Behavior of Bolted End plate Connections under Internal Blast Load

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ABSTRACT

Terroristic and hostile attacks as well as accidental explosions cause local damages or even general collapse of structures and induce significant loss of life and property. Considering the ever-increasing hostile and terroristic threats, the concept of passive defence should be considered in design of structures. Therefore, study of behaviour of different structural members including columns, beams and connections under blast loading is of great importance. Among the mentioned structural members, connections have a key role in general response of a structure to blast load and its improper design or construction may results in structure collapse. In this paper, the behaviour of bolted end plate connections under blast loading is investigated. Bolted end plate connections are widely used in steel framed structures. Some of significant characteristics of end plate connections are the moment resistance, the rotational stiffness and ductility. When an explosion occurs in a structure, a huge amount of energy is applied on structure in a very short time and high ductility is needed to absorb such a great amount of energy. Finite element models are used to simulate the behaviour of the connection under blast load. To assure the results of finite element models, model verification is carried out using the results of an experimental test conducted by previous researchers. Having assured the accuracy and ability of finite element models in predicting the behaviour of bolted end plate connection, a 7-storey building is designed and the moment and shear force at location of the first storey connection are used to design a bolted end plate connection. The connection is then exposed to internal blast of a TNT charge. The charge is assumed to be placed at the room centre and its weight is considered to be 15, 30 and 45 kg. Nonlinear explicit dynamic analysis is used for simulation of structure response to blast loading. The results show that the shear bolts are failed due to the blast pressures and the beam experiences torsion. Based on the results of this study, it is recommended to use 2 rows of horizontal shear bolts to prevent the failure of shear bolts.

Key Words: Passive defence, end plate connection, blast, finite element method

1 INTRODUCTION

Considering the ever-increasing hostile and terroristic threats as well as the probability of accidental explosions in structures, such as gas explosion in kitchen, investigation of structure response to blast loading is of great importance. Therefore, many researchers in the recent decay tried to study the behaviour of different structures and structural members under blast loading. One of the most important structural members is beam-to-column connections, since the integrity of a structure is provided by its connections.

The traditional view is to use rigid and full strength beam-to-column connections in the steel MR frames in seismic areas. However, after the Northridge earthquake–California-1994, bolted connections which are generally semi-rigid and partially resistant have been extensively studied [1].

Bolted connections are widely used in steel framed structures. Since bolted connections include more details such as bolts, angles, T-stubs and plates that cause congestion at connection zone, the inelastic behaviour of such connections is intrinsically more complicated than welded