensions of the structural system components based on “rules of thumb” or experience obtained from “similar” projects. Although, working with “rules of thumb” yields reasonable results when the structure is simple in terms of geometry and the magnitudes of the lateral loads due to wind and earthquakes acting on the structural system are small compared to the gravity loads, it can be quite difficult to choose an appropriate structural system on previous experience when the structure has a complex geometry and in seismically active regions where the lateral loads acting on the system can be quite large. Therefore, the architects and structural engineers need to exchange information and experiment with various design options throughout the design process.

Today it is widely accepted that building design is a multidisciplinary process of collaboration which requires the involvement of experts in the fields design and production. Kvan (2000) and Cheng (2003) affirm that building design is a collaborative process where workgroups move forward by making group evaluations. The exchange of modelling information is a vital issue in establishing the collaboration between the architects and structural engineers.

Building Information Modelling (BIM) has recently emerged as the framework which enables the exchange of design data between the disciplines related to building design. BIM encompasses the compilation and the use of building data pertaining to design, construction and management. BIM software employ object oriented methods to associate geometrical attributes, spatial relationships geographical data and the information on building components. Almost any type of data related to the life cycle of a building can be defined and contained within building information models (Haagenrud et al., 2008). Extended information on the historical development and features of building information modelling can be obtained from (Eastman, 1999), (Kalay, 1998), (Kim et al., 1997) and (Eastman et al., 2011).

IFC (Industry Foundation Classes) is considered as the most mature building information data model available. Four versions of IFC has been developed since 1994 and widely used CAD products in the construction such

as Architectural Desktop, Revit, ArchiCAD and Allplan support the IFC standard (Froese, 2003).

There are two opposing views in the construction industry on the maturity of the IFC model at its current state. First view is that, the IFC model is essentially a fully developed industry standard and the second view is that the IFC model is an early product of the information exchange technology, since it is still quite hard to implement the IFC based collaboration solutions in complex cases (Froese, 2003).

This paper investigates the use of integrated design software which does not use the IFC data model to establish collaboration between students of architecture and civil engineering in developing an appropriate structural system configuration for a two story house at a multidisciplinary design workshop.

2. IDECAD PLATFORM

IdeCAD Structural and IdeCAD Architectural, both of which were fully developed in Turkey, are widely used architectural and structural design software in the Turkish construction industry. Although, IdeCAD platform does not support IFC, its information modelling structure allows the exchange of design information between the structural engineering and the architectural design packages.

IdeCAD Architectural v7.16 was used for the architectural modelling of the building, whereas the modelling and analysis of the structural system as well as the design and detailing of the structural system components were carried out with ideCAD Structural V7.16 in the multidisciplinary workshop reported in this study. The graphical user interface and the geometric modelling features of IdeCAD Structural, which is an integrated design software for reinforced concrete structures, is quite similar to those of the IdeCAD Architectural, which facilitates the collaboration and the exchange of modelling information between the structural engineers with the architects (www.idecad.com).

IdeCAD Architectural is used to prepare architectural floor plans and sections as well as preparing rendered drawings of the architectural model. IdeCAD Structural is used to check the compliance of the structural system and its components against the Turkish building standards, “TS 500/2000: Requirements for Design and Construction of Reinforced Concrete Structures” and “TDY2007: Turkish Earthquake Resistant Design Code” and to generate structural drawings. IdeCAD Structural can also be used to obtain the amounts of concrete, steel reinforcement and formwork to be used in the

project. Extensive information on the features of IdeCAD Structural and Architectural packages can be obtained from the IdeCAD web site (www.idecad.com).

3. MULTIDISCIPLINARY WORKSHOP

The workshop was conducted with the students of architecture and civil engineering. The civil engineering students were in the senior year of their undergraduate education and have completed all the relevant courses on structural analysis and reinforced concrete design. These students were given a 2 day training on the modelling, analysis, design and reporting features of IdeCAD Structural prior to the workshop. The students of architecture were third and fourth year students and were given a 1 day training on the features of IdeCAD Architectural.

The primary objective of the workshop was to inform the students of architecture and civil engineering on the collaborative efforts required when working on a common design project. The students were given the task of designing a simple two story house with three bedrooms, a living room and a separate dining room. The architecture students were responsible for carrying out the architectural design and preparing the relevant architectural drawings whereas the civil engineering students concentrated on the design of the structural system and its components. The geotechnical and seismic design parameters required for the structural design were provided by the instructors.

In the first stage of the workshop, the architecture students prepared a rough draft of the architectural layout and passed it onto the civil engineering students who came up with an initial design for the structural system. The architecture students then checked whether the structural system satisfied the architectural constraints. After the approval of the architecture students, civil engineering students proceeded to the structural modelling on the ideCAD Structural software. The civil engineering students selected C25 and S420 as the grades of concrete and structural steel as the construction materials to be used on the structural system. The gravity loads acting on the structure obtained from the Turkish standard "TS498/1997: Design Loads for Buildings" were applied to the structural system components. After the analysis of the structural system, the compliance of the structural system components were checked against the structural design codes using the reports generated by the software (Figure 1). The dimensions and steel reinforcements were modified several times to fix the structural problems reported by the ideCAD Structural and to check whether smaller component dimensions could be used on the project. The architecture students then reviewed and approved the revised dimensions of the structural components. After the approval of

architecture students, civil engineering students proceeded to preparing the structural drawings and reports while the architectural students started to work on the representational drawings and architectural plans of the building.

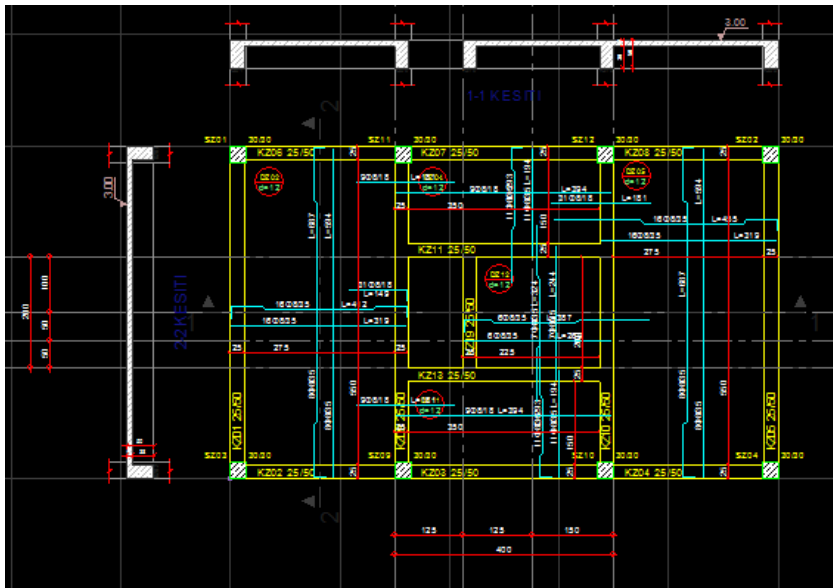


Figure 1. ideCAD Structural

4. CONCLUSIONS

The students participating in the workshop concentrated on the design of a simple residential dwelling and the scope of collaboration was limited to the structural aspects of the design. Even with the given simple residential project, the students had to revise the structural system several times in order to obtain an economical solution which satisfies the structural design codes as well as the architectural constraints. Limiting the scope of the collaboration and using integrated design software significantly facilitated the collaboration which in turn reflected on the productivity.

5. ACKNOWLEDGEMENT

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