# Robustness demands for structural joints of multistory steel building frames under elevated temperature

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**ABSTRACT**

Robustness of multistory steel building frames in case of extreme actions relies primarily on resistance of key elements, continuity between elements and ductility of elements and their connections. Seismic design requirements result in similar features when dissipative concepts are employed. Thus, seismic resistant structures are designed to exhibit a dissipative behavior by ensuring the dissipative elements have appropriate ductility and resistance and non-dissipative elements posses sufficient overstrength.

According to the capacity design approach, non-dissipative connections of dissipative members should be designed with overstrength compared to the dissipative members. Such strong connections can also mitigate the collapse when adjacent columns are removed. However, it is also possible that connections with less overstrength or even partial strength connections can have adequate robustness (ductility and redundancy) to arrest the progressive collapse. In this case, the connection should possess large deformation capacity. Previous experimental tests on extended end plate bolted connections shown that they can be stronger than the beams only when their capacity is governed by bolts in tension. In most cases, this means a brittle failure mode and a high risk when a critical member is removed. Therefore, a more ductile connection, where the design is governed by a ductile mode, for instance the end plate in bending, can behave more efficient and more reliable.

Under large stresses induced by single extreme actions, seismic resistant structures are expected to be less vulnerable than structures designed for gravity loads. However, in case some hazards occur simultaneously or consecutively in a very short period of time, e.g. fire after blast or fire after earthquake, the capacity of the connections can be exceeded and this can be the initiating event that can finally lead to the progressive collapse of the structure or large parts of it. These likely scenarios can be considered as failure/near collapse scenarios in a Performance Based Design methodology and therefore can be used for estimating the ultimate capacity necessary to avoid structural collapse.

The paper investigates the performance of seismic resistant structures in case of column loss, under ambient and elevated temperatures. Alternate load paths strategy, which is based on the acceptance of the failure of some components, but with the preservation of the main structural elements, is employed using nonlinear dynamic analyses. The demands in terms of ductility and overstrength for structural joints are evaluated for different column loss scenarios produced by extreme actions which then are compared to corresponding seismic demands. Acceptance criteria for connections are based on experimental tests performed at Politehnica University of Timisoara, Romania and University of Coimbra, Portugal.

**Keywords:** Robustness, Column loss, Seismic Resistant, Blast, Fire, Ductility, Steel Structures, Elevated temperature

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