



IJRASET

International Journal For Research in
Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** II **Month of publication:** February 2023

DOI: <https://doi.org/10.22214/ijraset.2023.49101>

www.ijraset.com

Call:  08813907089

E-mail ID: ijraset@gmail.com

A Review Paper on Progressive Collapse Analysis of Different Shell Structure: A Critical Review

Bhagyashree Tayade¹, Dr. Girija Deshpande², Prof. Prasad Joshi³

M.Tech Structural Engineering, JSPM's Rajarshi Shahu College of Engineering, Tathwade, Pune

Abstract: Progressive collapse occurs when one of the structural members fails, causing other structural members to fail. This leads to the collapse of all or part of the structure. Failure of a vertical structural member is the most common cause of progressive structural collapse. Explosive charges, accidents or deliberate destruction can cause the column to fail and collapse. The analysis is performed by removing the columns at different locations one by one according to General Service Administration (GSA) guidelines, and then evaluating the radius and column DCR values. The results concluded that the column removed from the center is more vulnerable to progressive collapse.

Keywords: Progressive collapse, DCR, GSA.

I. INTRODUCTION

Buildings are designed first and then designed for maximum forces or tension. But if the load applied to the entire structure or to one structural element exceeds this service load or stress limit value, the structure will fail or a structural element failure will occur. When the load exceeds the service loads, the building or any element, such as beams and columns, fails, leading to the failure of adjacent elements and the failure of the entire structure. This phenomenon is called progressive collapse or progressive failure. When a structure is subjected to an abnormal load, one of the structural elements may be more damaged, i.e., column, beam and slab. Failure of a vertical member or structural member such as a column is more sensitive than damage of a horizontal member such as a beam. When a vertical member such as a column is damaged by the impact of an impulsive load, the loads are distributed to other adjacent or neighboring components of the member. If the adjacent parts of the damaged element can withstand the additional load, then it will withstand the load, if not, it will not. If one of the adjacent structural elements fails again, the load-bearing capacity of the adjacent elements must be sufficient, otherwise the failure will gradually increase, which may lead to multiple failures that will damage the structure. R.C.C a building consists of elements such as column, beams, slabs, foundations, etc. These elements are also called supporting elements of the structure. Although there are mainly two types of loads acting on a structure and they are the continuous loads (DL) and the dynamic loads (LL). Self-loading consists of the weight of permanent structural elements such as a column; and the active load consists of the weight of moving people, furniture, etc. and wind load and seismic load also affect the structure. When an internal load-bearing part of a structure fails due to some means, such as an explosion or a car accident, which renders the structure or component unable to maintain its structural integrity, the phenomenon is known as collapse phenomena.

II. GENERAL SERVICE ADMINISTRATION GUIDELINES

According to this guideline, it is to ensure that when failure of members occurs at the commencement, this failure is referred as local failure and this local failure can be restricted at some point so that global failure i.e., failure of whole building can be prevented.

GSA specifies locations for column removal as,

- 1) Exterior column removal in buildings longer direction.
- 2) Exterior column removal in buildings shorter direction.
- 3) Corner column removal.
- 4) Interior column removal.

III. LITERATURE REVIEW

- 1) Jiahao Peng, Chao Hou and Luming Shen. 2022, *Progressive collapse analysis of corner supported composite modular buildings*

This paper presents an alternative analysis of the load path of a multi-story modular building in case of sudden leakage of external columns. Potential progressive failure is considered in a threat-independent approach using nonlinear static and dynamic analysis techniques.

The purpose of this paper is to investigate building system responses after a critical column has been destroyed by unspecified extreme events, rather than to assess the effects of specific events. A total of nine case studies were constructed with modular buildings of 2, 4 and 12 stories. Consider three basic column deletion scenarios: corner column, long edge column, and short edge column deletion.

2) *Huu-Tai Thai, Quang Vu Ho, Wenqian Li and Tuan Ngo. 2021, Progressive collapse and robustness of modular high-rise buildings.*

A comprehensive investigation on the progressive collapse and structural robustness of modular high-rise buildings was conducted in this study using the alternative load path method associated with a nonlinear dynamic analysis. This is the most accurate method for simulating the progressive collapse of a structure as it can consider all sources of nonlinearity and dynamic effects. Unlike low-rise structures, the dynamic effect due to supported member loss is more pronounced for high-rise buildings. Therefore, dynamic analysis methods should be used to accurately capture such effect.

