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Evaluation of Progressive Collapse in Steel Structures Designed Based on Iranian Code of Practice for Seismic Resistant Design Buildings (Standard No. 2800), 4th Edition and Iranian National Building Code (INBC), Part 10

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ABSTRACT

In this study, the progressive collapse is examined in steel structures with 4-, 8- and 10-story dual systems of moment resistant and braced frames. Probable risks and unusual loads can lead to progressive collapse in structures, e.g. design or construction errors, fires, gas explosions, accidental overloading, car accidents, bomb explosions, etc. Given the action of these forces over a relatively short period, the dynamic analysis of these incidents appears necessary. In this study, the effect of mentioned incidents is considered through the sudden loss of a member. The studied buildings are designed based to the Iranian National Building Code, Part 6 and Part 10 and Iranian Code of Practice for Seismic Resistant Design Buildings (Standard No. 2800), 4th edition. The structural frames are simulated by finite element method using Abaqus finite element software in order to assess the forces and displacements created in the members. Subsequently, the dynamic response of structure is determined according to the loads and how they are applied to the structure, items of analysis process model (APM) and sudden loss of members. The results of analyses suggest that the loss of middle columns in the studied braced frames is more critical than the loss of corner columns. In other words, the central columns of perimeter frame are more vulnerable than the corner columns.

Key words: Progressive collapse, steel structures, Iranian Code of Practice for Seismic Resistant Design Buildings (Standard No. 2800), progressive failure, Abaqus.

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1. INTRODUCTION

Progressive collapse is defined as the propagation of initial local rupture of a member towards another member, which ultimately results in the failure of whole structure or a large part of it. Possible risks and unusual loads which may cause progressive collapse are: design or construction errors, fires, gas explosions, accidental overloading, car accidents, bomb explosions, etc. Since these risks are less likely to happen, they are not considered in the structural design or they are addressed by indirect measurements. Most of them may cause an action over a relatively short period and lead to dynamic responses. Progressive collapse was first noticed by researchers in the 1970s after a partial collapse of a tower in Ronan Point, England. Progressive collapse received the great attention again after the terrorist attacks on the World Trade Center on September 11, 2001. In existing building codes, it is acceptable to design structures for the loads that may be applied during the lifetime of structure. Structures are not usually designed for unusual disasters which can cause global collapse. Most common codes just provide general recommendations for the adjustment of effect of progressive failure in structures loaded more than their design loads. Most standards refer to three design methods for the elimination of progressive collapse. The first method is reducing the exposure to damage and losses; the second and third methods are used to provide progressive collapse resistance (1, 2). Lew demonstrated that the chain