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"Comparative Analysis of Blast Load on Multi Storey R.C.C. Building at Different Locations"

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Abstract - The increase in terrorist acts in recent years has made it clear that the effects of blast load on the structure are an important factor to be considered during the design phase. The primary goal of this article is to shed light on the comparative analysis of the building subjected to blast load is done by using Etabs software. Here 32 different load cases are taken, in which for external load with special emphasis placed on different standoff distances of blast that is 20m and 30m with incorporation of various TNT charge weights that is 50kgs, 100kgs, 200kgs and 300kgs in accordance with IS code 4991(1968). For internal load TNT charge of 50kgs, 40kgs, 30kgs and 20kgs are applied on corner column and central column of the building at various storeys. Response of models when subjected to blast load, in terms of storey displacement, storey drift and storey shear are analyzed using Time history analysis.

***Key Words*: Blast Load, Standoff Distance, RCC structure, Etabs2020, Time History Analysis, Displacement, Drift, Storey Shear.**

1.INTRODUCTION

Due to increase in the no. of accidental explosion and terrorist bombing on the important building like govt. buildings and other civilian facilities, structural protection against explosive loads draws more and more attentions. Blast loads are extremely short in nature but have high intensity, therefore analysis and design of structure for static and less dynamic loads like earthquake, wave and wind loads cannot be applied for structural design of blast resistant buildings. Also, the material behavior and structural response under blast load are usually nonlinear, time dependent and have complex stresses. Current approaches for blast resistant building designs mainly based on single degree of freedom (SDOF) simplification. Field and laboratory tests are not safe and easy to carry out and are expensive, therefore various computer technology and software such as ETABS are used for getting more reliable and detailed numerical and structural responses. Various time-history functions such as displacement, velocity, drift, acceleration is compared and analyzed at various storeys.

1.1 EXPLOSION & ITS TYPES

There are three kinds of explosions:

- Unconfined explosions
- Confined explosions
- Explosions occurred when explosives are attached to the structure

Unconfined explosions are either air burst or surface bust. In an air burst explosion, the high explosive detonates above ground level, and intermediate ground reflection amplification of the wave occurs before the primary blast wave reaches a building. A front known as a Mach stem is created by the interaction of the initial wave and the reflected wave when the shock wave propagates outward along the ground surface. However, when the detonation takes place near or on the ground surface, an explosion known as a surface burst. When an explosion occurs within a building, the pressures associated with the initial shock front will be high and therefore will be amplified by their reflections within the building. This type of explosion is called a confined explosion. If a detonating explosive comes into contact with a structural element, such as a column, the arrival of the detonation wave at the explosive's surface will cause intense stress waves to form in the material, which will cause the material to be crushed.

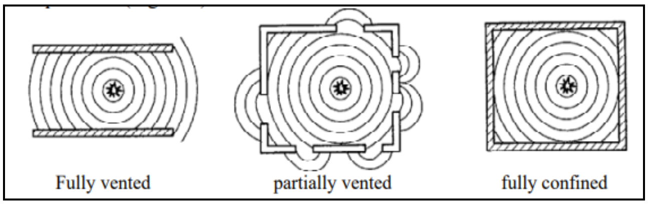

Fig.-1: Fully vented, partially vented and fully confined explosion

1.2 BLAST CHARACTERISTICS

When an eruption takes place, an exothermic chemical reaction happens in a period of few milliseconds. The explosive material (in either continuous or liquid form) is converted to very intense, dense, high-pressure gas. This well compressed air, traveling radially outward from the source at quick velocities is called the shockwave front. It expands at very extreme speeds and eventually reaches evenness with the encircling air. Usually, only about one-triennial of the chemical strength available in bombs is released in the explosion process. The remaining two-tertiary energy is freed relatively moderately as the detonation output mix with air and burn. While this process of blazing has little effect on the initial blast wave by way of its delayed incident than the original explosion, it can influence the later stages of the blast wave, particularly in eruptions in limited spaces. As the sudden strong wave expands, pressure decreases rapidly accompanying distance by way of spherical difference and dissipation of strength in warming the air. Also, pressure decays rapidly over period (as exponential function), usually in milliseconds. Thus, a blast causes an almost immediate rise in air pressure from air pressure to a large overpressure. As the shock front expands, the pressure drops but enhances negative as shown in Fig.

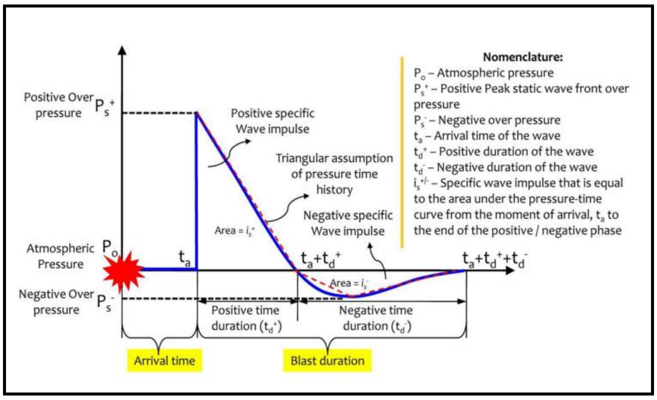

Fig- 2: Blast characteristics

1.3 MAJOR EFFECTS OF EXPLOSION

1. **Overpressure**

It is the pressure caused by a shock wave over and above normal atmospheric pressure. The magnitude of overpressure blast wave is inversely proportional to the distance of receiving object from the center of explosion.

2. **Thermal effects**

It happens when a fireball or an accumulation of hot gases is produced. If a building's fire-resisting system is damaged by a fireball impact or an overpressure impact that knocks off columns or burns the fire coating, the intense heat from the explosion may weaken structural members and contribute to their failure, potentially causing a localized or progressive collapse.

3. **Energized projectiles**

Energized projectiles, which can strike both people and structures and cause severe impact damage, are made up of shreds, debris, and missiles. Depending on the object, the object's closeness to the explosion, and the explosion strength, these objects are thrown by the explosion with varied amounts of force.

