EFFECT OF THE BUILDING HEIGHT ON PROGRESSIVE COLLAPSE

Majid MOHAMMADI
Assistant Professor, IIEES, Tehran, Iran
m.mohammadigh@iiees.ac.ir

Bahram KORDBAGH
Master of Science Student, IIEES, Tehran, Iran
b.kordbagh@iiees.ac.ir

Keywords: Progressive Collapse, Building Height, Steel Moment Resisting Frame, Alternate Path Method, Nonlinear Static Analysis

Progressive collapse is defined as extension of initial collapse, from a part of structure to another one that may result in destruction of structure. Possible risks and abnormal loads that cause progressive collapse are as follows: aircraft collision, design or construction error, firing, gas explosion, random overload, vehicles contusion, bomb blast and etc. such phenomenon are not consider in designing typical structure, since possibility of occurring these risks is very low. However, they should be regarded in very important or special structures.

In this research, effect of the building height on progressive collapse is studied. For this purpose, steel moment resisting structures designed for high seismicity zone areas, with four, eight and twelve- stories are considered and their progressive collapse are studied and compared.

Results indicate that the potential of progressive collapse decreases by increasing building height. The main reason is increasing structure indeterminate degree, and catenary action of members.

Increasing catastrophic events in recent years showed that the prevention or mitigation of progressive collapse must be included as a requirement in building design and analysis. Many methods have been proposed to mitigate progressive collapse and several building codes, standards, and design guidelines have discussed this issue. General Services Administration (GSA, 2003) and Department of Defence (DoD, 2005) have been used more than the others for designing and analysing of progressive collapse. The alternate load path method is a threat independent approach that commonly is used for analysis of progressive collapse. This approach is based on removing a load-bearing element and evaluating stability of remaining structure and also its ability to bridge over the removed element.

