IMPROVING EFFICIENCY AND COLABORATION IN EARTHQUAKE TIME HISTORY ANALYSIS OF TALL BUILDINGS

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ABSTRACT

New standards and regulations for seismic design of tall buildings require design engineers to use increased number of simulations in the assessment of the building structural system. In order to meet those requirements and while remaining cost competitive in the market structural engineers must seek to enhance analysis workflows that are currently overly rely on desktop computers and semi-manual pre and post-processing.

In the course of three recent building design projects Arup in Los Angeles developed a new workflow for earthquake time history analysis of buildings. We've employed extensive Pre and Post processing automation, Cloud Computing, Cloud Databases and custom web platforms. Although those techniques are already used in other industries this is a significant improvement and innovation to the current workflows in the construction industry.

In earthquake time history analysis structural engineers subjects a non-linear structural model to a set of earthquake ground motion records scaled to the site hazard of the designed building. While old regulations required only 3 ground motions, new regulations may require up to 22 (with some simulations using ground motions 100sec long). Considering various geometric design iterations and testing of sensitivity to input

properties the number of analysis results can easily escalate. Current desktop based computing workflows in the Construction industry are not suited for the amount of data generated.

Arup in Los Angeles employed a new Cloud enabled computing and storage taking advantage of latest advances in cloud computing and services. The workflow seeks to compress and automate the generation of the complex LS-Dyna models to post processing and reporting enabling the engineering team to focus on the design aspects of the project. The workflow comprises of automated development of structural models from geometry provided by the architect in Rhinoceros 3d, parallel solving of the LS-Dyna models on Penguin Computing, automated post-processing and streaming of analysis results to Amazon Web Services (AWS) Database. Results are interrogated back at Arup through a custom web interface and Grasshopper Rhinoceros components. This enables all members of the design team regardless of familiarity with commercial LS-Dyna post processing packages to obtain the design results they need to advance the project.

The paper will present current and future requirements and approaches for the analysis of tall buildings (particularly in Los Angeles and Seattle).This paper will describe all essential parts of the workflow from the architects' geometry to final sharing of results with the design engineers and the architect. The paper will also focus on the history, the development and practical application of the workflow over the course of three building design projects which included development of a series of custom written scripts in VB.net, C and Python.