4. **Debris damage**

There are two sorts of fragments are primary and secondary. Primary fragments, which are hurled at high speeds when an explosion occurs, are actually pieces of the explosion container with a mass of about 1 gramme.

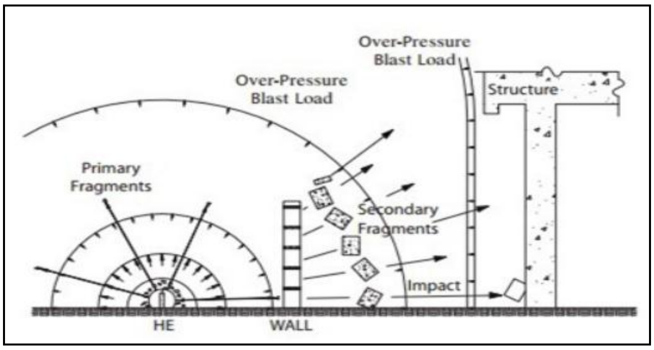

Fig. 3: Debris & broken fragments from explosion

Constrained or unrestrained objects, such as window shards, are examples of secondary objects that are flung by the explosion. These items' speeds, the distance between them and the target, the angle of incidence, and the physical characteristics of the pieces and the target all affect the damage they do.

5. **Cratering and ground shock.**

It is determined by the location of the explosion. Even highly resistant constructions can be destroyed or damaged by ground stress. When a bomb occurs just next to or on the earth surface, a crater is created. The kind of soil and proximity of the blast determine the size of the crater.

2.LITERATURE REVIEW

Swathi Ratna K. [1] proposed Analysis of RCC and SIMCON Building Subjected to Blast Effects. This study shows that buildings made with SIMCON have a higher fundamental frequency than those made of RCC. Simcon buildings exhibit better overall dynamic behavior than RCC buildings. The frequency of SIMCON buildings reduces as they get taller, but they are still higher than RCC buildings. Buildings made of RCC have more storey displacements than those made of SIMCON. When contrasted to the lowest levels, the top storeys have significant displacements. Structures' storey displacements rise as they get taller, however SIMCON structures have less displacement here. The explosive effect on the building grows as standoff distance decreases. But compared to RCC buildings, SIMCON buildings experience significantly fewer blast damage.

Lina K. Kadhum [2] proposed Architectural and Structural Design for Blast Resistant Tall Buildings Concrete from View Point Different Weight TNT. This study shows that the reinforced multi storey building is designed twice, once with typical gravity building without shear walls and another with shear walls. 3models of different charge weights 100 kgs, 350kgs and 750 kgs are designed with standoff distance 5m for analysis in terms of storey drift, displacement and storey shear. The 36-meter-tall structure was examined using ETABS2018. The structure was evaluated using American standards. It was built using ACI 318-14 and US Department of Defense TM5-1300. About drift, we can see the increase in drift with building without shear wall more than with shear wall. The maximum increase drift and displacement, it was seen on the 11th and 12th storeys.

P. Srikanth Reddy [3] proposed Blast Resistant Analysis and Design Techniques for R.C.C. Multistorey Building Using ETABS. This study presents architectural planning, blast resistance analysis and design of multi-storey RCC building using ETABS software as per IS 4991-1968.The 21m tall building is designed for blast load of 100kgs charge weight with different point of sources and displacement and shear force is checked. This study on a G+7 residential building demonstrates that increasing the stiffness of structural members by increasing their size yields better results and that doing so also helps to resist the uplift force on the footings by increasing the dead weights. The blast resistant design aims to improve structural integrity rather than have a building completely collapse. By providing moment resisting frames like shear walls, effects of blast load can be reduced and structural integrity of the building can be increased.

Venkata Sudha Ambavaram [4] proposed Dynamic performance of multi-storey buildings under surface blast: A case study. The investigation took into account four RC buildings of different heights and the identical design configuration. The chosen buildings were modeled using the industry-standard SAP2000 software and placed at standoff distances between 10 and 50 m, subject to charge weights between 10 and 30 kg. The results were addressed in terms of base shear, storey drifts, and maximum displacements. Additionally, analysis was done to reduce the impact of the blast reaction utilizing reinforcing techniques, such as jacketing the columns and adding bracings of various sizes. Maximum storey displacements, inter-storey drifts, and base shears all showed significant variation at R < 30 m, and more variation was seen for low-rise buildings after 30 m. However, for high-rise buildings, the displacement responses were significantly different at a closer standoff distance (R=10 m), while they remained the same at a standoff distance higher than 10 m. For low-rise buildings, the base shear was increased to 1.7–2.5 times with an increase in charge weight at R = 10 m. There was no noticeable difference in how the building responded to single and double bracings.

Ayush Meena [6] proposed Impact of Blast Loading over reinforced concrete without infill structures. Purpose of this research is to investigate the effect of blast load on the structure. G+3 RCC framed structure is designed in ETAB software. Four models are considered with stand-off distance 30m and 60m with blast yield of 150 kg TNT and 300 kg TNT. Variation of storey displacement and storey drift are recorded. When standoff distance is changed from 30m to 60m, Maximum storey displacement is reduced by 67% and storey drift is reduced by 66.7%. Also, when Blast yield is reduced to 150 kg from 300 kg, maximum storey displacement is reduced by 33% and storey drift is reduced by 31%. Without infill walls, here beams and columns are increased by changing 3 bays of 4m to 4 bays of 3m. With keeping the standoff distance, maximum storey displacement is reduced by around 40% and storey drift is reduced by 38%. Again, without infill walls, beams and columns are increased by changing 4 bays of 3m to 6 bays of 2m. With keeping the standoff distance, maximum storey displacement is reduced by around 74% and storey drift is reduced by 72%.

2.1 OBJECTIVES OF STUDY

- To study dynamic response and properties of the structure against blast loading.
- Enhancement of safety of important structure by reducing blast effects.
- To understand the effects of blast on structure and blast progression.
- For studying structural response when subjected to blast load using ETABS software as per IS Code 4991.
- To know structural response with different standoff distances and various charge weights when blast load is applied.

