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# DYNAMIC EFFECT OF BLAST LOAD

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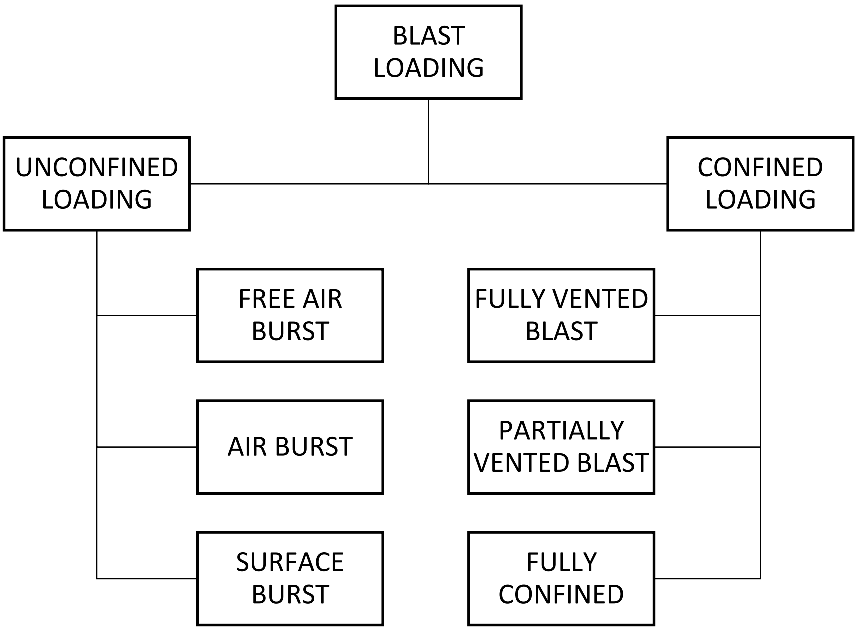
**Abstract**: A bomb explosion inside or near a building can inflict catastrophic damage to the building's external and internal structural frames, as well as the failure of walls, the blowing out of wide expanses of windows, and the shutdown of vital life-safety systems. Many factors can result in occupant deaths and injuries, including direct explosion effects, structural collapse, debris impact, fire, and smoke. In the present study, G+5 storeyed building is subjected to 200, 400kg charge weight of the blast load with a standoff distance of 10, 15, 20, 40 and 60m. IS:4991 – 1968 is used to determine the blast parameters. The time history analysis is carried out using ETABS 2019 software. Blast pressure time history graphs are also prepared. A comparative study for blast loading is carried out for different parameters like maximum storey displacement and storey drift. Safe charge explosive and safe stand-off distance are obtained for the RCC structure with the sections of structural elements. To make the building more resistible for blast load, various structural systems like shear wall and steel bracings are implemented.

**Keywords**: Blast load; Standoff distance; Charge weight; ETABS 2019.

## I. INTRODUCTION

One of the most important difficulties for structural engineers is to protect civilian buildings against terrorist attacks. Events in recent decades have heightened structural designers' awareness of the potential of terrorist attacks with explosive devices. Structures that are analyzed for blast loads are exposed to loads that are not addressed in normal design. Structures are exposed to a fast-moving shock wave that may apply pressures several times higher than those seen during the most powerful storms. The peak intensity of the blast phenomena, on the other hand, lasts for a relatively short time. (kashif,2014). Many nations have begun extensive research into structural analysis considering blast impacts and measures to safeguard buildings in order to develop solutions for preserving important infrastructure and the built environment. A booming terrorist assault on a structure may be avoided using a variety of methods. (Hao,2014). The blast can generally categorize as external and internal blast.

➢ The classification of blast loads is done based on the confinement of explosives as two types:



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## II. LITERATURE REVIEW

1. Kashif and Varma (2015) studied the blast load of 100 kg and 500 kg of TNT put 30 meters from the location of explosion in a five-story RCC symmetric building. Each case's blast load was computed using IS 4991-1968, and a non-linear direct integration time history analysis was performed using SAP-2000. Appreciate load was given to the beam-column joint in accordance with IS4991-1968. The conclusion was that the structure was not responding like a cantilever structure under blast force, which is different from earthquake and wind loads. For both 100 kg and 500 kg TNT explosive, the results of the performance level of the building, maximum displacement, and plastic hinges locations were established and compared.
2. Suraj Dharamraj Bhosale et al (2016) studied the reinforced concrete building G+5 story having structure 4m of 4 bays along in x direction and 5m of 2 bays and 3m of 2 bays along y direction and height of the story kept as 3m each. Effect of peak static pressure and reflected overpressure was more at ground story then upper story varies linearly.
3. Charan L et al (2018) studied on the effect of Blast loading on RCC building. In this study, a reinforced concrete building with G+4 stories were constructed with 4m of 2 bays and 5m of 2 bays in both the x and y directions, with the bottom story at 3.5m and the remaining story's at 3m. It is subjected to blast loads of 100, 300, and 500 kg at stand-off distances of 30, 40, and 50 meters. IS: 4991-1968 is used to determine the blast load, and ETABS 2016 is used to do a nonlinear dynamic analysis. The pressure is reduced when the point of explosion is far away from the building, but it is high at a distance of 30m from the front face of the building, according to the results of the dynamic nonlinear analysis.
4. Payal Kadam et al (2019) carried out analytical study on the blast parameters by analytical approach and obtain the pressure variation on different faces of building using IS:4991-1968. Three different explosion weights (100,500, and 1000 kg) are exploded in the air at three different standoff distances (15,30, and 45 m) and at 0,6 and 12 m vertical. According to the data, the peak reflected pressure on all faces of the building is substantially more than the peak positive pressure; thus, the effect of the reflected pressure is stronger on the front face (side where the explosion occurred) of the building or structure. The reflected pressure is smaller than the peak positive pressure on the building's side face and roof. As a result, when compared to the front face, the effect of reflected pressure on these faces is low.
5. Venkata Sudha Ambavaram et al (2021) studied on the impact of surface blast on low-rise and high-rise structures. This study evaluates and develops five RC buildings with the same plan arrangement in line with Indian Standards (IS:4991-1968). The current study investigated G +2, G +5, G +7, G +10, and G +15 story buildings subjected to surface blasting with charge weights of 10 kg, 20 kg, and 30 kg at standoff distances ranging from 10 to 50 meters. SAP2000 software was used to model these structures. The findings show a considerable difference for high-rise buildings for shorter standoff distances and the same for standoff lengths greater than 10 meters. At R=10 m, the base shear was raised to 1.7-2.5 times with an increase in charge weight for low-rise buildings.

