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Progressive Collapse Assessment of a Seismically Designed RC Moment-resisting Building according to the Iranian Design Codes

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Abstract

Progressive Collapse is considered as a chain effect following a small portion failure and at last results in a disproportional collapse of building. In last decades many researches have been conducted on different structural systems concerning progressive collapse. This study mainly focuses on progressive collapse assessment of a RC moment-resisting frame which is designed according to the Iranian building codes. The seven storied building with moderate ductility detailing is located in Tehran which is high seismicity zone due to Iranian building code (2800 code). To investigate progressive collapse potential, several non-linear dynamic procedures (NDP) with preceded column removal scenarios due to GSA2013 are carried out and the ability of model to successfully absorb member loss with alternate load path is assessed. Moreover for further investigation, nonlinear static analysis is conducted to compare the analysis outcomes. Results demonstrate progressive collapse is triggered at the beams of higher stories but for the considered column removal approaches, the vertical displacement time history responses of joints above removed columns continue to converge and reach a stable state. According to the conventional seismic loading and design methods, in moment resisting frames, columns and beams of upper stories are mainly weaker than lowers, and therefore tends to be more vulnerable to instantaneous column loss which must be taken into account for progressive collapse design.

Keywords: Progressive Collapse, RC Building, non-linear dynamic assessment.

1. INTRODUCTION

A structure is subjected to progressive collapse when local failure of a primary structural component results into the failure of adjacent structural members and eventually resulting disproportional damage. Progressive collapse is defined in ASCE/SEI 7 (2010) as the spread of an initial local failure from element to element, eventually resulting in the collapse of an entire structure or disproportionally large part of it [1]. The conventional design methods take into account the gravity loads and lateral loads according to the location of the building, but the buildings may experience abnormal loads other than conventional design loads such as air blast pressures generated by an explosion or impact by vehicles, etc. which can trigger progressive collapse. In the past few decades many progressive collapse occurred, mainly caused by terrorist attacks, hence design guidelines such as GSA [2] and UFC [3] addressed progressive collapse. In this study a seven storied RC moment-resisting building [the most common structural system for low and medium rise RC buildings in Iran] which is designed according to the Iranian codes [4] [5], is modeled to evaluate its progressive collapse resistance via non-linear dynamic alternate path (AP) method and acceptance criteria suggested by GSA2013.

2. DESIGN DETAILS OF THE RC MOMENT-RESISTING BUILDING

The building is designed following the Iranian design codes for design of concrete structures and the code for seismic design (2800 code). All the stories have identical height of 3.2 m and the total height of the building is 24.9 m. The dead load and live load of the roof story is 550 kg/m^2 and 150 kg/m^2 respectively and that of each remaining story is 600 kg/m^2 and 250 kg/m^2, whereas the dead and live load of staircase is 650 kg/m^2 and 350 kg/m^2. The cladding load is considered 250 kg/m^2. The building is located in Tehran with the design ground acceleration 0.35g for high seismicity zones, soil class III and atypical plan according to 2800 code (The plan of the building is illustrated in Figure 1). Table 1 displays the dimensional and reinforcement