3. MODELLING & ANALYSIS

In this study an attempt has been made to do comparative analysis of RCC building under the blast load at different location in the building. The blast load is applied on the RCC structure as an overpressure under the influence of time. Selection of G + 5 storey RCC structure has been selected. Calculation of Gravity loads as per specifications of IS: 800-2007 as well as blast loading as per IS:4991-1968 and applying on the building. External load is applied on the front and side faces of the building in the form of UDL and internal load is applied on the particular column in the form of Point load. After application of load, blast analysis of the building is performed by the time history function as a triangular load. For studying dynamic response of the structure Non-linear modal analysis is done with time step size of 0.1s with 4000 time steps on all models and results are interpreted, analyzing the critical value of the Displacement, Drift and Storey Shear for design purpose.

3.1 Preliminary Data

Material properties	
Grade of Concrete	M-30
Grade of Steel	Fe 550
Dimension of members	
Column size	450*450 mm
Beam size	300*450 mm
Slab thickness	150 mm
Thickness of outer wall	230 mm
Thickness of inner wall	100 mm
Load Taken	
Dead load on Slab	3.75 KN/m2
Dead load on outer walls	12.9 KN/m2
Dead load on inner walls	5.61 KN/m2
Live Load on building	3 KN/m2
Live Load on Roof	1.5 KN/m2
Building Configurations	
No. of storeys	6 (G+5)
Height of Building	18 m
Storey height	3 m
Total dimension of plan in X direction	14m (2 bays of 3.5m & 2 bays of 4m)
Total dimension of plan in Y direction	14m (2 bays of 3.5m & 2 bays of 4m)

Table-1: Preliminary Data

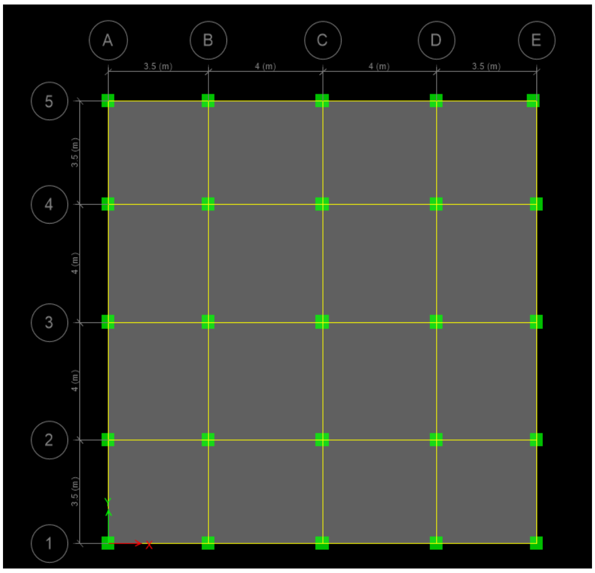

Fig- 4: Plan of the G+5 building

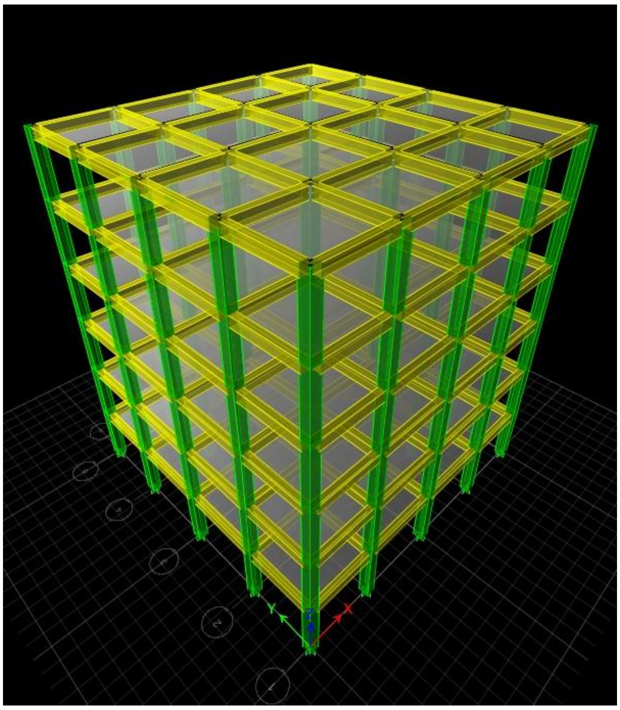

Fig- 5: 3-D view of the building

3.2 LOADING DATA

Load combinations:

1.5(DL + LL)
1.2(DL + LL)
2(DL + 0.25LL)
DL + 0.25LL + BL
1.2DL + LL + BL
DL + 0.35LL + BL

Calculation for **External Blast Load**:

Calculation of blast pressure and the time duration of the blast explosion as per specification of IS:4991-1968.

Scaled Distance, X = D/⍰$^{1/3}$

Scaled time, to = Actual time /⍰$^{1/3}$

Where D = Distance of the building from ground zero

W = Explosive charge in tonne

Blast Parameters

Pso = Peak side-on overpressure (kg/cm^2)
Po = the ambient atmospheric pressure = $1 kg/cm^2$
Pro = Peak reflected overpressure (kg/cm^2)
Qo =Dynamic Pressure (kg/cm^2)\
Td = Duration of equivalent triangular pulse (milliseconds)
To = Positive phase duration (milliseconds)
M = Mach no. of the incident pulse
U = Shock front velocity = M*a

Pressure on Building

S = H or B/2 .... whichever is less

Reflected overpressure, Pr = (pso + cd x qo)

Where, Cd = drag coefficient

Clearance time, Tc = 3S/U > Td

Transit time, Tt = L/U >Td
Pressure rise time, Tr = 4S/U >Td

If Tr > Td, then back pressure is not considered

Calculation for **Internal Blast Load**:

Here the internal blast in the building is calculated by empirical equation given by **Los Alamos Scientific Laboratory** and excel sheet is prepared for calculation of blast overpressure,