## III. BLAST LOAD PHENOMENA AND INTERACTION

During a blast, a tremendous amount of energy is released in the form of hot gases, which induces condensation or compression of surrounding gases, resulting in gas expansion. The blast wave is made up of compressed or condensed air that moves away from the explosion source (detonation point). The strength of pressure reduces as the distance from the place of blast rises, and the time required to reach the structure increases. The blast wave propagation curves for various pressures and distances from the explosion or blast source are shown in Figure 1.

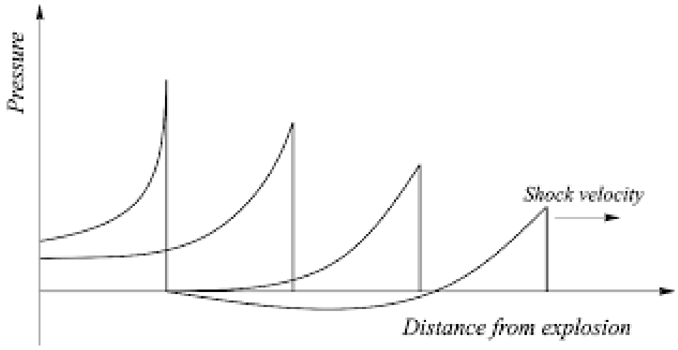


**Figure -1 Blast Wave Propagation**

A shock front or wave is created when a blast wave generated from an explosion travels over the surrounding air. This shock wave engulfed the entire structure, which was subjected to blast pressure. The material type, explosive weight, quantity of energy generated during the blast, standoff distance between the detonation point and the structure, and the

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severity of the pressure created are all elements that influence the blast load. The interaction of the blast wave and the building is seen in Figure 2.

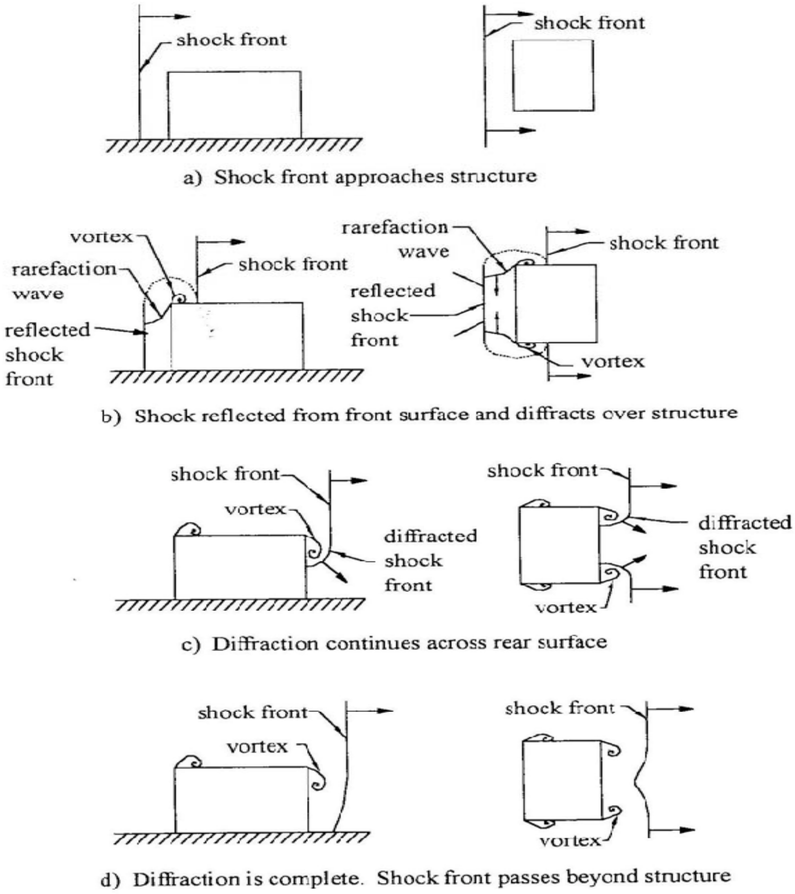


**Figure -2 Interaction of blast wave with building**

## IV. PROBLEM DISCRIPTION

In this numerical study G+5 storied building with different structural model cases are considered. The building of plan dimension 14 m X 14 m and height of the building is 18.5 m. Figs. 3, 4 & 5 shows the plan and 3D view of the bare frame, braced frame and shear wall frame building considered. Table I & II represents the structural properties of building.

