BLAST RESISTANCE OF G+10 COMMERCIAL BUILDING WITH AND WITHOUT SHEAR WALL SHAPE COMPARISON

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Abstract. The effect of blast load on the structure was an essential aspect to be taken into account during the design process even though such kind of attacks are very scare in nature. blast effect must be consider while designing a building just like wind ,seismic load and shear wall with and without shear wall load is be measured in this project mainly discuss about the shape comparison of the G+10 commercial building and that be with shear wall and without shear wall. when the blast load is applied to the structure then how much of deflection of the structure is appeared with and without shear wall shape comparison of the building so that we find the deflection of the structure by recording the values on the graph and so that how much of deflection is occurs and then that structure is safe with shear wall are not. applying loads on the each section of the building like beams and columns so that may get the how much of deformation the structure is appeared so may that the structure is safe without shear wall. mainly in this we find the displacement, acceleration, max displacement and max drift by taking that values and finding the deflection of the structure and that was the exact values of the deformed shape will be given. when subjected to blast load using ETABS software with prominence given to different standoff distances the blast load and incorporating various charge weights of TNT according to IS code 4991.

Key Words. ETABS software , Graphs, max Drift, max Displacement , Acceleration, Displacement, TNT(Trinitrotoluene).

Introduction. The number of terrorist activities and threats has been exponentially increased in the recent few years across the globe and hence it has become a vital issue to consider blast load effects from the stage of designing a structure just like the consideration of Earthquake loads, Wind Loads etc. The terrorist actions has become an important issue and safe guard of the citizens against terrorist acts includes prediction, prevention & mitigation of such actions has gained importance.

The central intension of this examination is to reveal insight into the system of managing with the blast induced effects from the planning and design stage of the structure and to know the reaction of the structure when exposed blast loading with significance importance given on different Standoff separations of the impact and considering different charge loads of TNT as according to IS Code 4991 utilizing ETABS software. Impact idea ought to be considered at idea level since it assists with building a very much planned structure which can display improved blast resistance along with aesthetic appearance. For guaranteeing security of the current structures against impact, a strategy for assessment, investigation and retrofitting is required. A clear understanding of the characteristics of blast, will help us to design the buildings to be blast resistant more competently. Basic methods for enhancing the ability of a structure to survive a blast should be with respect to both architectural & structural approach. The main endeavor of the study is to provide guidance for blast resistant design of buildings & using ETABS software to identify the response of a structure when subjected to blast load with importance given on a range of Standoff distances of the blast on the building and considering various charge weights of TNT according to IS Code 4991. Based on the needs & purpose of the building, the Dead loads, Partition Wall loads & Live loads are considered for the study of the structure according to the specifications of IS 875-1987
OBJECTIVES OF THE WORK
1) The purpose of the study is to through light on designing blast resistant buildings, which will enhance the building security against the effects of explosions.
2) To understand the explosion process and to have clear idea about the effects of explosion on buildings.
3) For assessing the probability of occurrence of an explosion and the impact that is to be included in the design based on the type of structure or importance of the structure.
4) To know the response of a structure when a building is subjected to blast loads using ETABS software in accordance with IS Code 4991.
5) To study the response of a building when imposed with blast load for various standoff distances and different charge weights.
6) To come to a conclusion of optimum percentage of safety that is to be included in the design for making a building economical.

Explosions and Blast occurrence
Explosions are grouped based on their type as nuclear explosion, physical explosion & chemical explosions. In case of nuclear blasts the energy will be released because of the high speed nuclear reaction which is a result of the formation of unlike atomic nuclei formed because of relocation of the neutrons & protons in an interacting nuclei. In the case of an explosion the energy will be released from the actions such as mixing of liquids, burning of explosive materials, bursting of gas cylinder etc. Rapid oxidation of fuel essentials mainly carbon & hydrogen atoms results in chemical explosion. Based on the physical state of the explosive materials they can be classified as solids, liquids & gases. The major type of explosives known are of solid state explosives. Based on the sensitivity of ignition the explosives are classified as primary & secondary explosions. Primary explosions are the one which gets easily detonated by easy ignition just with a spark of fire or when subjected to flame. For instance primary explosives such as Mercury fulminate, lead azide etc. Secondary explosions are the materials which generate blast waves which results in extensive damage to the nearby areas. When high explosive is detonated it will produce very hot gases with the generation of pressure up to a measure of $3 \times 10^5$ kg/cm² & developing temperature in the range of 3000°C to 4000°C. The hot gases produced starts expanding in all the directions which results in the movement of the surrounding air outwards in compressed form.

IS-Code Books
The IS-code utilized for this undertaking was IS-4991:1968(CRITERIA FOR BLAST RESISTANT DESIGN OF STRUCTURES FOR EXPLOSIONS ABOVE GROUND) And for the safety check the earthquake resistance code is also used IS-1893(Part1):2002(CRITEARIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES) and for wind loads IS-875 Part-3:1987(WIND LOAD) And for shear wall IS-456:2000 according to clause - 32 and little data about in IS-13920-1993 statement 9.

Modelling of Structure
A RCC structure is fundamentally a get together of slabs ,beams ,columns and foundation inter connected to each other as a unit, we have embraced 3 cases by expecting various shapes for a similar structure .the structure are appearing below with shear wall and without shear walls. As explained below.