P = 13(W/V)

Where, P = Blast Overpressure (KN/M^2)
W = Explosion Charge weight in kg
V = Confined volume of air (m^3)

3.3 LOAD CASES

LOAD CASES	
For External Blast Load	
1	0.05t TNT at 20m
2	0.1t TNT at 20m
3	0.2t TNT at 20m
4	0.3t TNT at 20m
5	0.05t TNT at 30m
6	0.1t TNT at 30m
7	0.2t TNT at 30m
8	0.3t TNT at 30m
For Internal Blast Load	
9	0.05t TNT at Top Storey Corner Cl
10	0.05t TNT at Top Storey Central Cl
11	0.05t TNT at Middle Storey Corner Cl
12	0.05t TNT at Middle Storey Central Cl
13	0.05t TNT at Ground Floor Corner Cl
14	0.05t TNT at Ground Floor Central Cl
15	0.04t TNT at Top Storey Corner Cl
16	0.04t TNT at Top Storey Central Cl
17	0.04t TNT at Middle Storey Corner Cl
18	0.04t TNT at Middle Storey Central Cl
19	0.04t TNT at Ground Floor Corner Cl
20	0.04t TNT at Ground Floor Central Cl
21	0.03t TNT at Top Storey Corner Cl
22	0.03t TNT at Top Storey Central Cl
23	0.03t TNT at Middle Storey Corner Cl
24	0.03t TNT at Middle Storey Central Cl
25	0.03t TNT at Ground Floor Corner Cl
26	0.03t TNT at Ground Floor Central Cl
27	0.02t TNT at Top Storey Corner Cl
28	0.02t TNT at Top Storey Central Cl
29	0.02t TNT at Middle Storey Corner Cl
30	0.02t TNT at Middle Storey Central Cl
31	0.02t TNT at Ground Floor Corner Cl
32	0.02t TNT at Ground Floor Central Cl

Table-2: Load cases for modelling

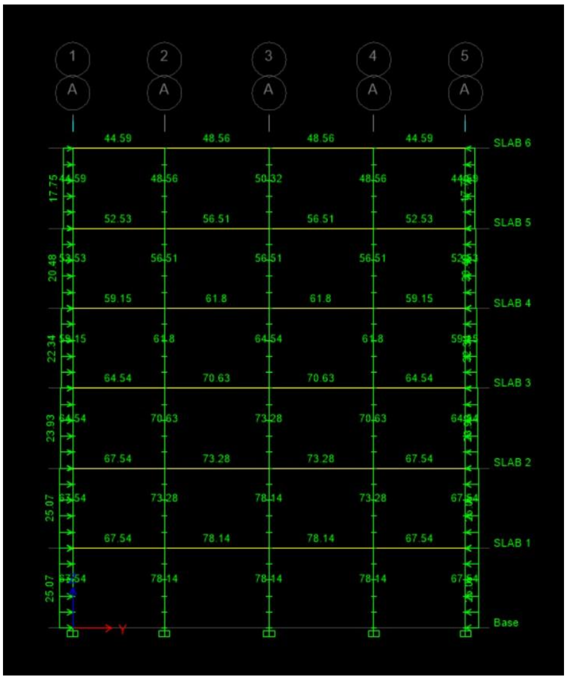

Fig- 6: External Blast Pressure on the building

4. RESULTS & DISCUSSION

4.1 FOR EXTERNAL LOAD

0.05t BLAST LOAD ON BUILDING AT 20M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	20.000	55	107.91	42.97
	20.396	56	103.99	41.4
	21.36	58	97.12	38.85
Slab 2	20.224	55	107.91	42.97
	20.616	56	103.99	41.4
	21.57	59	94.18	37.87
Slab 3	20.881	57	99.08	39.44
	21.26	58	97.12	38.85
	22.187	61	89.27	35.9
Slab 4	21.932	60	91.23	36.89
	22.293	61	89.27	35.9
	23.179	63	83.39	34.34
Slab 5	23.324	64	81.42	33.35
	23.664	65	78.48	32.37
	24.5	67	74.56	31.78
Slab 6	25	68	72.59	30.8
	25.318	69	70.63	29.82
	26.101	71	67.69	28.84

Table-3: 0.05t Blast Load at 20m Standoff Distance

0.1t BLAST LOAD ON BUILDING AT 20M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	20.000	44	173.64	62.39
	20.396	44	173.64	62.39
	21.36	47	150.09	55.72
Slab 2	20.224	44	173.64	62.39
	20.616	45	162.85	58.86
	21.57	47	150.09	55.72
Slab 3	20.881	45	162.85	58.86
	21.26	46	156.96	57.29
	22.187	48	143.23	53.17
Slab 4	21.932	48	143.23	53.17
	22.293	49	137.34	51.6
	23.179	50	131.45	49.64
Slab 5	23.324	51	125.57	48.07
	23.664	51	125.57	48.07
	24.5	53	116.74	45.52
Slab 6	25	54	111.83	43.95
	25.318	55	107.91	42.97
	26.101	57	99.08	39.44

Table-4: 0.1t Blast Load at 20m Standoff Distance

0.2t BLAST LOAD ON BUILDING AT 20M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	20.000	35	293.32	90.84
	20.396	35	293.32	90.84
	21.36	37	255.06	82.8
Slab 2	20.224	35	293.32	90.84
	20.616	36	269.78	85.54
	21.57	37	255.06	82.8
Slab 3	20.881	36	269.78	85.54
	21.26	37	255.06	82.8
	22.187	38	239.36	78.68
Slab 4	21.932	38	239.36	78.68
	22.293	39	223.67	74.95
	23.179	40	213.86	72.79
Slab 5	23.324	40	213.86	72.79
	23.664	41	204.05	70.24
	24.5	42	193.26	67.1
Slab 6	25	43	183.45	64.55
	25.318	44	173.64	62.39
	26.101	45	162.85	58.86

