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# PROGRESSIVE COLLAPSE ANALYSIS AND COMPARISON OF INTERMEDIATE AND SPECIAL STEEL MOMENT FRAME UNDER FIRE CONDITIONS

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Progressive collapse occurs when any one of load carrying members is removed or damaged suddenly and other structural elements are not able to support the weight of the building, so this causes a local or global failure in the structure. Fire, blast, design/construction error, vehicle impact and abnormal loads such as strong ground motions are the main reasons for the progressive collapse of structures. Due to local fire, one or more structural members may be damaged; it can cause local damage and following that progressive collapse in the building. The aim of this paper is to investigate the progressive behavior of a different type of steel frames under fire conditions. For this purpose, an Intermediate and Special steel moment frame are designed according to part six and ten of Iranian national building codes and requirements of fourth edition of Standard No. 2800 using ETABS software. Then the progressive collapse behavior under fire load based on UFC code and using the nonlinear dynamic analysis method has been investigated using OpenSees. OpenSees is an open-source object-oriented software framework developed at UC Berkeley. The OpenSees framework has been extended to deal with structural behavior under fire conditions. For modeling using OpenSees, beam and column elements are modeled as thermal elements, all beams and columns are subdivided into eight and twelve smaller elements respectively and analyzed under heat transfer analysis. All frames were heated using ISO834 standard fire as shown in Figure 1.

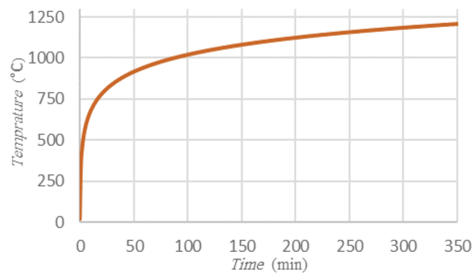


*Figure 1. ISO834 standard fire curve.*

The results of the behavior of two steel frames are compared in different fire scenarios. In this paper, six scenarios of fire were considered in stories 1, 2 and 4, for the corner column and the middle column. Two scenarios of fire on the first story are shown in Figure 2. Deflected shape of the frames for two heating scenarios of the first story at failure temperatures are shown in Figure 3.

The results of the displacement and forces of the elements under heat and their adjacent elements have been investigated to evaluate the most critical fire scenarios and the role of structural ductility in facing the progressive collapse mechanism under fire condition.

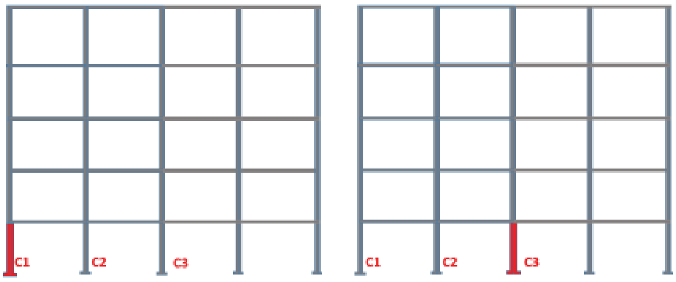


*Figure 2. Fire scenarios in the (a) S1C1 corner, (b) S1C3 middle columns of the first story.*



*Figure 3. Deflection of frames in (a) S1C1, (b) S1C3 fire scenarios.*

## REFERENCES


Sun, R., Huang, Z., and Burgess, I.W. (2012). Progressive collapse analysis of steel structures under fie conditions. *Engineering Structures*. https://doi.org/10.1016/j.engstruct.2011.10.009.

Rackauskaite, E. and El Rimawi, J. (2015). A study on the effect of compartment fires on the behaviour of multi- storey steel framed structures. *Fire Technology*.

Shepherd, P.G. andBurgess, I.W. (2011). On the buckeling of axially restrained steel columns in fire. *Engineering Structures*, doi:10.1016/j.engstruct.2011.06.007.

Wang, P., Wang, Y., and Li, G. (2011). A new design method for calculating critical temperatures of restrained steel column in fire. *Fire Safty Journal*.

OpenSEES (2000). *The Open System for Earthquake the Engineering Simulation*. University of California, Berkeley.

Unified Facilities Criteria (UFC) (2005). *Design of Building to Resist Progressive Collapse*. Washington (DC): Dept. of Defence.

Iranian National Building Code for Structural Design, Part 10 (2013). Design of Steel Buildings.

Iranian National Building Code for Structural Design, Part 6 (2013). Minimum Building Loads.

Iranian Code of Practice for Seismic Resistant Design of Building. Standard No. 2800, $4^{th}$ Edition (2013). *Building and Housing Research Center.*