**TABLE - I SECTIONAL PROPERTIES OF MODEL**

| Sectional properties | |
|---|---|
| Story height | 3.0 m |
| Size of beam | 300mm X 450mm |
| Size of column | 450mm X 450mm |
| Structural wall thickness | 230mm |
| Slab thickness | 150mm |
| Shear wall thickness | 150mm |
| Grade of concrete | M30 |
| Grade of steel (Rebar) | Fe500 |
| Grade of structural steel (Bracing) | Fe250 |

**TABLE - II DIFFERENT LOADS**

| Different loads | |
|---|---|
| Floor finish | 1.0 $kN/m^2$ |
| Live load | 3 $kN/m^2$ |
| Roof live load | 1.5 $kN/m^2$ |
| Water proofing | 1.5 $kN/m^2$ |

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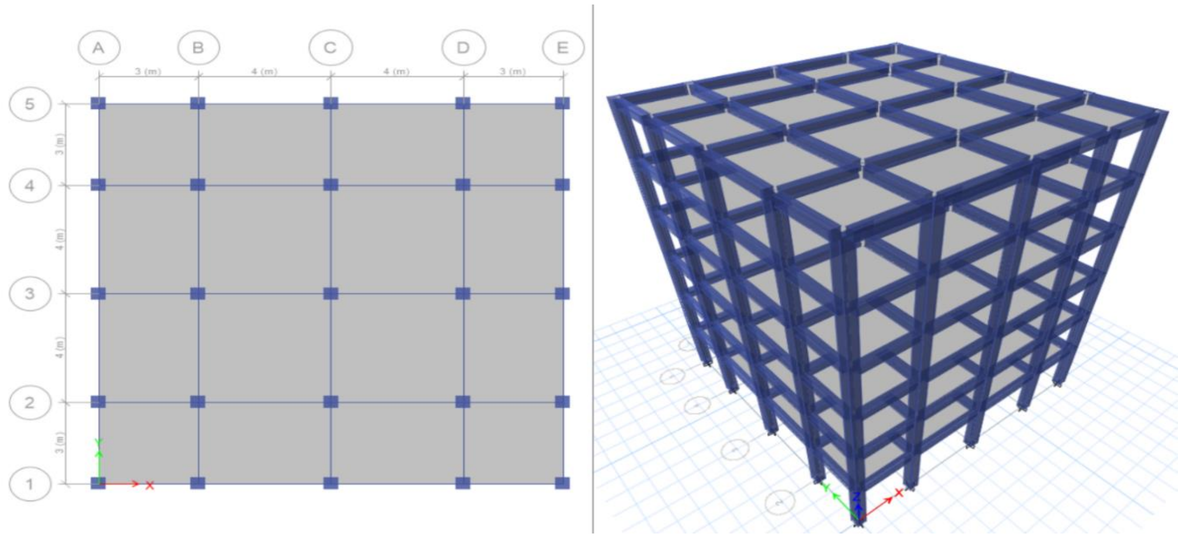


