© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 11 Issue: 04 | October - December 2020
Paper is available at http://www.jrps.in | Email : info@jrps.in

To Study the Effects of Shear walls in Multistory Building by Using STAAD PRO

Shail Agrawal[*], Satyendra Dubey[**]

[*] Research Scholar, department of Civil Engineering, Gyan ganga institute of technology and science jabalpur mp
[**] Assistant professor, department of Civil Engineering, Gyan ganga institute of technology and science jabalpur mp

Abstract- Construction Structures or buildings are major implementation of civil engineering and architectural. In the present day several multi-storey buildings are made around the world and are used for commercial purposes such as corporate space, offices etc. However, the buildings have a specific life span depending upon the site of construction as well as material used in the complete structure. After a certain period of time the building is collapsed. The present research work aims at the collapse behaviour of a building. The complete process is carried out using analytical approach on Staad.Pro tool. A RCC structure is designed as per the IS codes. 4 storey building is considered in the study. Two different loads are applied mainly the dead load and the live load. Columns are designed for axial forces and biaxial moments per IS 456:2000. Columns are also designed for shear forces. Beams are designed for flexure, shear and torsion. For design to be performed as per IS: 13920 the width of the member is kept more than 200mm. The grade of concrete used is M20 and the reinforcement used as Fe415 Steel. Results are evaluated for displacement, shear, moment, and axial forces for all the directions of x, y and z directions. Results are also calibrated by removing specified beams and columns from the design model of the building to comprehend the collapsing behaviour. Results are compared at the final stage.

Keywords - structure, Staad.pro, dead load, live load, RCC

I. Introduction

Prevention or mitigation of progressive collapse appears to be an important issue in the development of several structural design codes. They highlight the necessity of providing sufficient structural integrity, ductility, and redundancy to indirectly compensate the risk of disproportional collapse.

Awareness on the issue of progressive collapse took place after the structural failure of Ronan point in 1968. After the terrorist attack on Murrah federal office building in 1995 more and more research efforts were put to understand the progressive collapse. But it is important to note that collapse of the World Trade Centre (commonly known as 9/11) has led to the detailed investigations for the enhancement of robustness of structures in order to save precious loss of life and property under such attacks.

A. Progressive Collapse

Progressive collapse is generally defined as small or local structural failure results in damage and failure of the adjoining members and in turn, causing total collapse of the building or a disproportionately large part of it. Progressive collapse of building structures is initiated by loss of one or more vertical load carrying members, usually columns. After one or more columns fail, an alternative load path is needed to transfer the load to other structural elements. If the neighbouring elements are not designed to resist the redistributed loads, failure will happen with further load redistribution until equilibrium is reached, resulting in partial or total collapse of the structure.

Pressure Loads

1. Internal gas explosions
2. Blast
3. Wind over pressure
4. Extreme values of environmental loads

Impact Loads

1. Aircraft impact
2. Vehicular collision
3. Earthquake
4. Overload due to occupant overuse
5. Storage of hazardous materials

II. Literature Review

Leslaw Kwasniewski (2010) presented a case study of progressive collapse analysis of a selected multi-story building. The subject of the numerical study is an existing 8-story steel framed structure built for fire tests in the Cardington Large Building Test Facility, UK. The problem is investigated using nonlinear dynamic finite element simulations carried out following the

GSA guidelines. The paper focuses on model development for global models subject to increasing vertical loading and notional column removal. Taking advantage of parallel processing on multiprocessor computers, a detailed 3D model with large number of finite elements has been developed for the entire structure. The objective of the presented feasibility study is to identify modelling parameters affecting the final result (potential of progressive collapse) and propose a hierarchical verification and validation program for reducing outcome uncertainties.

Meng-Hao Tsai (2011) studied the effects of three common types of exterior non-structural RC walls on the progressive collapse potential of an RC frame are investigated. Linear and nonlinear static analyses are carried out for the RC frames with and without the non-structural walls under three different column-loss scenarios. Changes in demand-to-capacity ratios indicate that without considering the non-structural walls, the moment demand of beams may be overestimated while the shear demand may be underestimated, especially for the panel-type walls. They may increase the collapse resistance of the building frame under column loss, but with decreased ductility capacity. With a constant opening rate of 60%, the wing-type exterior wall is a better option than the parapet-type and panel-type walls from the structural aspect. The panel-type wall appears to be the worst choice since shear failure of their connected beam members may be induced.

P.P Chandurkar (2013) did a detail study to determine the solution for shear wall location in multi-storey building with the help of four different models. The buildings were modeled using software ETAB Nonlinear v 9.5.0.After analysing ten storey building for earthquake located in zone II, zone III, zone IV and zone V essential parameters like lateral displacement, story drift and total cost required for ground floor were found in both the cases by replacing column with shear wall and conclusion was drawn that shear wall in short span at corner(model 4) is economical as compared with other models. It was observed that shear wall is economical and effective in high rise buildings and providing shear walls at adequate locations substantially reduces the displacement due to earthquake. If the dimensions of shear wall are large then major amount of horizontal forces are taken by shear wall.

Samrat Prakash Khokale (2017) found critical Shear wall in building which causes maximum damage or collapse after the removal. Shear strength of Shear wall is the main factors considered for study. After this collapse pattern of building is studied using same software. This paper presents current design approaches found in the U.S. and European building codes and standards for the prevention of progressive collapse due to abnormal loading. Because the definition of abnormal loading is not well established, design provisions are based on an approach that protects buildings by means of strength, ductility and redundancy.

MD Goel et al (2017) had did investigations of 4 storey RCC building with 3 x 3 bays having longitudinal bay span of 5m and transverse bay span of 4m. The height of building is 3.5 m at each floor except the ground floor of 4m height. The behavioural changes have been investigated to sudden collapse of load bearing member.