Table-5: 0.2t Blast Load at 20m Standoff Distance

0.3t BLAST LOAD ON BUILDING AT 20M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	20.000	30	412.02	114.19
	20.396	31	387.5	110.26
	21.36	32	362.97	105.36
Slab 2	20.224	31	387.5	110.26
	20.616	31	387.5	110.26
	21.57	33	338.45	100.45
Slab 3	20.881	32	362.97	105.36
	21.26	32	362.97	105.36
	22.187	34	315.88	96.14
Slab 4	21.932	33	338.45	100.45
	22.293	34	315.88	96.14
	23.179	35	293.32	90.84
Slab 5	23.324	35	293.32	90.84
	23.664	36	269.78	85.54
	24.5	37	255.06	82.8
Slab 6	25	38	239.36	78.68
	25.318	38	239.36	78.68
	26.101	39	223.67	74.95

Table-6: 0.3t Blast Load at 20m Standoff Distance

0.05t BLAST LOAD ON BUILDING AT 30M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	30.00	82	53.96	23.35
	30.27	83	52.97	23.35
	30.92	84	51.99	22.76
Slab 2	30.15	82	53.96	23.35
	30.41	83	52.97	23.35
	31.07	85	51.01	22.76
Slab 3	30.59	84	51.99	22.76
	30.85	84	51.99	22.76
	31.50	86	50.03	22.76
Slab 4	31.32	86	50.03	22.76
	31.58	86	50.03	22.76
	32.21	88	48.07	21.78
Slab 5	32.31	88	48.07	21.78
	32.56	89	47.09	21.78
	33.17	91	45.13	20.8
Slab 6	33.54	92	44.15	19.82
	33.78	92	44.15	19.82
	34.37	94	42.18	18.84

Table-7: 0.05t Blast Load at 30m Standoff Distance

0.1t BLAST LOAD ON BUILDING AT 30M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	30.00	65	78.48	32.37
	30.27	66	75.54	31.78
	30.92	67	74.56	31.78
Slab 2	30.15	65	78.48	32.37
	30.41	66	75.54	31.78
	31.07	67	74.56	31.78
Slab 3	30.59	66	75.54	31.78
	30.85	67	74.56	31.78
	31.50	68	72.59	30.8
Slab 4	31.32	68	72.59	30.8
	31.58	69	70.63	29.83
	32.21	70	69.65	29.82
Slab 5	32.31	70	69.65	29.82
	32.56	71	67.69	28.84
	33.17	72	65.67	27.86
Slab 6	33.54	71	64.75	28.25
	33.78	73	64.75	28.25
	34.37	75	60.82	26.29

Table-8: 0.1t Blast Load at 30m Standoff Distance

0.2t BLAST LOAD ON BUILDING AT 30M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	30.00	52	121.64	47.48
	30.27	52	121.64	47.48
	30.92	53	116.74	45.52
Slab 2	30.15	52	121.64	47.48
	30.41	53	116.74	45.52
	31.07	54	111.83	43.95
Slab 3	30.59	53	116.74	45.52
	30.85	53	116.74	45.52
	31.50	54	111.83	43.95
Slab 4	31.32	54	111.83	43.95
	31.58	55	107.91	42.97
	32.21	56	103.99	41.4
Slab 5	32.31	56	103.99	41.4
	32.56	56	103.99	41.4
	33.17	57	99.08	39.44
Slab 6	33.54	58	97.12	38.85
	33.78	58	97.12	38.85
	34.37	59	94.18	37.87

Table-9: 0.2t Blast Load at 30m Standoff Distance

0.3t BLAST LOAD ON BUILDING AT 30M STANDOFF DISTANCE				
Slab	Distance b/w source & target	scaled distance,x	pressure on front face (KN/m2)	pressure on side face (KN/m2)
Slab 1	30.00	45	162.85	58.86
	30.27	46	156.96	57.29
	30.92	47	150.09	55.72
Slab 2	30.15	46	156.96	57.29
	30.41	46	156.96	57.29
	31.07	47	150.09	55.72
Slab 3	30.59	46	156.96	57.29
	30.85	47	150.09	55.72
	31.50	48	143.23	53.17
Slab 4	31.32	47	150.09	55.72
	31.58	48	143.23	53.17
	32.21	49	137.34	51.06
Slab 5	32.31	49	137.34	51.06
	32.56	49	137.34	51.06
	33.17	50	131.45	49.64
Slab 6	33.54	51	125.57	48.07
	33.78	51	125.57	48.07
	34.37	52	121.64	47.48

