Towards a fully digital modelling of structural joints at ULS

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Abstract

This article describes the reasons that led structural engineers to develop a software whose goal is a fast and reliable determination of steel connection ultimate resistance, and how it can help the engineers to stay connected to the BIM digital workflows.

Keywords: yield analysis, computational design, steel connection analysis, cloud software

1 Introduction

The story started in 2010 in SETEC-TPI offices in Paris. The authors oversaw the independent checking of structural steel structures for the "Fondation Louis Vuitton". The outstanding building geometry, designed by Frank Gehry, led to highly complex steel structures, with little apparent structural sense. But unlike some others "geometry-driven" steel structures, these ones are supporting heavy glazed "sails", subjected to complex dynamic wind effects. There was therefore a real need for detailed structural checks. Checking 3D plastic capacity of complex steel assemblies undergoing complete 3D force systems, using Eurocode requirements, appeared to be a very challenging task. The problems encountered with general purpose finite element software, conducted to rely mainly on hand calculations.

Indeed, the emergence of BIM as a collaborative, interactive way of designing and checking projects, highlights the need of fully digital tools for all project members. Design is faster, checks are faster, and changes are faster. One fundamental idea behind the process is that once a design change is proposed, it can be treated very quickly by all members, and the project is updated permanently.

Although having been the first to get professional numerical tools in the 70's, the structural engineer is now among the ones with the biggest lacks in his numerical chain, and remains often reluctant to the fast-iterative management of complex BIM projects.

Another idea behind BIM is that it can be used during the building's life, for maintenance and, from the engineer's point of view, to assess structural health, for example when coupled to wireless sensors of all kinds that are now rapidly spreading. Structural health monitoring normally relies on reverse engineering for interpreting the data, and on direct simulation to analyze the possible impact of the changes on the structure's safety. Automatizing the whole chain is, here also, the key for the supervision of infrastructures, and developing, for example, alert thresholds.

After the end of this project, it was thus observed that this problem was becoming rather common, Not only for bolted assemblies of steel structure, but also for 3D parts of concrete structures, timber

https://doi.org/10.2749/222137817821232810
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