Alok Rathore (2017) development of Tall building has been rapidly increasing worldwide introducing new challenges that require to be met through structural style by correct engineering judgments. In trendy tall buildings, lateral hundreds induced by wind or earthquake are typically resisted by a system of coupled shear walls. however once the building will increase in height say 90 m, the stiffness of the structure becomes additional vital as height of the building will increase, the stiffness of the building reduces then the lateral load resisting system is employed offer sufficient lateral stiffness by providing outrigger beams between the core and external columns is usually wont to provide spare lateral stiffness to the structure. The outrigger with Belt truss is employed as one of the structural system to effectively management the excessive drift because of lateral load. Thus, it'll improve the performance by preventing the structural and non-structural damage of the building below seismic loading and wind loading. The objective of this paper is to check the outrigger structural system in high rise RC building below the action of laterals hundreds like seismic hundreds and wind load.

Reddy, 2016 studied the stress concerning recognizing the presence of floating column in multi-storeyed buildings and the way to reduce the risk issue of earthquake effects by strengthening the floating columns building with Bracings. Throughout this present study four models are used specifically, 'Model 1 (G+9 normal RC Building)', 'Model 2 (G+9 RC Floating column Building)', 'Model 3 (G+9 RC Floating column Building with Bracings at corner)', 'Model 4 (G+9 RC Floating column Building with Bracings at centre)'. Seismic analysis is meted out on all four models using Equivalent static technique and Response spectrum technique in 2 zones (III, V) severally. Comparison of results structure shears, structure Drifts, most Displacement, period of time and Base shear for all four models are dead. Because the Model four throw in higher results compared to different Models, its performance is reviewed using pushover analysis and also the performance levels are mentioned by comparison Model four with Model three. This seismic assessment is dead exploitation ETABS software system as per the code book IS:1893-2002.

III. ANALYSIS OF RCC BUILDING

A. Analytical Model

A RCC building with or without shear wall is designed according to Indian codes. Figure 1shows a 3 storey building and the plan of building is asymmetric throughout the height. The height of building is 3.2m at each floor and the elevation of building with or without shear wall is shown in figure 2. For each storey the size of all beams is designed and kept constant with a dimension 230 mm x 300 mm and column size is 230 mm x 450 mm. Building is designed according to IS codes for dead and live load condition.

Table 1 Building plan

Dead load	4 KN/m^2
Live load	3 KN/m^2
Member dead load (wall load)	15 KN/m^2
Parapet wall dead load	5 KN/m^2

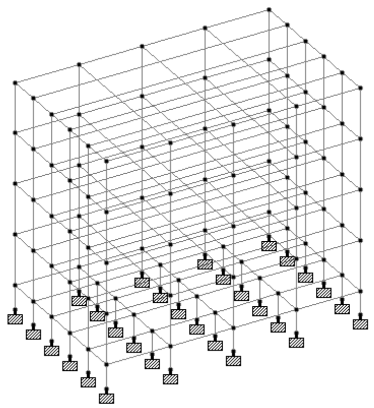

Figure 1 Building plan

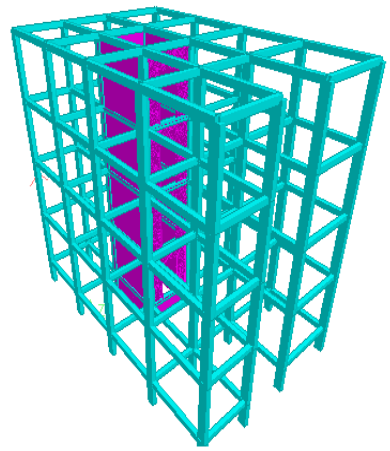

Figure 2 Building plan

IV. RESULTS AND DISCUSSION

A RCC building is designed according to Indian code. We have considered 4 storey building along having floor height of 3.2 m and the depth of foundation is to be 1.5 m. All columns are of 230 mm x 450 mm. All beam sizes are 230 mm x 300 mm. Consider two loads i.e. dead load and live load. In dead load consider the self-weight of the structure, wall weight of 15 KN/m, parapet wall weight of 5 KN/m, floor weight of 4 KN/m^2 and in live load of 4 KN/sqm. The combination of both the Loads is considered according to Indian standards code IS 456. Concrete grade considered is M25 and steel grade Fe 415. The exterior column of ground floor is removed one by one in a series to find out the critical columns. Comparative study of various parameters like axial forces on column, node displacement at top nodes of removed column and support reactions in vertical direction of both the frame (with and without shear wall) is carried out.

A. Critical Column at Ground Floor of Rcc Building

Figure 3 shows the numbering of column at ground floor. A series of column removal scenario are applied on outer column of 4 storey building to determine the critical columns at ground floor. Each exterior column removal scenario at ground floor is conducted by delete command from STAAD Pro.

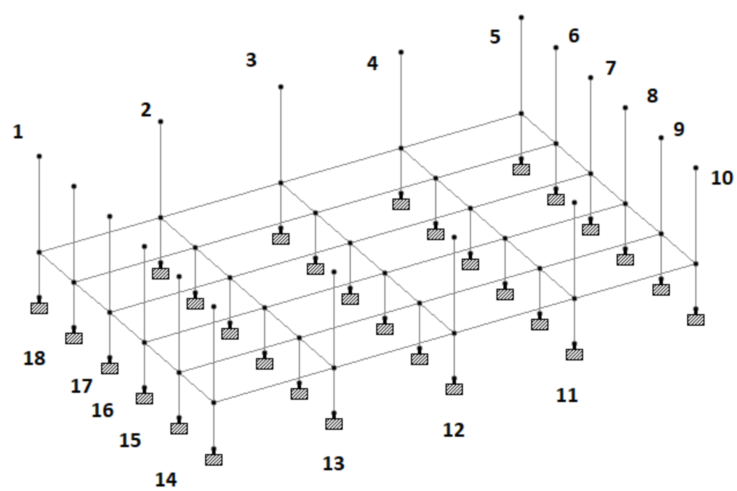

Figure 3 Numbering of columns of ground floor

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 11 Issue: 04 | October - December 2020
Paper is available at http://www.jrps.in | Email : info@jrps.in

B. No collapse in column

After computing the results of the state when no column was removed, several columns were removed and axial forces are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in Figure 4 after removal of column 16 on column 17, i.e. 298.94 KN to 1190.94 KN.

