



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

9940 572 462

6381 907 438

[ijirset@gmail.com](mailto:ijirset@gmail.com)

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# Assessment of Progressive Collapse of Multistorey RC Building by Using STADD PRO

Hole Sayali Pramod<sup>1</sup>, Prof. P.J. Salunke<sup>2</sup>

P.G. Student, Department of Civil Engineering, M.G.M.'S College of Engineering and Technology, Navi Mumbai, Maharashtra, India<sup>1</sup>

Professor, Department of Civil Engineering, M.G.M.'S College of Engineering and Technology, Navi Mumbai, Maharashtra, India<sup>2</sup>

**ABSTRACT** - Progressive collapse in a structure occurs when major structural load carrying failed, and the remaining structural elements cannot support the weight of the building and fail. This failure usually occurs in a domino effect and leads to a progressive collapse failure in the structure. The bombing of the Murray Federal Building in Oklahoma City is a typical example of progressive collapse failure. The initial bomb caused only 10% of the structure's damage, and the resulting progressive collapse failure lead to 90% of the structure's damage. Also the progressive collapse of Ronan point apartment building in 1968 and world trade centre (WTC), and to give idea about constructing building safer from progressive collapse. The purpose of this research is to prevent progressive collapse of any existing RC building. . The objectives of project work is to study various types of progressive collapse and its mechanisms and analyze (G+15) RC earthquake resisting building for seismic zone III as per IS 1893:2002 by using STADD PRO software for linear dynamic analysis procedure. I removed several columns at different position of building which leads to progressive collapse. To prevent progressive collapse bracing system is used with different arrangement. The vertical displacement, moment, deflection and inter storey drift data recorded without bracing system and with bracing system and compared. The model was created in a structural analysis program STADD PRO. The STADD PRO analysis conducted in this research was based on non-linear material properties. The ultimate goal of this progressive collapse research on building is to develop better building evaluation and design guideline for structural engineers to use to prevent collapse in new and existing building. Future progressive collapse research recommendation are also presented.

**KEYWORDS:**RCC Building, IS-1893-2015, IS-456-2000, ,STADD PRO software Base Shear, Lateral storey drift, Displacement, time period, GSA Linear dynamic analysis, use X and V bracing.

## I. INTRODUCTION

Progressive collapse of building structures is initiated when one or more vertical load carrying members, such as columns or walls, are removed. Once a column or a wall is removed due to abnormal loading, the building's weight (gravity load) transfers to adjacent columns or walls in the structure. If these columns or walls are not adequate to resist and redistribute the additional gravity load, that part of the structure collapses. The vertical load carrying elements of the structure continue to collapse until the additional loading is stabilized. As a result, a large part of the structure may collapse, causing greater damage to the structure than the initial impact. Progressive collapse of structures refers to local damage due to occasional and abnormal events such as gas explosions, bomb attacks and vehicular collisions. The local damage causes a subsequent chain reaction mechanism spreading throughout the entire structure, which in turn leads to a catastrophic collapse. Now a days avoid the progressive collapse of the structure is very important.

## II. LITERATURE REVIEW

The present work is aimed at assessment of progressive collapse of RC Building. This project studies the behaviour of structure in progressive collapse. Compute the data before and after the removal of column. The main response parameters are horizontal displacement, vertical displacement, inter storey drift, deflection of beam above removed column. To achieve this goal, a computer program STADD PRO is used to model and analyse the buildings.

**.Abitkar & Joshi (2019)** different analysis procedures, philosophies and the Codal provisions for this around the world. These analysis procedures are useful while analysing with different software packages. SAP2000 is one of the useful tools while doing nonlinear dynamic analysis as some of the peculiarities in SAP helps to complete the analysis in short time.

**Divya & Nikhil (July 2019)** conducts analytical study of RC structure for progressive collapse and economic beam design. Progressive collapse resistance of 8-storey RC structure with 24 m height and aspect ratio 1. This dynamic phenomena created due to various human activities and natural phenomena adversely affect buildings, its occupants and human life. Aim of this study is to understand performance of RC building under the column removal scenario during an earthquake data. Nonlinear direct integration analysis is performed using ETABS 17.0.1 to understand response of a structure during seismic action. For this study column removal locations considered are corner, intermediate and perimeter of the plans. Beams are considered for this study optimum. L/D ratio of Beam is obtained as per IS 456 - 2000, for 3m and 4m span L/D ratio 12 is considered and L/D ratio 10 is considered for 6m span beam. DCR value is less than 2.

