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Traditional Design versus BIM Based Design

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Abstract

The paper shortly presents the history and development of the traditional design in civil engineering. Next, the idea of Building Information Modelling (BIM) and its practical benefits are described. Main part of the paper is devoted to discussion about what kind of difficulties we may encounter during the implementation of the BIM technology and how they are related to the potential benefits. Case study presents the existing design prepared in BIM technology.

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Keywords: traditional design; civil engineering; CAD; BIM

1. Introduction

Designer's work has changed over the last decades dramatically. For many centuries designers have had at their disposal only sheets of papyrus, paper, ...ink, and simple abacus. Classic methods of structural design have been developed for centuries and remained unchanged with time. An architect (builder) was (and still is) responsible for the entire investment project, and could be considered as "a walking database" containing all approved information as well as information about identified collisions which has to be solved.

In the second half of the 20th century architects and engineers have stopped to use traditional drawing and calculation tools. Currently, the most commonly used tools by the design engineers are CAD / CAE systems. However, the next step called BIM is coming fast and wide front.

Development of CAD design software has been an evolutionary process. On the one hand, the development of the automotive industry enforces increasing optimizations of the construction of vehicles. Similarly, the aviation industry demanded aircraft design ever lighter, streamlined, and consuming less fuel and flying longer distances. Only the use of increasingly accurate computational methods as well as development of computer graphics (2D and 3D) enabled to give up very costly laboratory experiments in small-scale models or full scale tests.

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2. Traditional methods of designing with the help of CAD systems

Architectural and engineering design is a task for large teams consisting of specialists, such as architects, constructors, installation engineers, quantity surveyors, project managers. For many centuries the basis of the projects were (and are) 2D drawings (plans, sections, elevations) of designed building in a symbolic manner, in accordance with the principles accepted by all participants in this process. Usually the architectural concept is fundamentally different from the final design and structural design. Architects mainly use sketches of bodies (3D elements shown in perspective) whereas civil engineers - plans or details drawings. Another source of confusions or mistakes are two types of plans: architectural projection shows what is below the cut surface, which is usually located at a height of 1 m above the designed floor, as an architect is interested in the layout of the designed story. In contrast, a building (construction) plan shows what is under the ceiling of the floor considered by architect, since constructor is interested in the substructure supporting the floor considered by architect.

In the classical method of designing each of the specialists work on separate industry drawings (prepared on tracing papers) with only those elements for which they are responsible. Tracing papers produced by specialists are imposed on each other during the coordination meeting to check the compatibility of the project.

CAD systems modernized the process. Instead of tracing papers the separate layers in the CAD program are used by each of the specialists. However, designer works in CAD on plans of the same building and the interdisciplinary collisions (e.g. structure-installation) are inevitable. The coordination meeting and correspondence are devoted mainly to solve the conflicts. Use of the CAD systems makes this process easier although it is time consuming and not always successful. When on one layer with installation something is changed then quite often it is not on 2D drawings not only with plans, but also with cross-sections or elevations, which should be changed both in architectural and structural design.

In parallel with CAD software CAE systems have been developed to support the calculation of the structure. Special programs have been developed for installations. Nowadays functionality of available CAE programs is very high - starting from simple programs for static or dynamic analysis of specific elements or structure, including checking the requirements specified by standards. Complex calculation systems (such as Autodesk Robot) collaborating with CAD/BIM systems are developed steadily. They allow for comprehensive modelling of the structure, the load patterns combination module supports thousands of different variants. Final results of analysis can be easily transferred to CAD/BIM systems in order to adjust the 2D/3D model and produce structural drawings (dimensioning and reinforcement drawings, detailed design of steel connections etc.).

3. BIM based design

3.1. Definition of BIM

Acronym BIM is translated in two ways: either as Building Information Modelling or Building Information Management. American Committee of the National Information Model Standard Project Committee defines BIM as "*a digital representation of physical and functional characteristics of a facility...and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.*" (buildingSMART, 2010). [1]

U.S. Government General Services Administration defines BIM as "*the development and use of a multi-faceted computer software data model to not only document a building design, but to simulate the construction and operation of a new capital facility or a recapitalized (modernized) facility.*" [2]

Another document issued by British Standard Institution *Specification for information management for the capital/delivery phase of construction projects using building information modelling* (PAS 1192-2:2013) defines BIM as "*the process of design, construction and use of the building or facility infrastructure using information about virtual objects*" [3]

In 1962, American engineer Douglas C. Englebart described his vision of an architect work:

"(...)the architect next begins to enter a series of specifications and data–a six-inch slab floor, twelve-inch concrete walls eight feet high within the excavation, and so on. When he has finished, the revised scene appears on the screen. A structure is taking shape. He examines it, adjusts it… These lists grow into an evermore-detailed, interlinked structure, which represents the maturing thought behind the actual design." [4]

Above description is a very good characteristic of the essence of BIM.