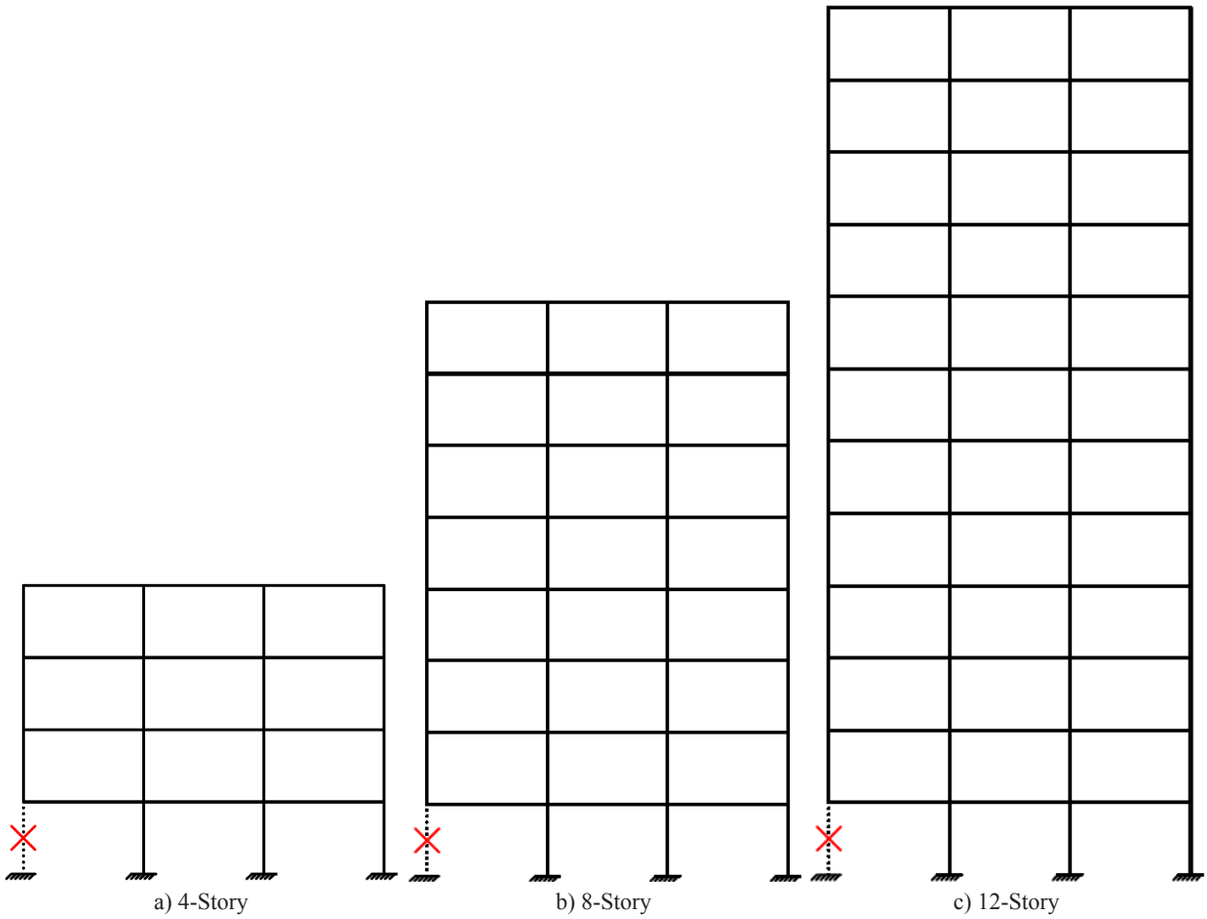
There are different analysis procedures for the alternate path method that have been suggested in guidelines. These procedures are linear static, linear dynamic, nonlinear static and nonlinear dynamic. In recent decades, many studies have been performed to evaluate the potential of progressive collapse of buildings by computer modelling and also to evaluate the advantages and disadvantages of each four progressive collapse analysis procedures some of these studies have been performed by Marjanishvili (2004); Powell (2005); Marjanishvili and Agnew (2006); McKay (2008). A more complex nonlinear analysis is required to obtain more realistic results but it is better that the static and the dynamic analysis properly be incorporated so that the best results can be achieved for analysis of progressive collapse.

The structures are considered in this study are the four, eight and twelve stories special steel moment frames structures that have been designed in accordance with building and seismic codes of Iran. It is assumed that the structures located on soil type 2 and type of used steel is St-37. Height of stories is 3 m and spans of the structures are 5 m. Applied gravity loads to the structures are assumed to be as shown in Table 1.

Table 1. Gravity loads

Load type	Story	Roof
Dead load (Kg/m^2)	600	650
Live load (Kg/m2)	200	150
Perimeter walls (Kg/m)	700	300

For the structures, corner column in first story were removed (Figure 1).



a) 4-Story b) 8-Story c) 12-Story

Figure 1. Remove corner column in first story

REFERENCES

DoD (2005) Design of buildings to resist progressive collapse, Unified Facilities Criteria (UFC) 4-023-03, Department of Defense (DoD)

GSA (2003) Progressive collapse analysis and design guidelines for new federal office buildings and major modernization projects, General Services Administration

Marjanishvili S (2004) Progressive Analysis Procedure for Progressive Collapse, *Journal of Performance of Constructed Facilities*, 18(2): 79-85

Marjanishvili S and Agnew E (2006) Comparison of Various Procedures for Progressive Collapse Analysis, *Journal of Performance of Constructed* Facilities, 20(4): 362-74

McKay AE (2008) Alternate Path Method in Progressive Collapse Analysis: Variation of Dynamic and Non-linear Load Increase Factor, M.Sc. Thesis, Department of Civil and Environmental Engineering, University of Texas, San Antonio, Texas

Powell G (2005) Progressive Collapse: Case Study Using Nonlinear Analysis, Proceedings of the 2005 structures congress and the 2005 forensic engineering symposium, Apr. 20-24, New York, NY