**Figure - 3 plan and 3D view of structure model cases for all bare frame**

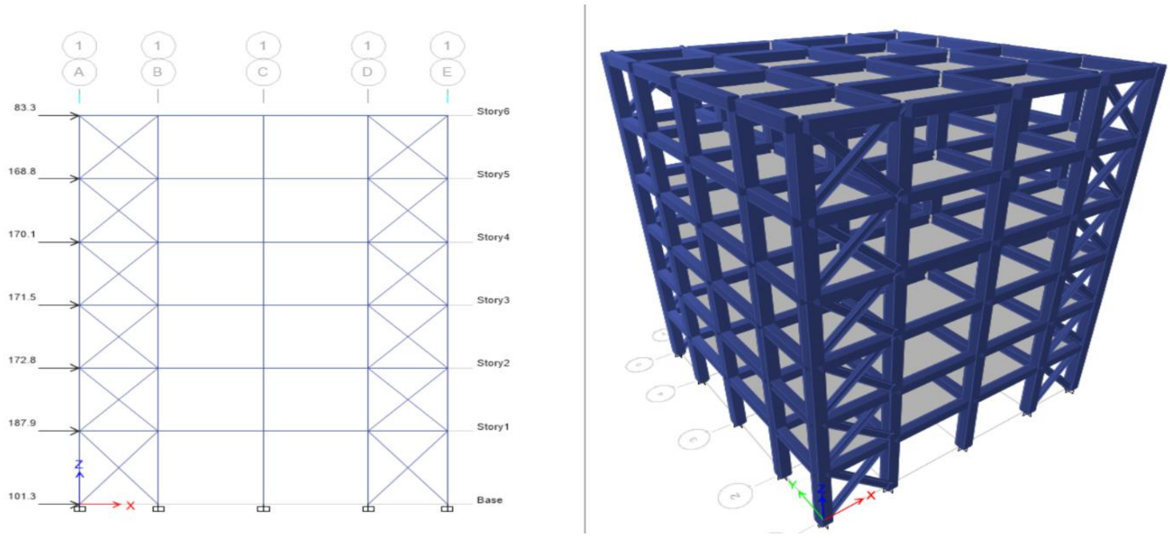


**Figure - 4 plan and 3D view of structure model cases for all braced frame**

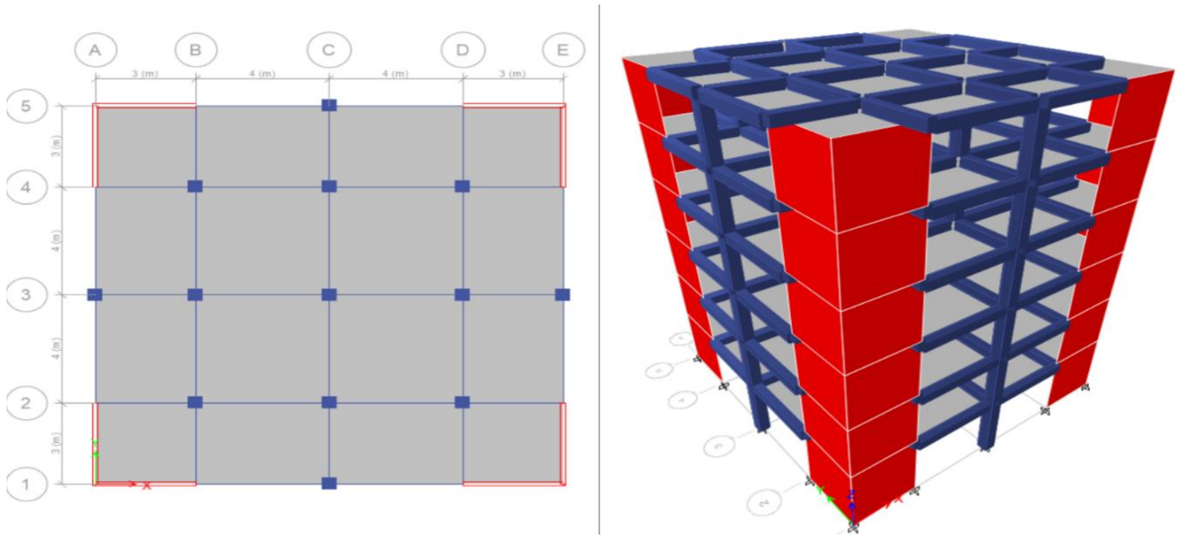


**Figure - 5 plan and 3D view of structure model cases for all shear wall frame**

  

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**TABLE - III PRESSURE AND JOINT LOAD ACTING ON THE FRONT FACE OF THE BUILDING DUE TO EXPLOSIVE WEIGHT OF 200kg AT 10m AND 15m STANDOFF DISTANCE**

| Joint | F. L | Z (10m) | Z (15m) | P (10m) | P (15m) | A ($m^2$) | F (10m) | F (15m) |
|---|---|---|---|---|---|---|---|---|
| 1 | GL | 17.1 | 25.65 | 2823 | 701.15 | 7 | 19761 | 4908.05 |
| 2 & 4 | | 17.45 | 26.18 | 2600 | 654.425 | 6.13 | 15938 | 4011.63 |
| 3 & 5 | | 18.1 | 27.15 | 2218.13 | 572.95 | 2.63 | 5833.69 | 1506.86 |
| 1 | 1 | 17.35 | 26.03 | 2663.83 | 667.78 | 13 | 34629.83 | 8681.08 |
| 2 & 4 | | 17.7 | 26.55 | 2441 | 621.05 | 11.38 | 27778.58 | 7067.55 |
| 3 & 5 | | 18.35 | 27.53 | 2138.47 | 552.83 | 4.88 | 10435.72 | 2697.79 |
| 1 | 2 | 18 | 27 | 2250 | 581 | 12 | 27000 | 6972 |
| 2 & 4 | | 18.3 | 27.45 | 2154.4 | 556.85 | 10.5 | 22621.2 | 5846.93 |
| 3 & 5 | | 18.95 | 28.43 | 1947.27 | 504.53 | 4.5 | 8762.7 | 2270.36 |
| 1 | 3 | 18.95 | 28.43 | 1947.27 | 504.53 | 12 | 23367.2 | 6054.3 |
| 2 & 4 | | 19.25 | 28.88 | 1851.67 | 480.38 | 10.5 | 19442.5 | 5043.94 |
| 3 & 5 | | 19.85 | 29.78 | 1660.467 | 432.08 | 4.5 | 7472.1 | 1944.34 |
| 1 | 4 | 20.15 | 30.23 | 1564.87 | 414.38 | 12 | 18778.4 | 4972.5 |
| 2 & 4 | | 20.45 | 30.68 | 1469.27 | 403.13 | 10.5 | 15427.3 | 4232.81 |
| 3 & 5 | | 21.05 | 31.58 | 1286.57 | 380.63 | 4.5 | 5789.55 | 1712.81 |
| 7 | 5 | 21.65 | 32.48 | 1197.37 | 358.13 | 12 | 14368.4 | 4297.5 |
| 2 & 4 | | 21.9 | 32.85 | 1160.2 | 348.75 | 10.5 | 12182.1 | 3661.88 |
| 3 & 5 | | 22.45 | 33.68 | 1078.43 | 329.25 | 4.5 | 4852.95 | 1481.63 |
| 1 | 6 | 23.3 | 34.95 | 952.07 | 299.5 | 6 | 5712.4 | 1797 |
| 2 & 4 | | 23.55 | 35.33 | 914.9 | 290.75 | 5.25 | 4803.23 | 1526.44 |
| 3 & 5 | | 24.05 | 36.08 | 843.55 | 273.83 | 2.25 | 1897.99 | 616.11 |

**TABLE - IV PRESSURE AND JOINT LOAD ACTING ON THE FRONT FACE OF THE BUILDING DUE TO EXPLOSIVE WEIGHT OF 400kg AT 10m AND 15m STANDOFF DISTANCE**

