ANALYTICAL EVALUATION OF BLAST PERFORMANCE OF STEEL BRACED FRAME STRUCTURES

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Key words: Steel structures – Blast effects – Nonlinear dynamic analysis – Strengthening – Multi-hazard

The current practice in blast-resistant design of building structures for conventional blast loads is, in general, to design the building envelope (infill and curtain walls) to resist the design blast load and dissipate energy through inelastic response while keeping inhabitants safe from the blast overpressures and debris. For conventional design blast loads, standard practice usually is to assume that the dynamic reactions of the façade components will produce only a moderate lateral response of the building structural frame. This is due to the relatively large natural period of the structure (compared to the façade components) and inertial mass. However, for larger than conventional threats, specially reinforced blast-resistant façade systems are required which may result in transfer of large lateral forces into the building frame structure. This may result in large force and deformation demands on the lateral load resisting frames.

This paper presents an analytical study of the implications of the use of blast-resistant façade systems on the lateral response of steel braced frame structures under large blast loads. The lateral response of different types of mid-rise (3 to 12 stories) steel braced frame structures is investigated through MDOF (multi-degree-of-freedom) nonlinear dynamic analysis. Plastic hinge definitions for frame members follow ASCE 41-06 and UFC 4-023-03 guidelines for nonlinear dynamic analysis of structures. The performance of different types of braced frames is evaluated and compared through assessment of overall frame stability, plastic deformations and strength demands on frame members. These results are linked to structural performance levels from ASCE 41-06, which are based on seismic design criteria. Furthermore, the structures that are likely to undergo significant damage and have higher potential risk for collapse are identified. For these structures, conventional construction seismic rehabilitation methods are used to strengthen the lateral load resisting systems and they are evaluated based on the improvement in structural performance. The paper discusses the effects of different building design parameters (e.g. number of stories, type of lateral force resisting system) on the expected structural performance of steel frame buildings under blast loads. Finally, the paper discusses an on-going test program consisting of blast tests on a full-scale steel frame structure with conventional and blast resistant façades. The results from these tests will be used in future research to validate and improve the analysis methodology.