Table-10: 0.3t Blast Load at 30m Standoff Distance

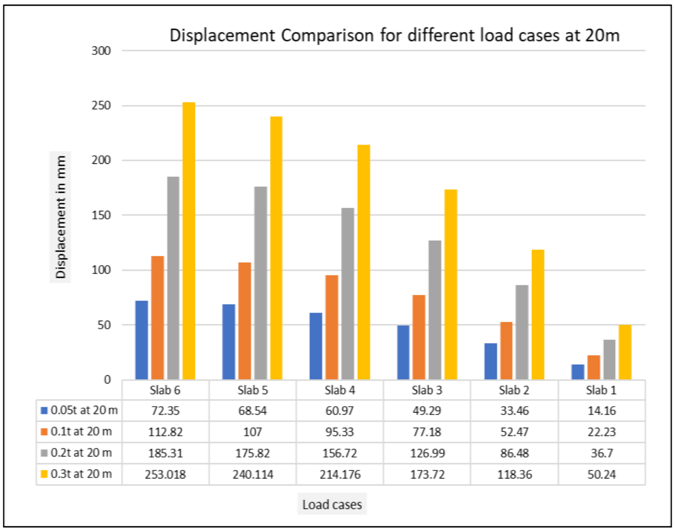

Chart 1: Storey Displacement at 20m standoff distance

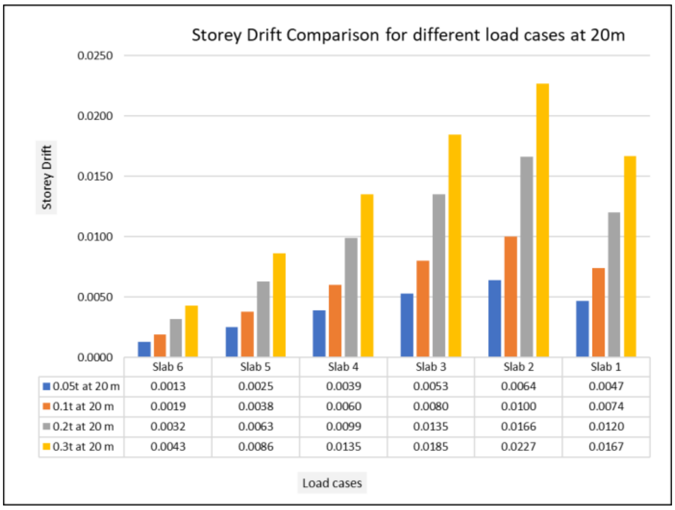

Chart 2: Storey Drift at 20m standoff distance

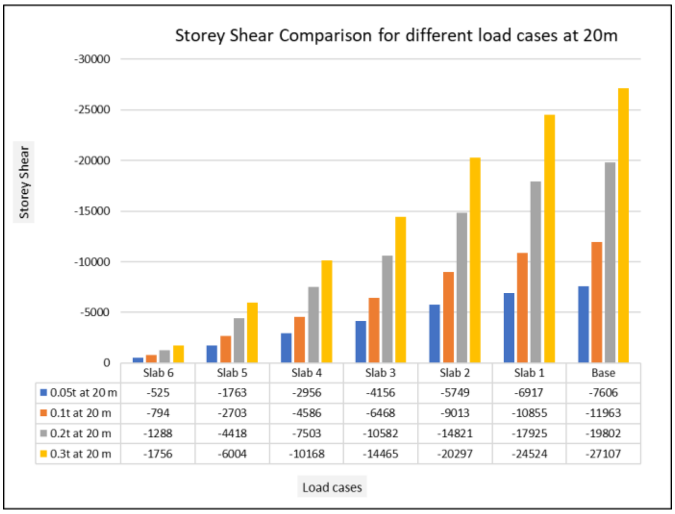

Chart 3: Storey Shear at 20m standoff distance

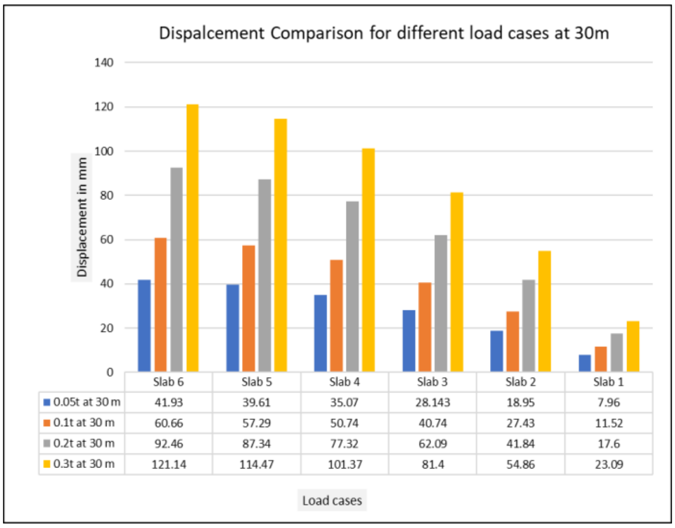

Chart 4: Storey Displacement at 30m standoff distance

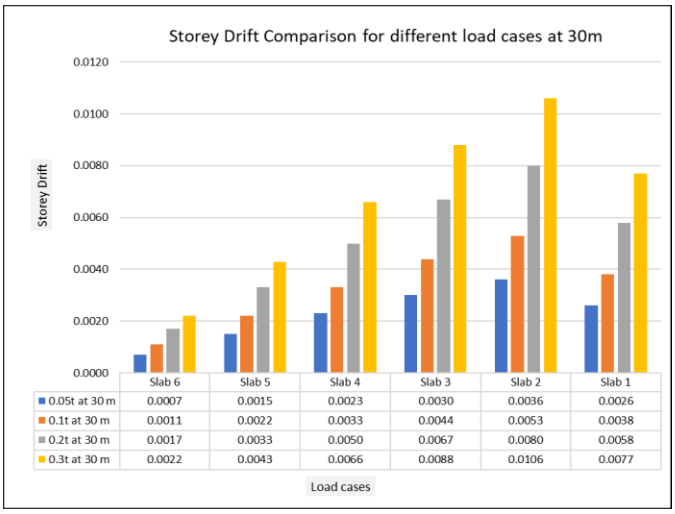

Chart 5: Storey Drift for at 30m standoff distance

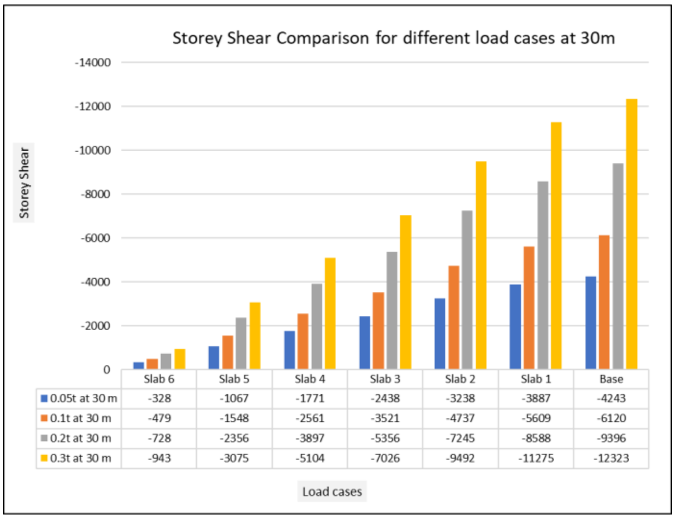

Chart 6: Storey Shear at 30m standoff distance

4.2 FOR INTERNAL BLAST LOAD

INTERNAL BLAST LOAD ON BUILDING				
Location at which load is applied	Charge weight in Kgs	Over Pressure (KN/m2)	Max. Displacement in the building (mm)	Max. Storey drift
At GF Central Cl	50	338.54	1.49	0.00042
	40	270.83	1.19	0.00033
	30	203.125	0.89	0.00025
	20	135.42	0.59	0.00017
At GF Corner Cl	50	1768.7	14.5	0.00448
	40	1414.96	11.6	0.00358
	30	1061.22	8.69	0.00268
	20	707.48	5.78	0.00179
At M.S. Central Cl	50	338.54	11.87	0.00127
	40	270.83	9.49	0.00090
	30	203.125	7.12	0.00068
	20	135.42	4.75	0.00045
At M.S. Corner Cl	50	1768.7	119	0.01155
	40	1414.96	87.41	0.00918
	30	1061.22	71.39	0.00693
	20	707.48	47.57	0.00462
At T.S. Central Cl	50	338.54	18.89	0.00126
	40	270.83	14.38	0.00096
	30	203.125	11.32	0.00072
	20	135.42	7.54	0.00048
At T.S. Corner Cl	50	1768.7	189.94	0.01204
	40	1414.96	151.95	0.00964
	30	1061.22	113.95	0.00723
	20	707.48	75.93	0.00482