| Joint | F. L | Z (10m) | Z (15m) | P (10m) | P (15m) | A $m^2$ | F (10m) | F (15m) |
|---|---|---|---|---|---|---|---|---|
| 1 | GL | 13.57 | 20.36 | 5141 | 1499.54 | 7 | 35987 | 10496.78 |
| 2 & 4 | | 13.85 | 20.78 | 4930 | 1365.7 | 6.13 | 30220.9 | 8371.74 |
| 3 & 5 | | 14.4 | 21.6 | 4540 | 1204.8 | 2.63 | 11940.2 | 3168.62 |
| 1 | 1 | 13.8 | 20.7 | 4967 | 1389.6 | 13 | 64571 | 18064.8 |
| 2 & 4 | | 14.05 | 21.08 | 4785 | 1282.85 | 11.38 | 54453.3 | 14598.83 |
| 3 & 5 | | 14.55 | 21.83 | 4440 | 1171.35 | 4.88 | 21667.2 | 5716.19 |
| 1 | 2 | 14.45 | 21.68 | 4506.5 | 1193.65 | 12 | 54078 | 14323.8 |
| 2 & 4 | | 14.55 | 21.83 | 4440 | 1171.35 | 10.5 | 46620 | 12299.18 |
| 3 & 5 | | 15.05 | 22.58 | 4120 | 1059.85 | 4.5 | 18540 | 4769.33 |
| 1 | 3 | 15 | 22.5 | 4160 | 1071 | 12 | 49920 | 12852 |
| 2 & 4 | | 15.25 | 22.88 | 4000.83 | 1015.25 | 10.5 | 42008.8 | 10660.13 |
| 3 & 5 | | 15.75 | 23.63 | 3682.5 | 903.75 | 4.5 | 16571.3 | 4066.88 |
| 1 | 4 | 16 | 24 | 3523.33 | 848 | 12 | 42280 | 10176 |
| 2 & 4 | | 16.25 | 24.38 | 3364.17 | 814.63 | 10.5 | 35323.8 | 8553.56 |
| 3 & 5 | | 16.7 | 25.05 | 3077.67 | 754.55 | 4.5 | 13849.5 | 3395.48 |
| 1 | 5 | 17.15 | 25.73 | 2791.17 | 694.48 | 12 | 33494 | 8333.7 |
| 2 & 4 | | 17.4 | 26.1 | 2632 | 661.1 | 10.5 | 27636 | 6941.55 |
| 3 & 5 | | 17.8 | 26.7 | 2377.33 | 607.7 | 4.5 | 10698 | 2734.65 |
| 1 | 6 | 18.5 | 27.75 | 2090.67 | 540.75 | 6 | 12544 | 3244.5 |
| 2 & 4 | | 18.7 | 28.05 | 2026.93 | 524.65 | 5.25 | 10641.4 | 2754.41 |
| 3 & 5 | | 19.1 | 28.65 | 1899.47 | 492.45 | 2.25 | 4273.8 | 1108.01 |

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Similarly, Joint load, F acting on the building is calculated for charge weight of 200kg & 400kg with 20m, 40m and 60m standoff distance.

## V. RESULTS AND DISCUSSION

This chapter discusses the behaviour of a building subjected to a blast load acting on the front face of the building with various charge weights and standoff distance. Storey displacement, storey drift, joint displacement v/s time, joint velocity v/s time, joint acceleration v/s time, and column forces are used to calculate the building's response. As seen below, the retrieved results are summarised and discussed.

It can be seen in Fig. 6 that the displacement increases as the blast source gets closer to the building. The storey displacement in the building increases as the explosion source point or standoff distance decreases and the charge weight increases.

Figure 7 shows how storey drift increases as the blast source gets closer to the building. As a result, the drift is inversely proportional to the standoff distance while being directly proportional to the blast charge weight. And it's worth mentioning that lower-storey drift is bigger than higher-storey drift.