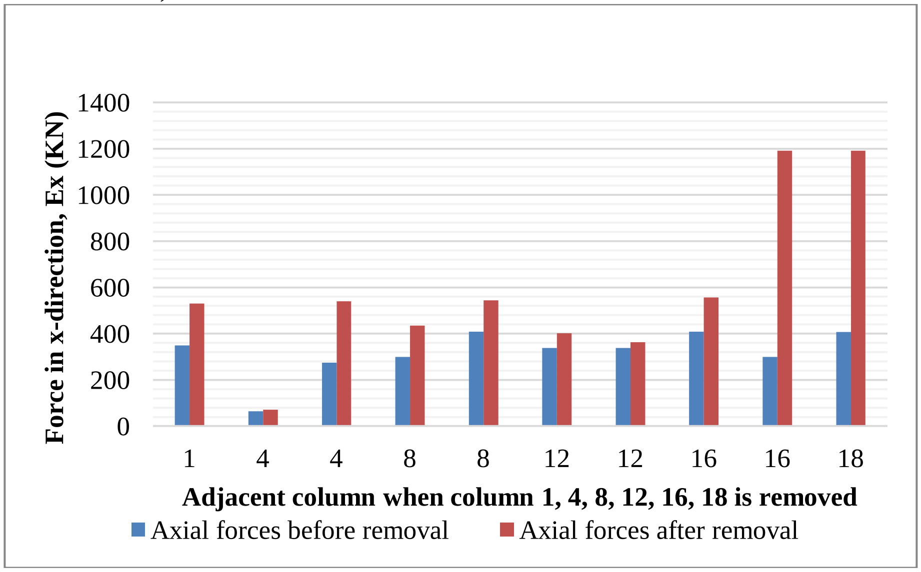

Figure 4 Axial force before column removal and after column removal

Now, after removal of columns, results of reaction forces are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 5 after removal of column 16 on column 17, i.e. 323.36 KN to 1201.56 KN.

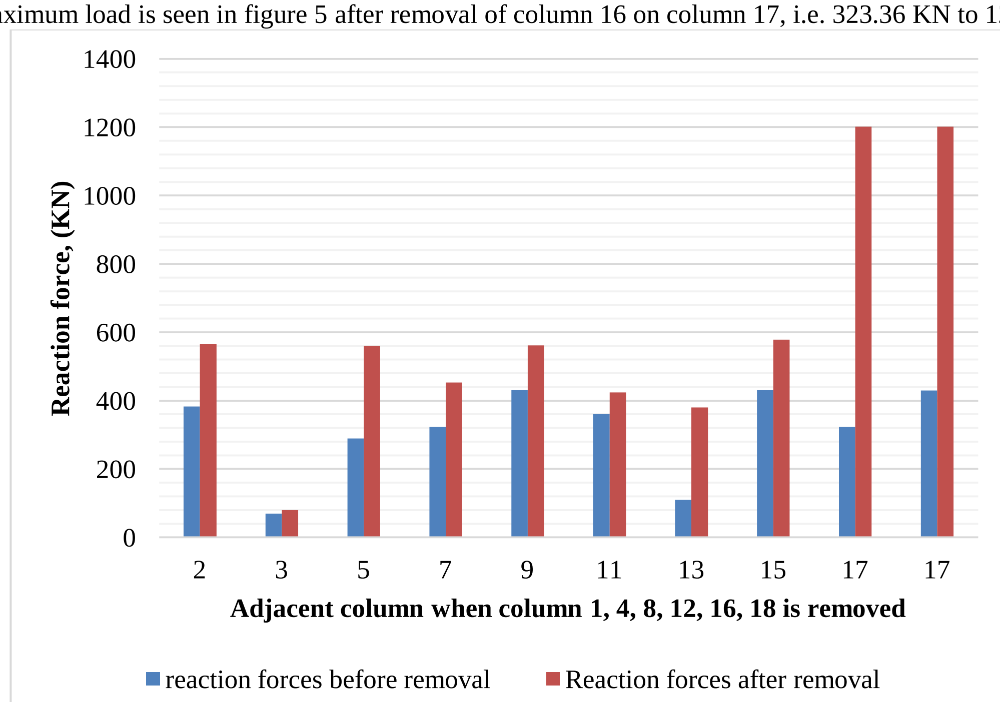

Figure 5 Reaction force in y-direction before column removal and after column removal

After removal of columns, results of reaction forces due to shear force in y direction are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 6 after removal of column 16 on column 17, i.e. 6.050 KN to 29.011 KN.

