Development of New Material Models for Thermal Behavior of Cold-Formed G-450 and G-550 Steels in OpenSees Software

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Abstract

In this study, new steel material classes were added to the OpenSees 3.0.0 library to model their behavior within cold-formed profiles under high temperatures. The new material classes that were added are capable of modeling G-450 and G-550 grade galvanized steels under mechanical and thermal loads. Gypsum panel, a nonstructural material within walls, significantly contributed to the lateral resistance of cold-formed structures. For the first time, the relevant material class was added to OpenSees. First, heat transfer analysis was performed to determine the temperature distribution within different parts of the frame structure. Second, the structure was analyzed under gravity loads, followed by thermal loads. Results from the first step were applied to the structure, and a transient thermomechanical analysis was performed. The output of this analysis included the deformation and force of the members of the structure. The behavior of each new material class was compared with the experimental results to determine the accuracy of the developed OpenSees scripts. Moreover, the results related to modeling with this material class were compared with those of the material classes available in OpenSees. The results exhibited high accuracy with the new material class, and the difference in the results obtained with the current material classes in OpenSees was significant.