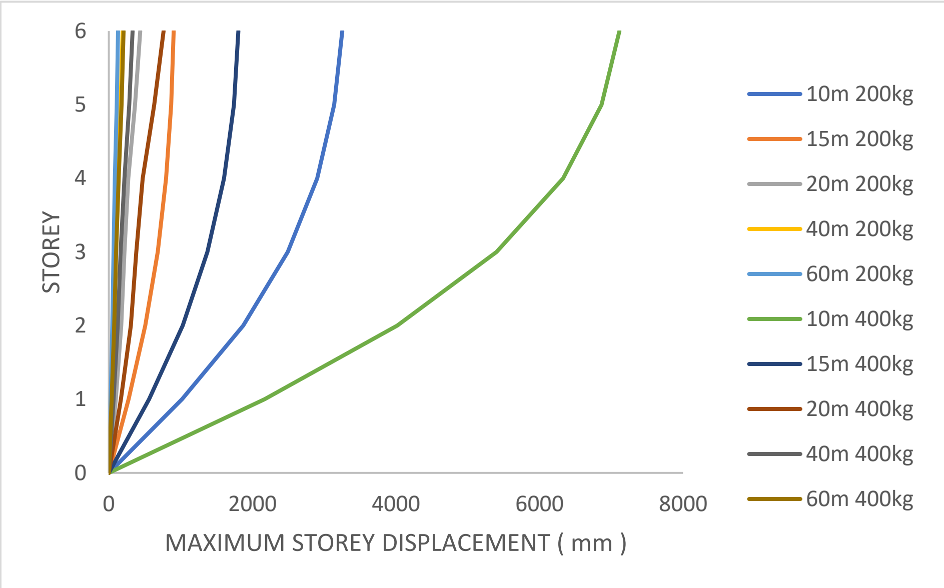


**Figure - 6 Displacement of the building along the storey**

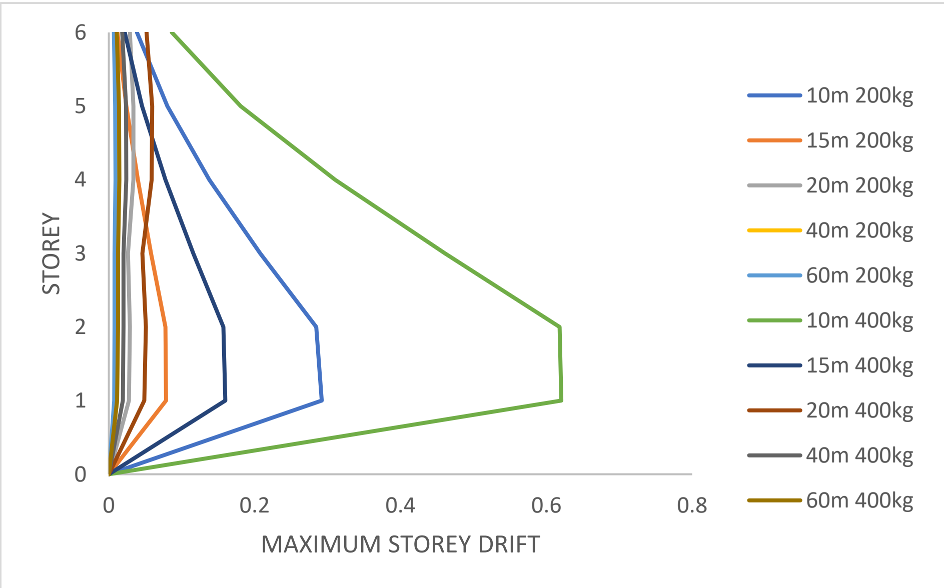


**Figure - 7 Drift of the building along the storey**

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When the building is subjected to a blast load of various charge weights with variable standoff distances, the response in terms of joint displacement, velocity, and acceleration is obtained. The plots of joint displacement (mm) versus time (sec), joint velocity (mm/sec) versus time (sec), and joint acceleration (mm/sec$^2$) versus time (sec) are shown in Figures 8, 9 and 10.

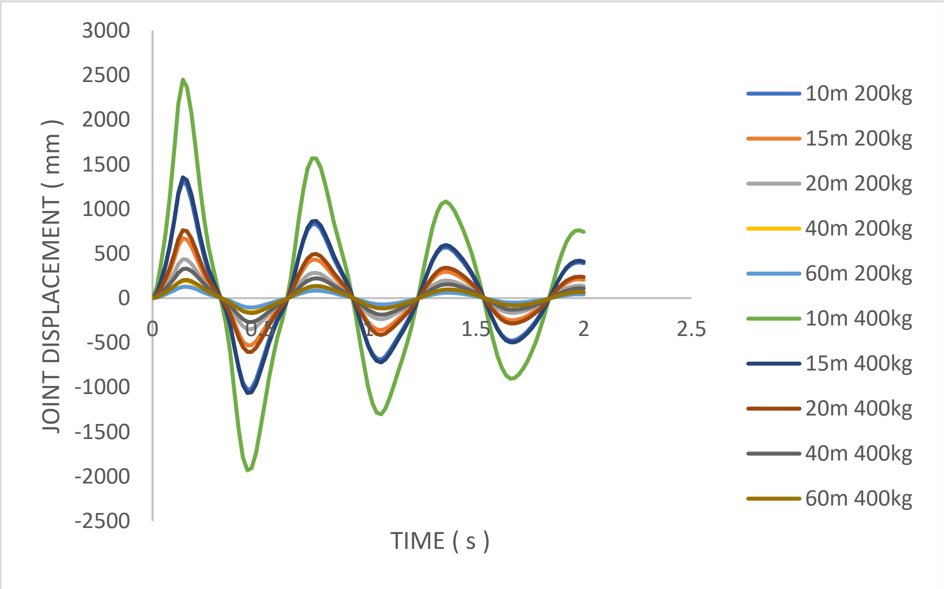


**Figure - 8 Joint Displacement (mm) vs time (s) plot**

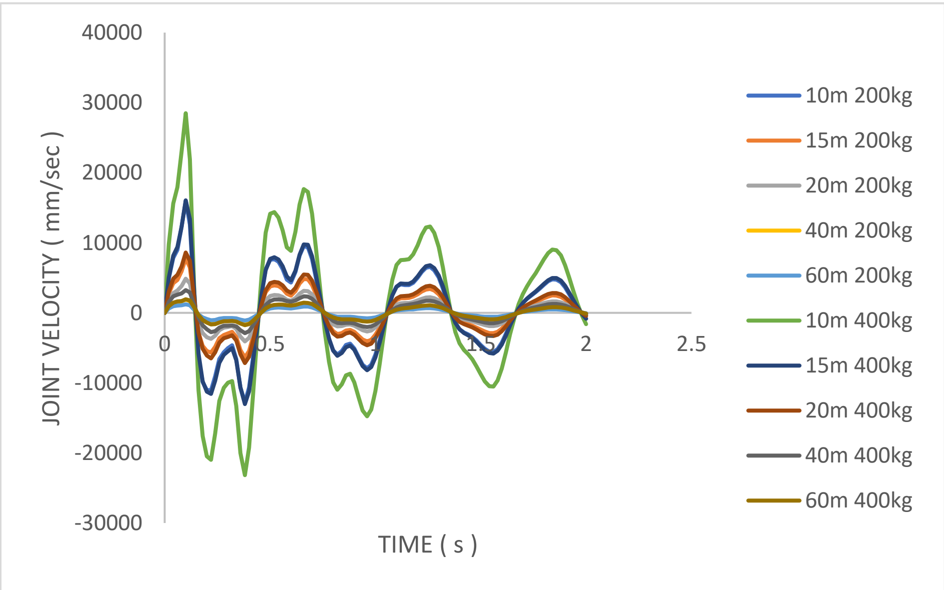


**Figure - 9 Joint Velocity (m/s) vs time (s) plot**

 

