Mitigation of Post 9-11 Realities in Steel Frame Structures As a Function of the Choice of Connection Geometry

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ABSTRACT

In light of post 9-11 realities, this paper will clarify the nature and consequence of violent column removal in steel frame structures due to proximate bomb blast, highlight the inherent fragilities of 35-year-old "traditional" steel frame connection geometries, discuss reasonable expectations for the mitigation of progressive floor collapse in steel frame buildings and specialty structures, and evaluate expected post-attack performance as a function of the choice of connection geometry. Using high-fidelity physics-based non-linear continuum modeling, this paper corroborates the conclusions of other blast researchers by casting serious doubt on the validity of the notion that post-Northridge seismic detailing of connections is a cure-all, including mitigation of the threat of terrorist attack. In particular, it will be demonstrated that implicit to gaining the necessary confidence in the performance of a steel frame building to survive the threat of direct bomb blast pressures, vehicular impact and/or progressive floor collapse is the selection of a girder-to-column-to-girder connection geometry that intuitively exhibits discrete structural continuity across a violently torn-loose column; inherently provides torsional strengthening and blast hardening of girder and column ends at the girder-to-column joint; and demonstrates proven reserve capacity, robustness, and joint ductility. Specific practical design applications used in the construction of U.S. Federal Government buildings and specialty structures just prior to and since September 11th, 2001 will be presented that clearly exhibit these essential attributes without adding cost to the steel frame.

The strategic and economic advantages of a steel frame girder-to-column connection geometry that inherently accommodates the use of robust hollow tube or box columns filled with concrete to enhance global dynamic structural response, and to proactively and preemptively mitigate progressive collapse, will be discussed. The use of hollow tube or box columns as interior "wet columns" or as chimney flues to mitigate thermal attack will also be discussed.

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