Table-11: Result of the Internal Load applied

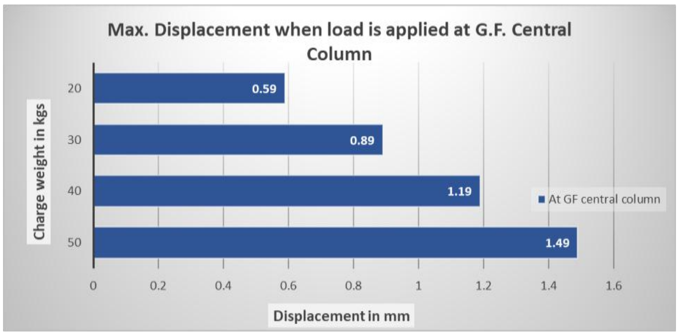

Chart 7: Max. Displacement when load is applied at GF central cl

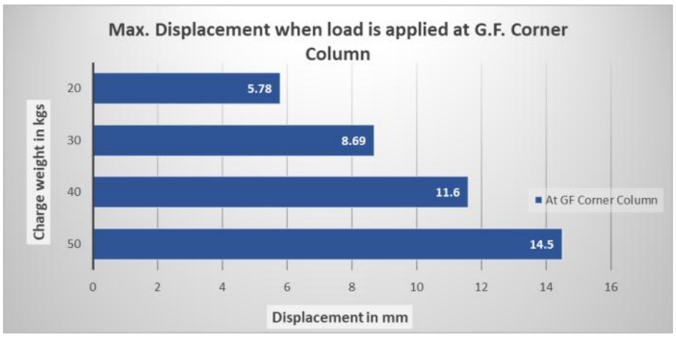

Chart 8: Max. Displacement when load is applied at GF corner column

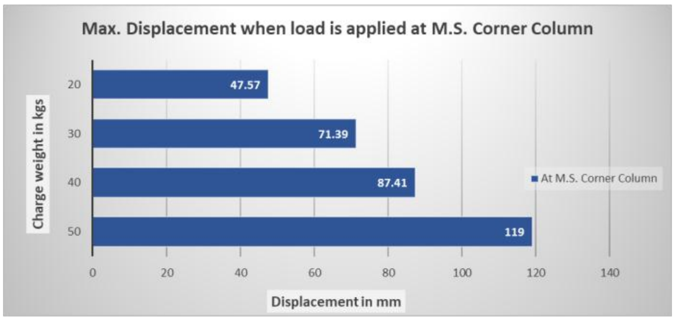

Chart 9: Max. Displacement when load is applied at MS central column

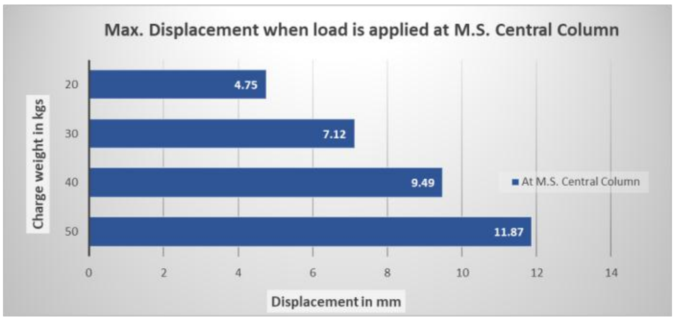

Chart 10: Max. Displacement when load is applied at MS corner column

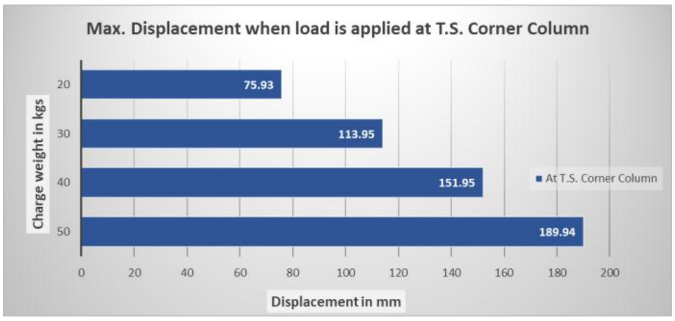

Chart 11: Max. Displacement when load is applied at TS corner column

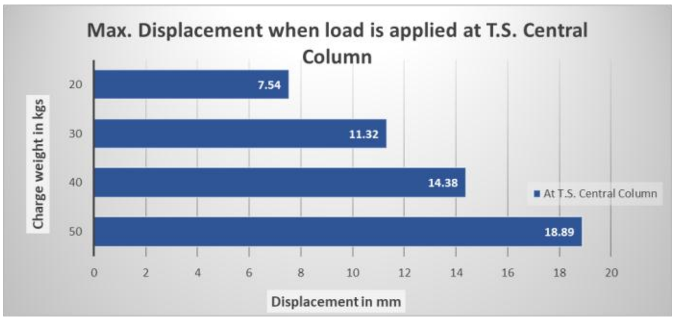

Chart 12: Max. Displacement when load is applied at TS central column

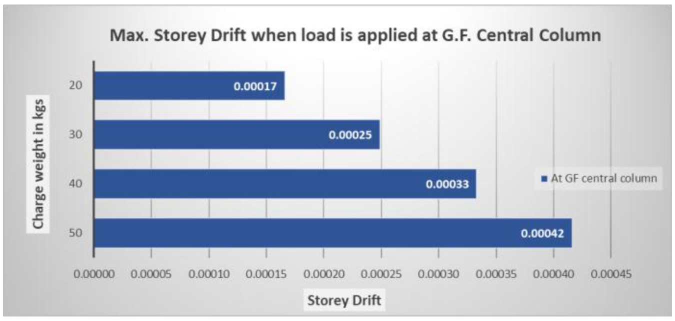

Chart 13: Max. storey drift when load is applied at GF central column

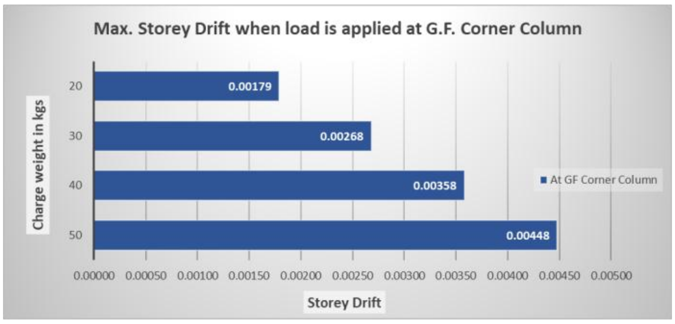

Chart 14: Max. storey drift when load is applied at GF corner column

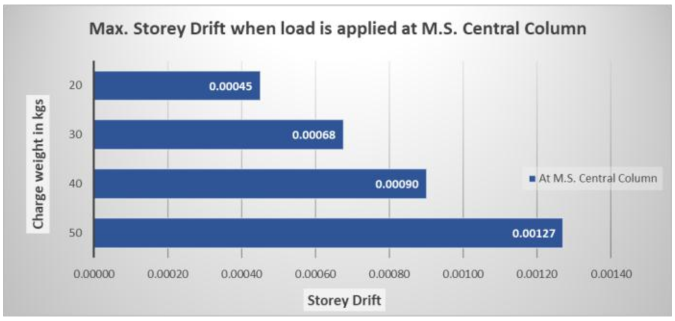

Chart 14: Max. storey drift when load is applied at MS central column

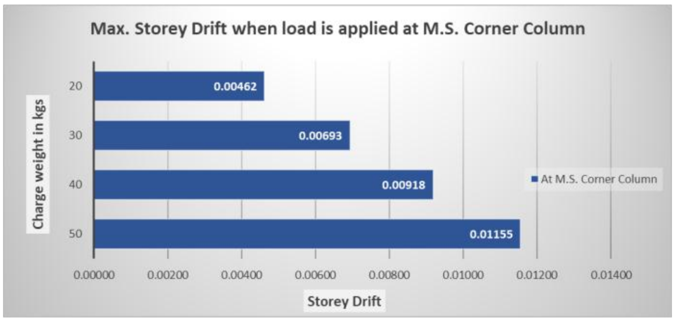

Chart 15: Max. storey drift when load is applied at MS corner column

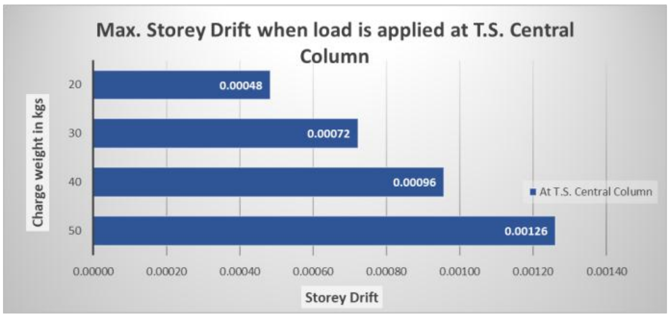

Chart 16: Max. storey drift when load is applied at TS central column

