Software for structural engineering and construction: the past, the present and the future

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Summary

The goal of this paper is to investigate the impact of computer software, computers and technology in general on the design and construction of civil engineering structures and to outline the trends that can be expected in the future. The author presents observations gathered during his design experience as a structural engineer, and from compiling a database of structural engineering software available online at www.bridgeart.net.

Keywords: software; structural design; interoperability; building information modeling (BIM); usability; engineering, architecture, and construction (AEC).

1. Introduction

The main focus of this paper is to evaluate the impact of computer software on the analysis, design and construction of civil engineering structures, and to summarize the current trends in the engineering software. Prior to approximately 1960s the structural design was accomplished primarily by manual calculations, graphical and semi-graphical methods. With the advent of computers, many repetitive design tasks have been automated and other problems with known theoretical solutions, such as finite element analysis, have been finally implemented for practical use by taking advantage of the computational power that had become available. Advanced computer analysis enabled to analyze and consequently build new structural forms that were out of the reach in previous era—such as long-span cable-stayed and segmental bridges with nonlinear time-dependent behavior. Today the design and construction community relies heavily on computer software; there are hundreds and possibly thousands of computer programs for analysis, design, computer aided design (CAD), drafting, architectural visualization, construction scheduling, geometry layout, detailing, data acquisition, structural health monitoring, etc. The widespread adoption of the limit state design philosophy resulted in a development of more complex and demanding structural design codes, and the use of computer software as a design tool has become almost a necessity. This more sophisticated design software places higher demands on structural engineers who still must master the underlying theory in order to use correct assumptions and approximations when developing computer models and interpreting results. Latest trends in the engineering software focus on developing integrated software solutions and on improving interoperability among the existing software packages. The emerging technologies—such as Industry Foundation Classes (IFC) data format for interoperability, Building Information Modeling (BIM), Virtual Building Environment (VBE) and many others—enable to encompass the entire project life cycle including conceptual design, final analysis and design, detailing, procurement, bidding, purchasing, fabrication, erection, and sales. Better quality and increased productivity are achieved by minimizing errors, minimizing overlapping tasks, increasing accuracy and efficiency.

2. The past

To better understand the present state of engineering software, let's look how the technology and its

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