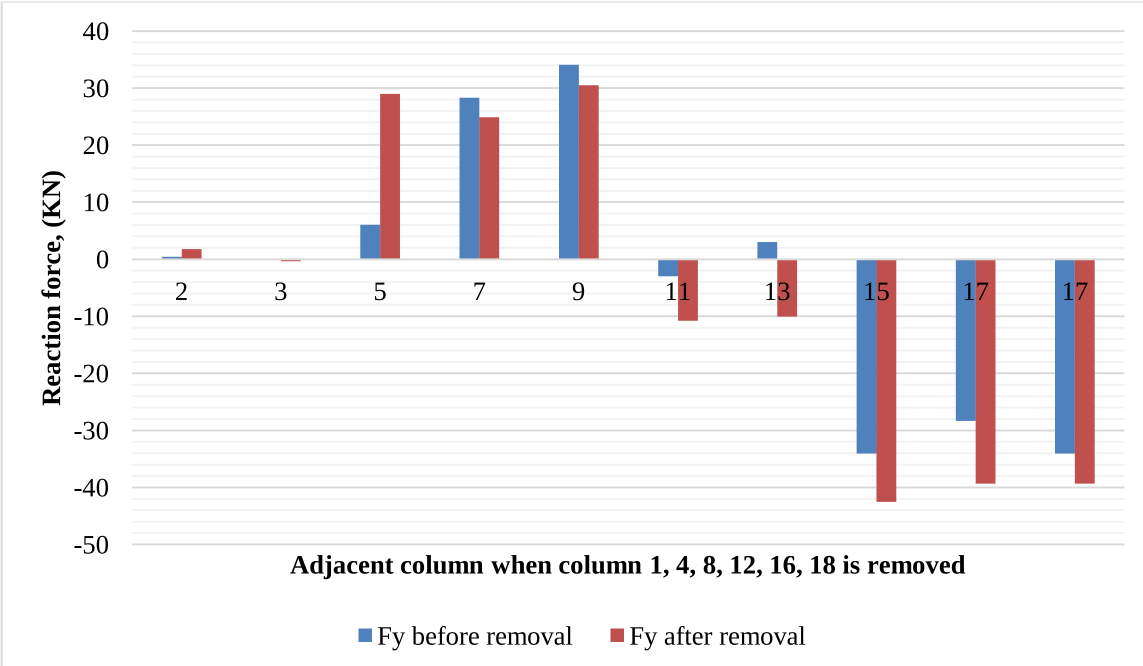

Figure 6 Reaction of shear force in z-direction before column removal and after column removal

After removal of columns, results of reaction forces due to shear force in y direction are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 7 after removal of column 8 on column 7, i.e. -0.309 KN to 13.63 KN.

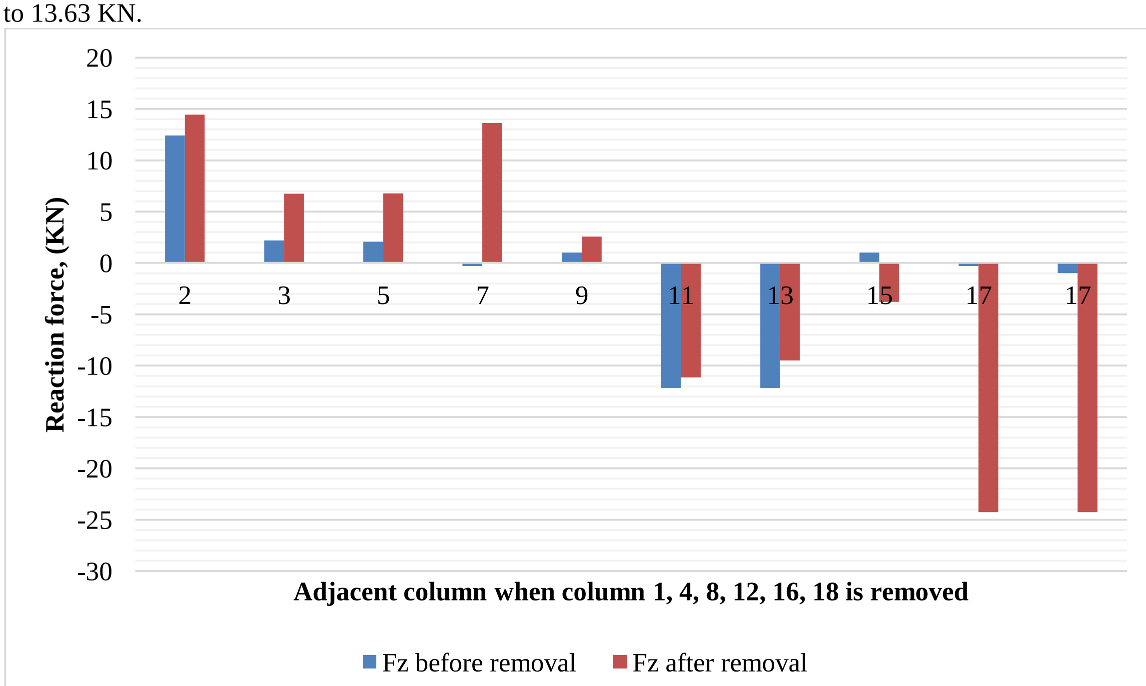

Figure 7 Reaction force before column removal and after column removal

After removal of columns, results of moment are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 8 after removal of column 8 on column 7, i.e. 0.231 KNm to 24.75 KNm.