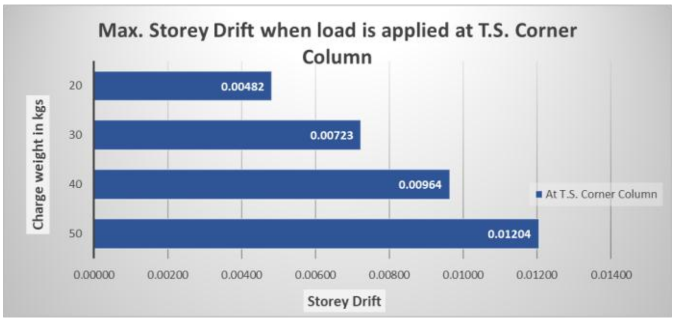

Chart 17: Max. storey drift when load is applied at TS corner column

5. CONCLUSION

Standoff distance and charge weight are main criteria for analysis of any blast resistance building.

Magnitude and lateral stability of the structure increase with increase in standoff distance.

It is not fully reliable or predictable for any analysis of blast explosion, as charge weight and its chemical reaction are different for different cases.

Peak overpressure Pro, increases with increase in standoff distance.

Nodal or joint displacement decreases with increase in standoff distance.

As the charge weight of blast increases, max. displacement and acceleration also increase.

Top storey experiences more storey displacement and drift than base storey when internal blast load is applied.

In this study for external blast load analysis, max. displacement, drift and storey shear are observed for 300kgs charge weight with a standoff distance of 20m.

For external blast load, max. storey drift is observed on the 1st floor of the building that is on Slab 2.

For internal blast load, maximum displacement and storey drift is observed for the load case of 50 kg blast load on top storey corner column

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