1. C-SHAPE PLAN
2. L-SHAPE PLAN
3. I- SHAPE PLAN
TABLE 1

| BUILDING DESCRIPTION:  |
|-------------------------|
| Length x breadth       | 30m x20m |
| No of storeys          | G+10     |
| Storey height          | 3m       |
| Beam dimensions        | 400mmx600mm |
| Column dimensions      | 600mmx600mm |
| Column dimensions      | 230mmx230mm |
| Shear wall thickness   | 150mm    |
| Slab thickness         | 150mm    |

Load applying on Structure:-

The applied load on the structure was calculated from the codebook:4991:1968. The load combinations of the structure was given below.

**Blast Load Combinations**

1.5xDL+1.5xLL
1.2xDL+1.2xLL+1xBL
1.5xDL+1xBL
0.9xDL+1xBL

**Calculation of Blast Loads**

Calculation of Blast Loads for various Charge weights & standoff distances are done below. Total of 12 cases are considered by varying charge weight & standoff distances.

Blast parameters obtained due to the denotation of a 0.150 tonne TNT (150kg's charge weight) explosive & Standoff distance of 10m are evaluated on an above ground rectangular structure for Height of the structure: 31.5m
Length of the structure: 30m
Width of the Structure: 20m
Stand-Off distance is varied from 10m, 15m, 20m.

i) Characteristics of blast-

Scaled distance x = 10/(0.150)\(^{1/3}\) = 18.82m

From Table 1 assuming \( P_a = 1 \) kg/cm\(^2\) and for the scaled distance 20m, the pressures are directly obtained:

\( P_{so} = 5.46 \text{ kg/cm}^2 \)
\( P_{ro} = 19.88 \text{ kg/cm}^2 \)
\( q_o = 4.506 \text{ kg/cm}^2 \)
The scaled times $t_o$ and $t_d$ obtained from Table 1 for scaled distance 15 m are multiplied by $(0.150)^{1/3}$ to get the values of the respective quantities for the actual explosion of 0.150 tonne charge.

$t_o = 12.47 \times (0.150)^{1/3} = 6.625$ milliseconds  
$t_d = 7.76 \times (0.150)^{1/3} = 4.123$ milliseconds  

$U = \text{shock front velocity} = M \times a$

$M = \sqrt{1 + \frac{6 \rho_o}{\gamma p^2}} = \sqrt{1 + \frac{6 \times 1.225}{7 \times 1}} = 2.383$

$a = 344 \text{m/s} \ (\text{Velocity of sound in air at mean sea level})$

$U = 2.383 \times 344 = 819.84 \text{m/millisecond}.$

ii) Pressure on the Building:

$H = 31.5 \text{m}, B = 20 \text{m}, L = 30 \text{m}$

$S = H \text{ or } B/2 \text{ whichever is less} = 31.5 \text{ & } 20/2 = 10 \text{ so } S = 10 \text{m}$

$t_c = \frac{S}{U} = \frac{10}{819.84} = 0.012 \text{ milliseconds}$  
$t_t = \frac{S}{U} = \frac{10}{819.84} = 0.012 \text{ milliseconds}$  
$t_r = \frac{S}{U} = \frac{10}{819.84} = 0.012 \text{ milliseconds}$

$t_r > t_d$ So, no pressure on the Backface are considered.

For Side face $C_d = -0.2, P_{so} + C_d q_o = 5.46 + (-0.2) \times 4.506 = 4.55 \text{ kg/cm}^2$

Conversion from Kg/cm$^2$ to KN/m$^2$  

$= 4.55 \text{Kg/cm}^2 \times 9.81 \text{ N/cm}^2 = (44.6 \text{N})/(10^{-4} \text{m}^2)$  

$= 446 \text{ KN/m}^2$

Graphs & Results

**Chart-1** Overall C-Shape Comparison With Shear wall
Chart-2: Overall C-Shape Comparison Without Shear wall

Chart-3: Overall L-Shape Comparison With Shear wall
**L-SHAPE WITHOUT SHEAR WALL GRAPH**

![Graph showing L-shape comparison without shear wall](image)

**Chart-4** Overall L-Shape Comparison Without Shear wall

**I-SHAPE WITH SHEAR WALL GRAPH**

![Graph showing I-shape comparison with shear wall](image)

**Chart-5** Overall I-Shape Comparison With Shear wall
CONCLUSION

1. Now a days the terrorist attacks were huge so for that purpose the main aim of this project is to resist the blast pressure or blast load.
2. When the bomb were exploses the design of this structure is were according to the code book IS 4991 so that all measures are Taken from the code book the standoff distance and the TNT the as we take in this project 150kg,250kg,350kg,450kg this are the TNT and the standoff distances are 10m,15m,20m, and these are standoff distances.
3. When the load is applying on the structure the structure is resisting the load while applying the blast load.
4. Main aim of the project is shape finding with shear wall so shape deflection is occurred with the high amount of load is applied on the structure so 450 kg of TNT and the standoff distance 15meter load is applied.
5. The deflection is occurring but the building is resisting the load which was applied on the structure.
6. And without shear wall so shape deflection is occurred on large amount but the building is resisting the load because of the beams and the column but over stress is appearing and the structure is safe and by design check all beams and columns are passing by the check.
7. So the structure is safe if otherwise the design check is showing failed then the structure is failed here the structure is safe.
8. The shapes are considered by the displacement, acceleration, maximum displacement, max drift so by the values of the above mention by these the shape comparison was done.
9. So the overall project was done by these values only the aim of the project is shape comparison with shear wall and without shear wall it has been done.

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