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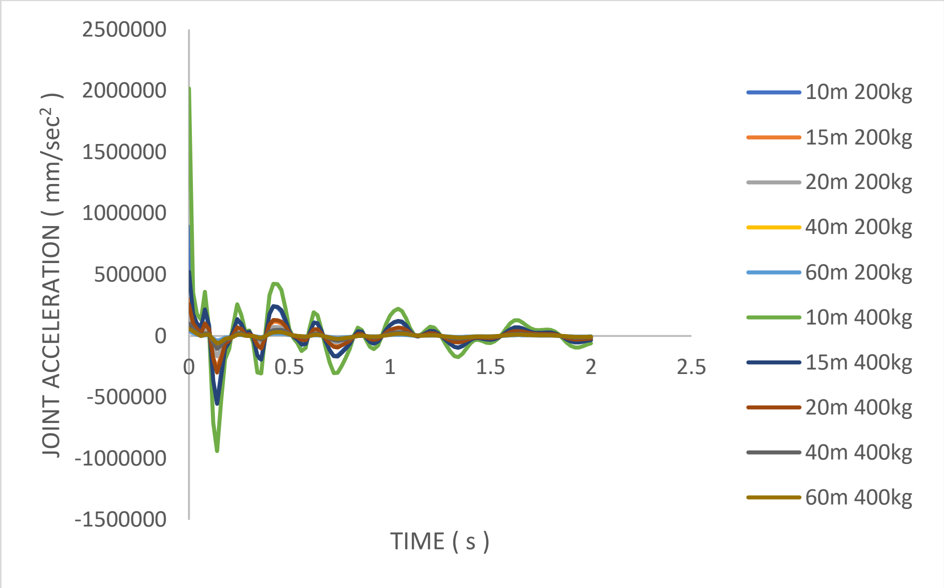


**Figure – 10 Joint Acceleration (m/sec$^2$) vs time (s) plot**

The following table V & VI shows the comparison of the above three graphs of joint displacement, velocity and acceleration with respect to time.

**TABLE - V COMPARISON OF JOINT DISPLACEMENT, VELOCITY AND ACCELERATION OF THE BUILDING SUBJECTED TO VARIOUS BLAST LOAD**

| Response | 200 kg | | | | |
|---|---|---|---|---|---|
| | 10m | 15m | 20m | 40m | 60m |
| **Displacement in mm** | 1315.032 | 672.592 | 436.823 | 192.270 | 128.276 |
| **Velocity in m/sec** | 16.00 | 7.78 | 4.87 | 1.90 | 1.22 |
| **Acceleration in m/sec$^2$** | 889.56 | 297.21 | 156.47 | 66.34 | 40.74 |

**TABLE - VI COMPARISON OF JOINT DISPLACEMENT, VELOCITY AND ACCELERATION OF THE BUILDING SUBJECTED TO VARIOUS BLAST LOAD**

| Response | 400 kg | | | | |
|---|---|---|---|---|---|
| | 10m | 15m | 20m | 40m | 60m |
| **Displacement in mm** | 2450.685 | 1354.567 | 761.565 | 330.713 | 205.039 |
| **Velocity in m/sec** | 28.50 | 16.06 | 8.61 | 3.25 | 1.94 |
| **Acceleration in m/sec$^2$** | 2018.31 | 523.49 | 256.69 | 100.96 | 57.56 |

Various structural systems, such as shear walls and steel bracings, are supplied at the building's corner periphery in order to make it a blast-resistant structure.

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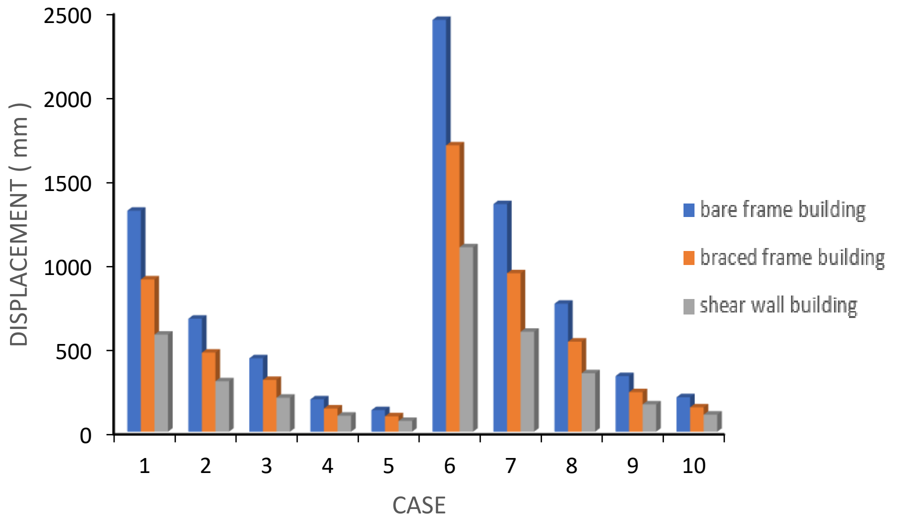


**Figure - 11 Storey displacement of bare frame building, building with corner shear wall and steel bracings**

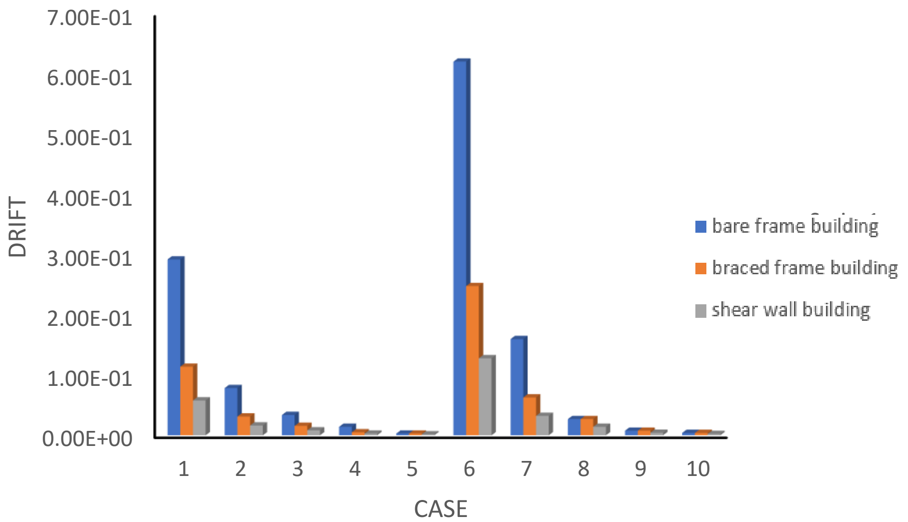


**Figure - 12 Storey drift of bare frame building, building with corner shear wall and steel bracings**

From Fig.11 and 12, it is observed that the displacement and drift in the building with shear wall and steel bracings is less than conventional bare frame building.