3) *Saeed Panahi and Seyed Mehdi Zahrai. 2021, Performance of typical plan concrete buildings under progressive collapse.*

In this study, the effect of typical concrete building plans (i.e., square and rectangular) on progressive collapse is investigated by 3D modeling of the buildings using finite element software LS-DYNA and corner column removal using APM in accordance with GSA and UFC regulations. The results show that the removal of a corner column in a rectangular building has more intense effects, including doubling the collapse rate, 1.5 times higher axial and shear loads in the columns, reverse movement of shear loads, and higher energy absorption than in the building. square building.

4) *SOMAYYEH KARIMIYAN. 2021, Study of progressive collapse distribution in reinforced concrete buildings due to simultaneous effects of earthquake loads and edge column removal.*

This study evaluated short- and medium-rise 3- and 5-story RC structures with intermediate moment-resisting frames under simultaneous captured ground motions and removal of edge columns.

The results show that the distribution of collapse in structures is specific, repeatable, comparable and independent of ground motions. Critical elements, failure paths and propagation in similar structures can therefore be predicted, which can be used to provide practical procedures for strengthening or retrofitting similar low- and medium-height structures in guidelines and standards. Later, the phenomenon of gradual collapse of structures is reduced and finally the damage can be controlled and reduced in similar structures.

5) *Ibrahim M.H. Alshaiikh, B.H. Abu Bakar, Emad A.H. Alwesabi, Hazizan Md Akil. 2020, Experimental investigation of the progressive collapse of reinforced concrete structures: An overview.*

This study examines various types of structures such as beam-column and beam-slab foundations, flat-frame structures, and large buildings. Many aspects including general overview, mechanisms of progressive failure resistance, evaluation of previous experimental tests in terms of alternative load path method, types of test procedures, effects of boundary conditions, additional reinforcing bars, seismic details, structural adjustment, infilled walls, reinforced concrete slabs and beams, demolished building, multi-risk, new schemes for reducing the replacement of prefabricated frames and concrete materials.

6) *Ahmed M. Yousef, Mahmoud. El-Mandouh. 2020, Dynamic analysis of high strength concrete frame buildings for progressive collapse.*

This paper contains that the progressive collapse analysis of three and six-story frame buildings constructed with HSC after removal of the central column is roughly similar to that of the same structures constructed with NSC. A three-story building constructed using NSC and HSC could not collapse if the linear static central columns were removed, while the situation changes for both six-story buildings and both NSC and HSC.

The three- and six-story NSC and HSC buildings would gradually collapse due to the dynamic linear and non-linear removal of the central columns. The ratio of the maximum nonlinear dynamic displacement to the maximum linear dynamic displacement for the three-story NSC and HSC buildings after removing the columns is 1.17 and 1.18, respectively, and for the six-story NSC and HSC, these ratios change from 1.89 and 1 to 0.86. buildings.

- 7) *Shubham Tripathi, Dr. A. K. Jain. 2019, Progressive collapse assessment of RCC structure under instantaneous removal of column and its modeling using ETABS.*

In this study, a direct static investigation of the resistance assessment was carried out in the dynamic breaking of a 12-story RC building by removing four columns, viz. i.e., corner, short side, long side and interior as per GSA 2013. The column has been removed at first floor and 7th floor respectively and the DCR reports on bending shafts as well as PMM and shear value sections are reviewed and presented as column charts. Only the beams up to the top floor will fail in any case of column evacuation from the first floor, and the column deflection is the main criterion for the dynamic structural failure procedure. Escape boxes in the 7th floor main buildings 4 upper floor joists are of greater concern than the lower floor joists.

- 8) *Hamed Yavari, Mohammad Soheil Ghobadi, Mansoor Yakhchalian. 2019, Progressive collapse potential of different types of irregular buildings located in diverse seismic sites.*

In this paper, progressive collapse studies of buildings exhibiting TI and IDVLI were carried out. More than 144 dynamic nonlinear progressive collapse potential analyzes were performed on 72 buildings under interior and exterior column removal scenarios. These buildings are 3, 6, and 9 stories high, with different intensity TI and different shapes IDVLI height and are located in different locations according to the level of seismic risk. Buildings of the same height are designed for almost the same basic range according to the relevant codes and are almost equivalent.