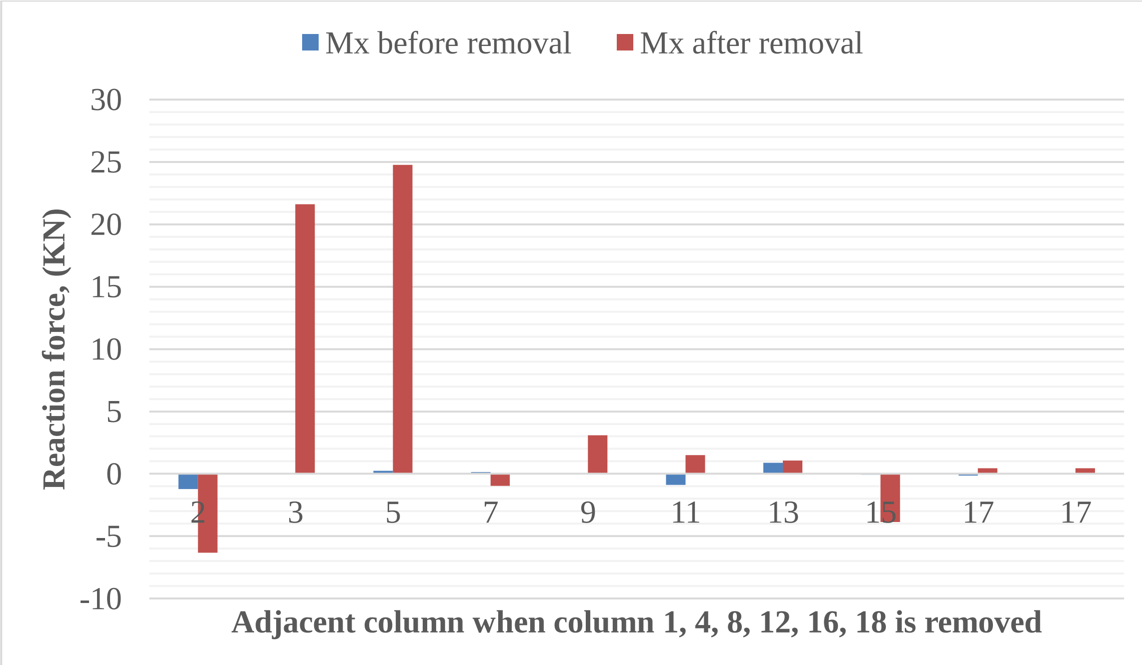

Figure 8 Moment force in x-direction before column removal and after column removal

After removal of columns, results of moment of shear force in y direction are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 9 after removal of column 16 on column 17, i.e. 3.560 KNm to 25.81 KNm.

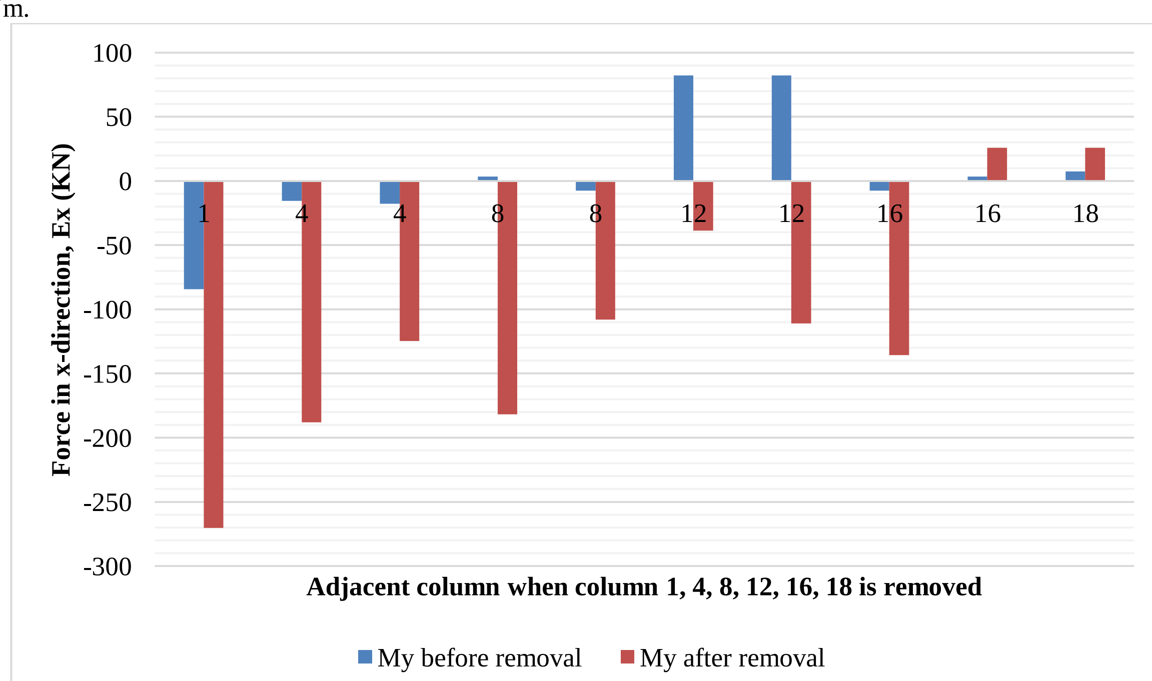

Figure 9 Moment force in y-direction before column removal and after column removal

After removal of columns, results of moment of shear force in z direction are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 10 after removal of column 4 on column 5, i.e. 49.95 KNm to 157.22 KNm.