The building with corner shear wall reduces the displacement and drift by 53.27% and 71.70% respectively when compared with bare frame building and the building with corner X steel bracings reduces displacement and drift by 29.60% and 50.55% respectively when compared with bare frame building.

Thus, it can be concluded that implementation of shear wall is more effective in the building against blast load when compared with bare frame building and corner X steel bracing building.

## CONCLUSION

- The findings of the buildings subjected to blast loads with various charge weights and standoff distances reveal that when the blast source point is 10m away from the front face of the building, the story displacement, story drift, and column forces are high.
- When the standoff distance is shorter and the charge weight is higher, the building responds more in terms of displacement and drift. As a result, the standoff distance and charge weight are inversely proportional to the response.
- The safe standoff distance for the building is chosen as 60m.
- When compared to a bare frame building, the use of a shear wall at the building's corner periphery reduces story displacement and drift by 53.27% and 71.70%, respectively.
- When compared to a bare frame building, the use of X steel bracings at the building's corner periphery reduces story displacement and drift by 29.60% and 50.55%, respectively.
- With the addition of a shear wall and steel bracing, the structure becomes more resistant to blast loads.

## REFERENCES

[1] Amol B., and Pontis. S. C., "Blast Analysis of Structures", International journal of Engineering Research and Technology, vol.02, (2013), pp.2120-2126.

[2] Charan L and S B Devaraju (2018), "The study of effect of Blast load on multi-storey building by using Time History method", International Research Journal of Engineering and Technology, vol.05(06), 1082-1089.

[3] D. M. Maccan, S. J. Smith, Blast Resistant Design of Reinforced Concrete Structure, Structure Magazine, April 2007.

[4] Demin George., and Varnitha M.S., " Structural Analysis of Blast Resistant Structures", International Journal for Scientific Research & Development, vol.04, (2016), pp.1141- 1144.

[5] H.M. Elsanadedy, T.H. Almusallam, Y.R. Alharbi, Y.A. Al-Salloum, H. Abbas., "Progressive collapse potential of a typical steel building due to blast attacks", Journal of Constructional Steel Research, 101(2014), pp.143-157.

[6] Jiji Madonna, Mrs. Vijaya G S and Er. Kirankumar K L (2016), "Analysis of High Rise RCC building subjected to Blast load", International Research Journal of Engineering and Technology, 03(08), 1934-1938

[7] Kadid A, Nezzar B, Yahiaoui D (2012) Nonlinear dynamic analysis of reinforced concrete slabs subjected to blast loading. Asian J Civ Eng 13:617–634

[8] M. V. Dharaneepathy, M. N. Keshava Raot and A. R. Santhakumarzf Critical Distance for Blast-resistant Design, Computer and Structures vol.54: pp.587-595 (1995)

[9] M. D. Goel., Dhiraj Agrawal., A. Choubey., "Collapse Behavior of RCC Building under Blast Load", Procedia Engineering 173 ( 2017 ) 1943 – 1950.

[10] Megha S. Mahaladkar, Ramya K., "Analysis of Muti-Storey RC Building Subjected to Blast Load using Time History Method", International Journal of Innovative Science and Research Technology, Volume 4, Issue 6, June 2019.

[11] Meghanadh M., and Reshma T.(2017), "Blast Analysis And Blast Resistant Design Of R.C.C Residential Building", International Journal of Civil Engineering and Technology, vol.08, pp.761-770.

[12] Nourzadeh D, Humar J, Braimah A (2017) Comparison of response of building structures to blast loading and seismic excitations. Proced Eng 210:320–325

[13] Payal Kadam., Vidya Patil.,(2019),"Analysis of RCC Structures Subjected to Spatial Blast Loading", Trends in Civil Engineering and Challenges for Sustainability, Volume 99, Page No 3-16.

[14] Quazi kasif., and Varma, M.B.(2014), "Effect of blast on G+4 RCC Frame Structure", International Journal of Emerging Technology and Advanced Engineering, vol.4(11), pp.145-149.

[15] S.M. Jayashree, R. R. Bharatwaj, S. M Helen Dynamic Response of A Space Framed Structure Subjected To Blast Load, International Journal of Civil And Structural Engineering Volume 4, No 1, 2013.

[16] Shi Y, Zhong X, Hong H (2010) A new method for progressive collapse analysis of RC frames under blast loading. J Eng Struct 32:1691–1703

[17] Sunita T, Bharti SD, Shrimali MK, Datta TK (2020) Efect of Surface Blast on Multistory Buildings. J Perform Constr Facil 34:1–15

[18] Suraj Dharamraj Bhosale, Shrinivas R Suryawanshi., "Dynamic Analysis of RCC Frame Structure subjected to Blast Loading without infilled Infilled Wall in Multi Storey building", International Journal of Current Engineering and Technology, Volume 6, Issue 3, Page No 929-934, June 2016.

[19] Thejashwini S and Dr. M N Hegde (2018), "Effects of Blast load on Multistoried RCC Building", International Research Journal of Engineering and Technology, 05(07), 1856-1861.

[20] IS Code IS: 4991-1968 —Criteria for blast resistant design of structures for explosion above ground", Bureau of Indian Standards (1968).