

Dimensional Quality Control of Concrete Elements Using As-Designed BIM

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Upon the completion of construction projects, contractors are required to submit as-built drawings that accurately capture the existing conditions of the finished project. In some cases, there may be disputes between owners and contractors regarding the discrepancies present in the as-built and as-designed models. One of the causes of such discrepancies is unclear or unachievable tolerances specified in project specifications. In cases where designers do not specify any tolerances, constructors take matters in their hands to ensure the quality and the structural integrity of the final product. The major consequences of such practices can be safety issues or an increase in cost due to rework. The motivation for this research is that integrating design and construction could help rectify tolerance problems before the start of construction work. BIM is replacing traditional paper-based 2D plans for representing the as-designed and as-built state of buildings. The objective of this research is to integrate dimensional tolerance specifications into as-designed BIM models, so that designers and contractors can work together to identify and eliminate tolerance incompatibilities, and prepare as-designed models with clear and achievable tolerances. Digital representation of tolerance information will enable contractors to continually keep track of tolerance requirements and to work with up-to-date tolerance information when there are changes to the design model. Furthermore, it would also help eliminate the problem of unclear specifications since it enables all project stakeholders visualize them in the model.

This study incorporates tolerance limits for various concrete elements as specified in ACI 117-90 document into as-designed BIM using a text parsing algorithm developed in MATLAB. Textual information about tolerances for concrete elements and an as-designed BIM model are the two-required input to run the algorithm. It analyzes the attributes of each element in the BIM model and enriches them with the corresponding tolerance information. The output is an as-designed BIM model enriched with dimensional tolerance information, i.e. max. allowable deviations in dimensions, distances and angles, for corresponding building elements. The model used for the preliminary experiment consists of a variety of concrete elements with different tolerance requirements. As-designed BIM model of a residential building was developed using Autodesk Revit software and converted to IFC format. The text parsing algorithm goes over each line to find the correct concrete element and adds the textual tolerance information for that particular type of structural concrete element under element's "Description" field. The tolerances specified in ACI 117-90 are used to develop a set of rules which were integrated into the model using the text parsing algorithm.

It is expected that the outcome of this research will be a step toward automating dimensional tolerance management practices for structural building elements. The issues regarding tolerance management, which is often overlooked in the industry, will be brought to attention. This study is also expected to provide a better understanding about how an elementary step taken during the design phase can make a significant impact on tolerance management. The scope of this study is limited to managing tolerance issues during the design phase, it does not phase out the problems related to tolerance management in later stages of project lifecycle. It could be regarded as a step toward solving tolerance related issues to minimize negative consequences of poor tolerance management throughout the project lifecycle.

Keywords: BIM, Dimensional Quality Control