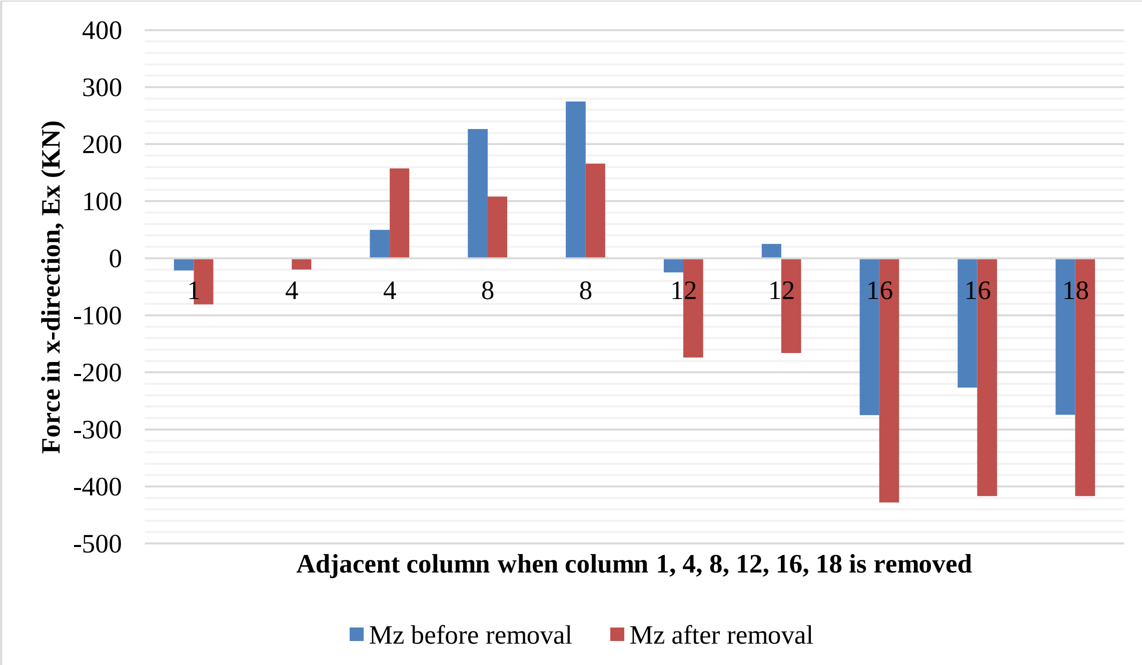

Figure 10 Displacement Mz before column removal and after column removal

After removal of columns, results of displacement due to axial force are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 11 after removal of column 1 on column 2, i.e. 0 mm to 0.019 mm.

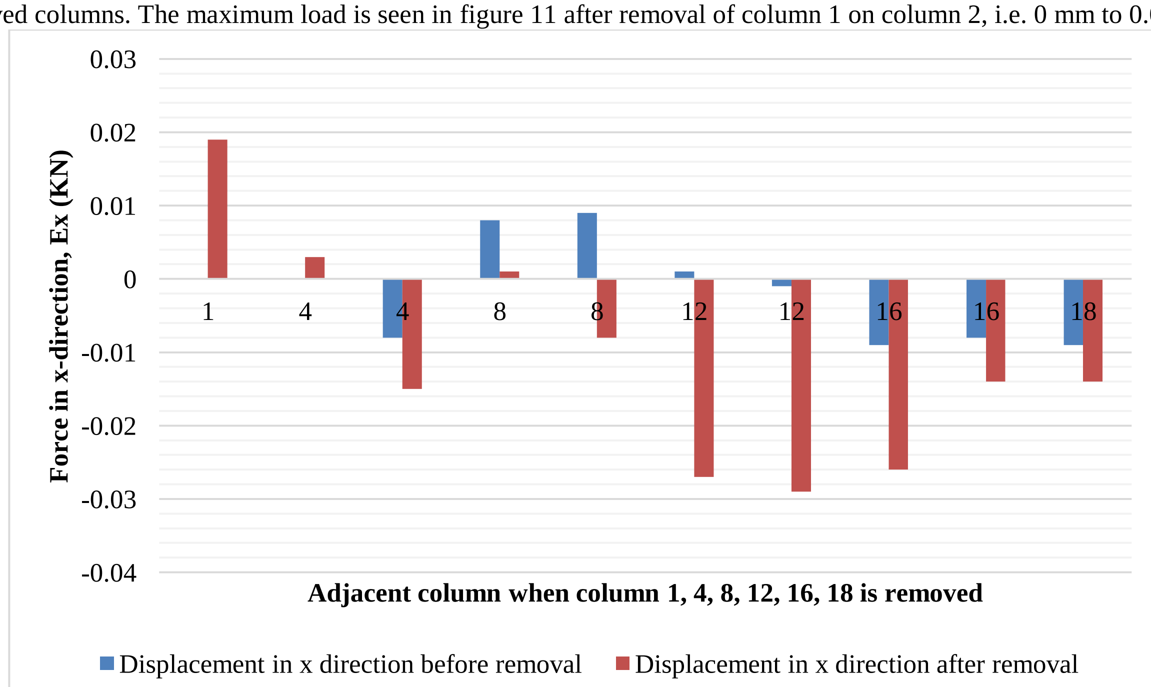

Figure 11 Displacement in x direction before column removal and after column removal

After removal of columns, results of displacement due to shear force in y direction are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 12 after removal of column 4 on column 3, i.e. 0mm.

© INTERNATIONAL JOURNAL FOR RESEARCH PUBLICATION & SEMINAR
ISSN: 2278-6848 | Volume: 11 Issue: 04 | October - December 2020
Paper is available at http://www.jrps.in | Email : info@jrps.in

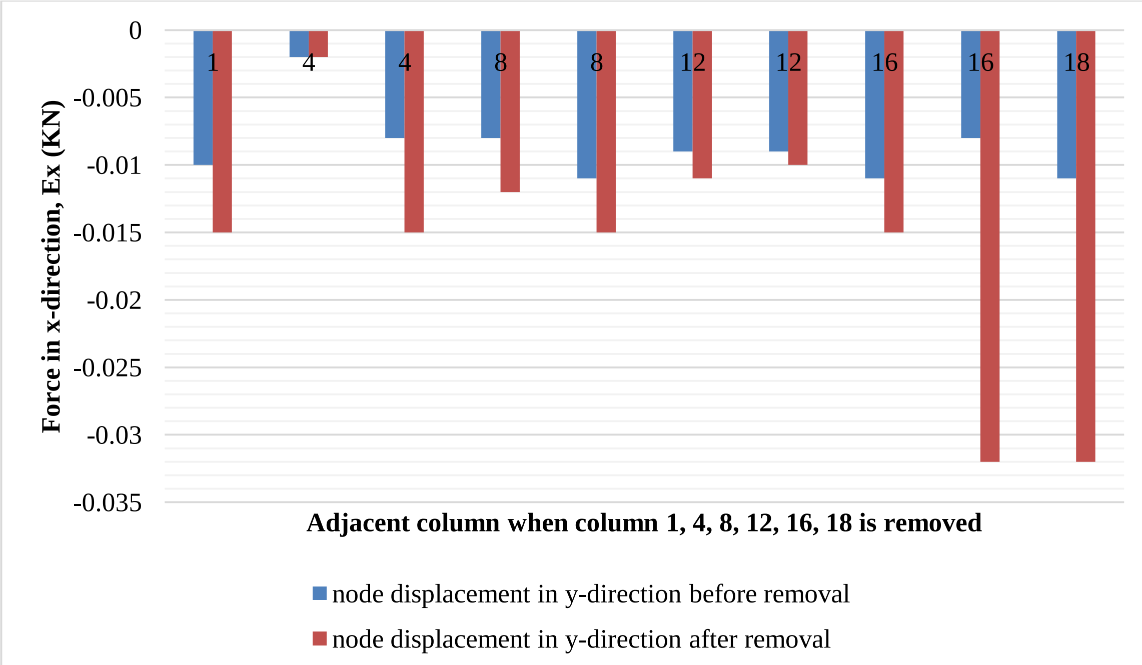

Figure 12 Displacement in y-direction before column removal and after column removal

