9th International Congress on Civil Engineering, May 8-10, 2012
Isfahan University of Technology (IUT), Isfahan, Iran

Evaluation of Progressive Collapse Potential of Steel Moment Frames in Different Seismic Zones of Iran

M. Wassegh [1], M.A. Hadianfard [2], M. Soltani Mohammadi

1- Graduate Student of Earthquake Engineering, Shiraz University of Technology
2- Assistant Prof. of Civil Engineering, Shiraz University of Technology
3- Associate Prof. of Earthquake Engineering, Tarbiat Modares University

m.wassegh@yahoo.com
hadianfard@sutech.ac.ir
msoltani@modares.ac.ir

Abstract

The progressive collapse-resisting capacity of the three story steel moment frames designed for moderate and very high level of seismic zones of Iran, is investigated using alternate path method recommended in the GSA and UFC guidelines. The linear static and nonlinear static analysis procedures were carried out in accordance with both the guidelines. It was observed that, for the steel structures designed for higher seismicity there is higher capacity for progressive collapse. However for short steel structures, there is no enough redundancy, hence the alternate paths will not be generated to redistribute loads of the failed elements and prepare resisting capacity for progressive collapse. It was also observed that, the direction of joist and pattern of gravity loads are effective parameters and so, it is better to be avoided from uniform gravity loading patterns.

Keywords: progressive collapse, alternate path method, push-down analysis, steel moment frames.

1. INTRODUCTION

During the lifespan of civil engineering structures, manmade hazards such as blast and impact and natural hazards like earthquakes, floods and fires may affect the structures. Structures are usually designed for probable events that may happen during their lifespan, but extreme events which they were not designed for, can result in catastrophic failure. In recent decades, some natural events such as the 1994 Northridge earthquake, 1995 Kobe earthquake and manmade events such as 1995 Murrah Federal building bombing and 2001 attack on the World Trade Center have shown that engineering structures are vulnerable to extreme events.

After the Northridge and Kobe earthquakes and the failure of moment resisting steel frames in these events, substantial research was accomplished by the engineering community to construct and design steel structures so that they would be more safe and reliable. But blast and impact effects on steel structures, in contrast to seismic effects, have not been adequately studied.

There are different definitions and interpretations for progressive collapse in civil engineering literatures and guidelines. Some of these definitions for the term progressive collapse are mentioned here. “Progressive collapse is defined as the spread of an initial local failure from element to element resulting, eventually, in the collapse of an entire structure or a disproportionate large part of it.” (ASCE 7-05 2005)[1]. “A progressive collapse is a situation where local failure of a primary structural component leads to the collapse of adjoining members which, in turn, leads to additional collapse. Hence, the total collapse is disproportionate to the original cause.” (GSA 2003) [2]. “Progressive collapse, A chain reaction failure of building members to an extent disproportionate to the original localized damage.” (UFC 4-010-01 2003) [3]. “Progressive collapse is the spread of damage through a chain reaction, for example through neighboring members or storey by storey. Often progressive collapse is disproportionate but the converse may not be true.” (Agarwal and England 2008) [4]. “Progressive collapse, where the initial failure of one or more components results in a series of subsequent failures of components not directly affected by the original actions is a mode of failure that can give rise to disproportionate failure.” (Canisius et al. 2007) [5]. “A progressive collapse is characterized by the loss of load-carrying capacity of a relatively small portion of a