**Baldota & Bhavana (2018)** analysed G+ 8 moment resisting steel frame building for progressive collapse considering two methods namely linear static and non linear static method by using ETABS 2015 software. In this attempt, the columns at different levels are subjected to varying temperatures ranging from 250°C-1000°C with the material properties and yield strength as per IS 800-2007. Different load combinations are considered as per IS 875 part I & II. According to General Service Administration (GSA) 2016 guidelines fire load is applied additionally at different storeys to the selected columns. The structure is analyzed and the DCR values obtained are checked as per GSA 2016 permissible limits.

**Pavithra & Manjula (2016)** used the buildings exposed to progressive collapse is produced by immediately deleting some vertical loads due to ultimate loads and results gives the failure of structural buildings. G+8 storey of building is considered for progressive collapse analysis by using dynamic methods. The sudden column removal gives damages of nearest beams up to some storey levels building conduct different seismic zones. The dynamic analysis is carried out using E-TABS Version 9.6.0 software. Demand capacity ratios (DCR) of multi typical storey RC framed structure are calculated approximately by using general service administration guidelines. The comparative analysis of frame structure in different ground motion zones for progressive collapse. During earthquake effect, the causes of progressive collapse are checked and safe and unsafe structural members are to be studied for different models are analyzed in different ground motion zones.

**Fatema & Hamane (2016)** it is proposed to carry out progressive collapse analysis of 13 storey RC frame building by removing different column one at a time as per the GSA guidelines. Building consists of 5 X 5 bay 5 m in both direction and designed by Indian code as a special moment resistant frame. Structural model of building has been created in ETABS and loads are applied as per GSA guidelines, for evaluation of progressive collapse linear static method of analysis and nonlinear static method of analysis has been used. As per GSA guidelines three column removal case one at a time has studied, namely corner column removal at ground floor, exterior column at ground floor and interior column at ground floor.

### III. METHODOLOGY

In the study, Assessment a progressive collapse of multistory rc building after removing column with or without bracing. 1. Selection of building geometry, G+15 storey. 2. Define the material property of frame. 3. Define the section property of frame beam, column and bracing. 4. Assign the joint pattern as fixed support. 5. Define the load pattern, dead load and live load. 6. Define the Response Spectrum Function. 7. Run the modal analysis. 8. Define load combination as guideline of GSA. 9. Obtain bending moment of every element before and after removal of column. 10. Calculate DCR value for every element. 11. Define Pushover and time history load cases. 12. Run the analysis without bracing and with bracing. 13. Comparison in analysis result as storey drift and vertical displacement. 14. Observation 15. Conclusion





#### IV. STRUCTURAL MODELLING

In this study, the effect of progressive collapse, the structure is modelled using STADD Pro in the sense that certain members are to be removed. Progressive collapse and dynamic effects is evaluated using time-history analysis as follows: 1. A model is created which contains the entire structure, including the column to be removed. 2. Analyze this model to obtain the internal forces of the column which will be removed. 3. Another model is created in which the column is removed in three different positions. 4. Simulate the removal of the column by running a time-history analysis in which these equivalent column loads are reduced to zero over a short period of time. This is done by applying a ramp time function in which loads opposite to those of the equivalent column loads are scaled from zero to the full value. 5. Another model is created with X and V Bracing systems of different arrangements in which the column is removed. 6. "ISA 200mm x 200mm x 18 mm" angle section bracing is used in this analysis. Analyze the model and compare the results obtained.

#### V. PRELIMINARY DATA

Following are the data assumed for carrying out this study, 1. Length in X direction=30m. 2. Length in Y direction=22.5m. 3. Typical storey height=3.2m. 4. Ground storey height=3.5m. 5. No. of storey =15. 6. Bay spacing in X direction= 7.5m 7. Bay spacing in Y direction= 7.5m 8. Columns Above Ground Floor = 600mm X 600mm. 9. Columns Below ground Floor = 600mm X 600mm.

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**ISSN** INTERNATIONAL  
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