After removal of columns, results of displacement due to shear force in z direction are computed and compared with the adjacent columns of the removed columns. The maximum load is seen in figure 13 after removal of column 12 on column 11, i.e. 0.002 mm to 0.01 mm.

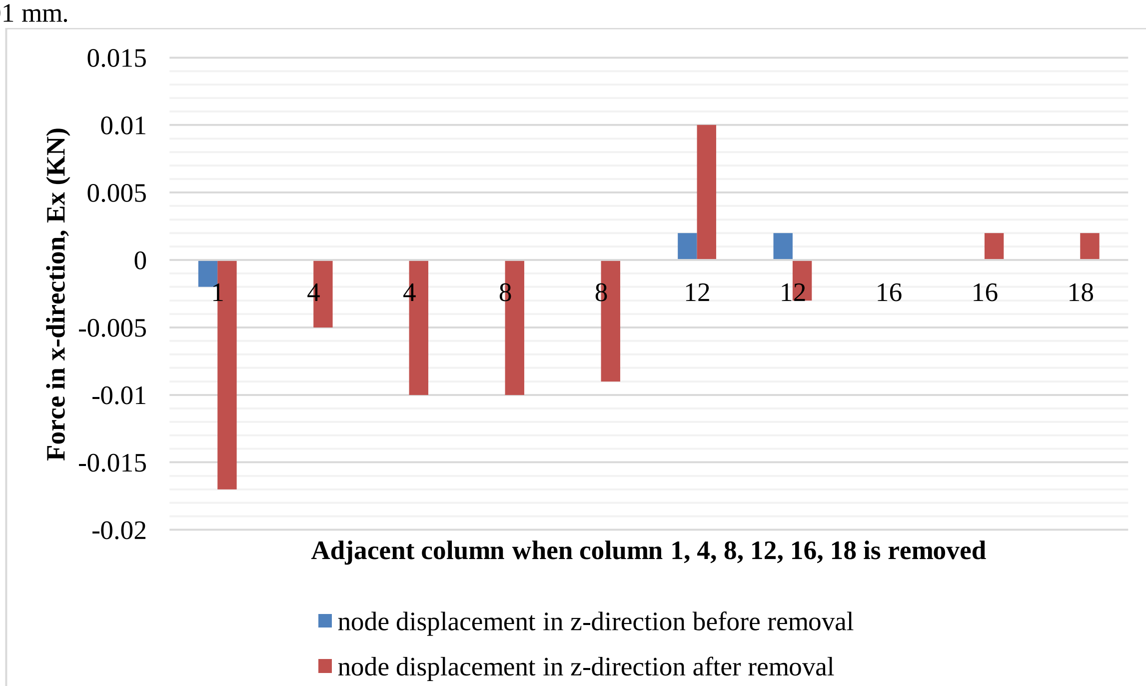

Figure 13 Displacement in z-direction before column removal and after column removal

When collapse in beam happened, the table shows the forces in each point the maximum axial force is 3615.616 KN and minimum axial force is -309.785 KN. In shear force in y-direction and z-direction case the maximum value is 293.667 KN for y-direction and 130.963 KN is z-direction and minimum value is -497.209 KN in y-direction and -294.590 is z-direction. In case of bending moment the value in minimum and maximum value in x-direction is -769.486 KNm and 1062.049 KNm, y-direction bending moment maximum and minimum value is 4819.469 KNm and -3977.905 KNm respectively and z-direction bending moment maximum and minimum value is 6264.044 KNm and -4983.654 KNm respectively.

Table 2 Determination of forces in staadpro

Beam	Node	Axial Force (KN)	Shear force (KN)		Bending moment (KNm)		
		Fx	**Fy**	**Fz**	**Mx**	**My**	**Mz**
202	**99**	**3615.616**	60.858	2.564	1.300	6.301	-19.723
178	**81**	**-309.785**	230.637	39.315	9.343	-32.246	249.849
159	**62**	323.949	**293.667**	3.479	-17.813	-3.324	376.634
49	**27**	326.411	**-497.209**	25.150	-42.244	10.363	527.621
162	**65**	22.162	-255.259	**130.963**	-14.605	-182.577	-320.934
74	**25**	72.389	-272.181	**-294.590**	-11.190	544.503	-507.444
172	**75**	-2.101	-3.564	62.205	**119.990**	-94.037	-83.936
184	**85**	-67.145	199.949	19.927	**-86.936**	5.589	136.927
74	**25**	72.389	-272.181	-294.590	-11.190	**544.503**	-507.444
158	**79**	30.416	-303.763	-244.295	-19.784	**-449.423**	569.387
135	**61**	-128.716	227.177	-3.315	-4.703	26.452	**707.711**
159	**80**	312.217	293.667	3.479	-17.813	7.806	**-563.053**

When collapse happened in beam the table shows the displacement in each point in x-direction the maximum displacement is 1.803mm and minimum displacement is -160.477mm. Displacement in y-direction and z-direction case the maximum value is 28.575mm for y-direction and 0.152mm is z-direction and minimum value is –243.433mm in y-direction and -109.143mm is z-direction. In case of rotational displacement the value in minimum and maximum value in rx-direction is -0.020rad and 0.000rad, ry-direction rotational displacement maximum and minimum value is 0.009rad and -0.007rad, in rz-direction rotational displacement maximum and minimum value is 0.057rad and -0.035rad respectively.