- 9) *Ardian Yolanda, Zulfikar Djauhari, Ridwan, and Enno Yuniarto. 2019, Progressive collapse of regular and irregular reinforced concrete moment frame.*

In this search. The analysis involved the removal of multiple columns at a critical location in the building as determined by the General Services Administration (GSA) 2013. Each analysis examined the required structural member capacity ratios (DCRs) and compared them to established acceptance criteria to prevent gradual collapse of structural buildings, the DCR ratio of regular and irregular buildings should be less than 2 and 1.5, respectively the result showed that the structure did not collapse after only one column was removed. After this find, several columns need to be removed so that it gradually collapses.

- 10) *Jian Hou, Li Song, Huanhuan Liu. 2015, Progressive collapse of RC frame structures after a central column loss.*

A static experimental study was conducted to investigate the progressive failure of the RC frame structure due to the loss of the central column. Based on the experimental results and analysis, a simplified calculation model for the progressive failure resistance of RC frame structures due to the loss of the central column, beams and frame plates as the contact mechanism and the spring mechanism as the tension membrane was proposed. The tensile strength of the frame plates is higher than the tensile strength of the frame beams, and the tensile strength of the frame plates in the short axis direction is clearly higher than in the long axis direction.

IV. CONCLUSION

As we studied the research of all authors, we conclude that the majority of the experimental studies used the static loading pattern without considering the dynamic effect in the actual collapse process. The numerical methods for progressive collapse have been introduced in these papers. The nonlinear dynamic effect in the simple structures (i.e., framed structures) is investigated based on the dynamic and energy theories.

REFERENCES

- [1] Alireza Kazem, Hossein Kazem, Benyamin Monavari(2014) Effect of Progressive Collapse in Reinforced Concrete and Steel frame Structures with irregularity in shape and height.
- [2] Bruce R. Ellingwood(2005) Building design for abnormal loads and progressive collapse.
- [3] P Neeraja and K Anish(2021) Investigation on progressive collapse failure in a multistorey irregular structure.
- [4] Y.A. Al-Salloum, H. Abbas, T.H. Almusallam, T. Ngo, P. Mendis(2017) Progressive collapse analysis of a typical RC high-rise tower.
- [5] Behrouz Asgarian, Soheil Dadras Eslamlou, Arash E. Zaghi, Masoud Mehr(2016) Progressive collapse analysis of power transmission towers.
- [6] Halil Sezen, Brian I. Song, and Kevin A. Giriunas (2014) Progressive Collapse Testing and Analysis of a Steel Frame Building.
- [7] E. Masoero, P. Darò, B.M. Chiaia. (2013) Progressive collapse of 2D framed structures: An analytical model.
- [8] Usman Ilyas, S H Farooq, I. Shahid, M. Ilyas (2015) Progressive Collapse of Reinforced Concrete Frame Structure under Column Damage Consideration.
- [9] Raghavendra C, Mr. Pradeep A R (2014) Progressive Collapse Analysis of Reinforced Concrete Framed Structure.
- [10] Behrouz Asgarian, Farshad Hashemi Rezvan (2011) Progressive collapse analysis of concentrically braced frames through EPCA algorithm.
- [11] Digesh D. Joshi, Paresh V. Patel and Saumil J. Tank (2010) Linear and Nonlinear Static Analysis for Assessment of Progressive Collapse Potential of Multistoried Building.



- [12] Leslaw Kwasniewski (2010) Nonlinear dynamic simulations of progressive collapse for a multistory building.
- [13] Seweryn Kokot, Armelle Anthoine, Paolo Negro, George Solomos (2012) Static and dynamic analysis of a reinforced concrete flat slab frame building for progressive collapse.
- [14] Meng-Hao Tsai, and Tsuei-Chiang Huang (2011) Progressive collapse analysis of an RC building with exterior partially infilled walls.
- [15] Mehrdad Sasani and Jesse Kropelnicki (2008) Progressive collapse analysis of a RC structure
- [16] Feng Fu (2009) Progressive collapse analysis of high-rise building with 3-D finite element modeling method.
- [17] Ram Shankar Singh, Yusuf Jamal and Meraj A. Khan. (2015) Progressive collapse analysis of reinforced concrete symmetrical and unsymmetrical framed structures by etabs.



10.22214/IJRASET



45.98



IMPACT FACTOR:
7.129



IMPACT FACTOR:
7.429



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089  (24*7 Support on Whatsapp)