Table 3 Determination of displacement in staadpro

Node	Horizontal	Vertical	Horizontal	Resultant	Rotational		
	X mm	**Y mm**	**Z mm**	**mm**	**rX rad**	**rY rad**	**rZ rad**
4	**1.803**	-1.117	-0.812	2.286	-0.001	-0.000	-0.003
78	**-160.477**	-6.756	-29.540	163.322	-0.001	0.003	0.044
90	-28.575	**28.575**	-22.123	36.144	-0.002	-0.003	0.001
91	-160.121	**-243.433**	-43.738	294.640	-0.002	-0.003	0.019
7	-1.092	-2.413	**0.152**	2.667	0.000	-0.000	0.004
75	-159.232	-129.971	**-109.143**	232.714	-0.013	0.003	0.015
37	-10.820	-243.306	-7.62	243.687	**0.000**	-0.000	-0.019
25	-20.878	-88.087	-8.331	90.906	**-0.020**	-0.003	-0.026
82	-126.161	-5.207	-29.514	129.667	0.000	**0.009**	0.047
90	-84.5058	-11.099	-62.865	105.918	-0.006	**-0.007**	0.002
80	-146.812	-5.537	-29.514	149.834	-0.002	0.008	**0.057**
85	-90.144	-6.985	-108.178	140.995	-0.008	0.005	**-0.035**
91	-160.121	-243.433	-43.738	**294.64**	-0.002	-0.003	0.019

V. CONCLUSION

In the present research work, a G+4 storey building is analysed using STAAD pro tool. The analysis is done based on the number of columns supporting the structure. Identification of critical column is done by collapsing column number 1, 4, 8, 12, 16 and 18 from the complete building model. Analysis has been carried out to calculate force on the adjacent columns before and after removal of columns to identify the critical column condition. The following conclusions are drawn from the results.

1. The column which showed the maximum load increase, before and after removal of adjacent column, on the application of axial force is known as critical column. The critical column which has been identified is column 17 on which axial force before and after removal of column 16 is 298.94 KN and 1190.94 KN.

2. The beam which is identified to bear maximum axial force of 1299.914 KN before collapsing is beam 206.
3. The beam which is identified to bear maximum axial force of 3615.616 KN after collapsing is beam 202.
4. The beam which is identified to bear maximum moment force of 685 KNm before collapsing is beam 135.

REFERENCES

[1] Leslaw Kwasniewski (2010), Non-linear dynamic simulations of progressive collapse for a multi-story building, Engineering Structures, 32, 1223-1235.

[2] Meng- Hao Tsai (2011), Progressive Collapse Analysis of an RC Building with Exterior Non-Structural Walls, The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction, 14, 377–384, 2011.

[3] P.P Chandurkar, P.S. Pajgade (2013), "Seismic analysis of RCC building with and without shear wall" IJMER, Vol.3, Issue 3, pp- 1805 -1810.

[4] Samrat Prakash Khokale (2017), Progressive Collapse of Shear wall Structure under Accidental Load, 540-549.

[5] MD Goel, D. Agrawal, A. Choubey (2017), collapse behaviour of RCC building under blas load, 11th International Symposium on plasticity and Impact Mechanics, 173, 1943-1950.

[6] IS 1893 (Part1): 2002, "Criteria for earthquake resistant design of structure,"

[7] IS 13920: 1993, "Ductile detailing of reinforced concrete structure subjected to seismic forces".

[8] General Provision and building, New Delhi, India.

[9] Bureau of Indian Standard, IS-456(2000), "Plain and Reinforced Concrete Code of Practice".

[10] T. A. Reddy, "*Comparative Seismic Study On Strengthening Of Floating Column Building Using Bracings*,", International Journal of Advances in Mechanical and Civil Engineering no. 5, pp. 65–71, 2016

[11] R. K. Sharma and N. L. Shelke, "*Dynamic Analysis of RCC Frame Structure with floating Column*," International Journal of Advanced Research in Science, Engineering and Technology vol. 3, no. 6, pp. 2302–2308, 2016

[12] B. S. Bhavya and P. Jisha, "*Seismic Evaluation of RC Unsymmetrical Building with Floating Columns & Soft storey Considering Different Configuration*,", International Journal of Innovative Research in Science, Engineering and Technology pp. 15456–15465, 2016.

[13] G. V. Kumar, "*Seismic Analysis Of Multistorey Building*," International Journal of Engineering and Innovative Technology vol. 3, no. 6, pp. 6–10, 2016.

[14] M. P. D. Motghare, "*Numerical Studies Of Rcc Frame With Different*,", International Journal Of Proresses In Engineering, Management, Science And Humanities no. 1, pp. 8–13, 2016

[15] R. K. Amritraj, M. Sheode, and K. K. Pathak, "*Analysis Of Building Frames With Floating Columns And Soft Storeys*,", International Journal of Latest Trends in Engineering and Technology no. 4, pp. 113–129, 2016

[16] A. Pardhi, P. Shah, P. Sapat, and K. Jha, "*Seismic Analysis Of Rcc Building With & Without Floating Columns*,", Paripex-Indian Journal Of Research pp. 1070–1076, 2016

[17] P. S. Singla, "*Effect of Floating Columns on Seismic Response of Multi-Storeyed RC Framed Buildings*,", International Journal of Engineering Research & Technology vol. 4, no. 06, pp. 1131–1136, 2015

[18] A. S. Balwaik, "*Comparative-Analysis-of-G-1-Structure-With-and-Without-Floating-Column*," , International Journal of Scientific & Engineering Research vol. 6, no. 6, pp. 990–992, 2015