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Study and Analysis of Blast Resistance Structure

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Abstract: A day by day increase in terrorist activity is the most dangerous problem facing by the world. Despite of the advancement in technology their is a feeling of insecurity among the people. Despite the fact that the magnitude of the explosion and load causes by it can not be anticipated perfectly, efforts can be made to reduce the consequences of the explosion. In this present work , a G+4 storey RCC building is subjected to 100Kg,150Kg,200Kg and 250Kg Tri nitro toluene (TNT) blast sources at a distance of 30m,40m and 50m from the building is considered for analysis.IS 4991-1968 is used for the manual calculation of blast load and force time history is performed in STAAD Pro. The parameter like moment on column and shear force and moment on beam are studied.
Keywords: Blast load, standoff distance, Beam-column joint force, time history, STAAD Pro.

I. INTRODUCTION

The rapid expansion of hot gases resulting from the detonation of an explosive charge gives rise to a compression wave called a shock wave, which propagates through the air. The front of the shock wave can be considered infinitely steep, for all practical purposes. That is, the time required for compression of the undisturbed air just ahead of the wave to full pressure just behind the wave is essentially zero.If the explosive source is spherical, the resulting shock wave will be spherical, since its surface is continually increasing, the energy per unit area continually decreases.Generally the buildings are not designed for blast load, so the blast load create very high pressure over a building than the general loading. Blast load last for only short duration of time. B.M. Luccioni et. al.(2004)[1]concluded that for blast analysis, simplifying assumptions is to be made for the structure and materials.S.Ahmad et.al. (2012)[2]said that for accurate analysis of structural response air blast and ground shock pressure must be considered .Aditya Kumar et. al. (2014)[3]concluded that while designing the structure in absence of relevant code is the significant concern behind the ignorance of blast phenomenon. Jiji Madonna et.al.(2016)[4]studied that standoff distance would have an impact on the pressure at various floors.Sarita Singla et. al. (2015)[5]concluded that as the distance increases from the building, blast pressure reduces.

II. BLAST FORCE AS TIME HISTORY

IS 4991-1968 used for the manual calculation of scaled distance and blast and the force for the assumed charge weight.For different time interval , variation of force for each beam-column joint is also manually calculated.By using finite element method in STAAD Pro, a time history load are applied for each beam-column joint along with dead and live load.Load generated due to blast is similar to wind load but as the blast load is impulse load so it last for very short period of time.As blast load have very high intensity initially and then decreases gradually to zero in very short interval of time,a time history function is used.

III. METHODOLOGY

In this present work 3 models of G+4 storey RCC building is considered for base dimensions of 20mx20m,30mx30m and 40mx40m. Following table shows the material property considered and description of models considered.

Table 1-Property of material considered

Grade of concrete	M25
Grade of steel	Fe415
Density of concrete	25kN/m^3
Density of steel	78.5kN/m^3

Table 2- Description of models

Models	1	2	3
Number of bays in X-direction	4	6	8
Number of bays in Y-direction	4	6	8
Width of bays in X-direction	5	5	5
Width of bays in Y-direction	5	5	5
Height of each storey	3	3	3
column	0.3mx0.5m	0.4mx0.5m	0.4mx0.5m
Beam	0.3mx0.4m	0.3mx0.4m	0.3mx0.4m
Slab	0.12m	0.12m	0.12m
wall	0.23m	0.23m	0.23m

IV. COMPUTATION OF BLAST WAVE PARAMETERS

A TNT explosive of 100Kg,150Kg,200Kg and 250Kg weights are considered for the study .the source of blast is considered at a distance of 30m,40m and 50m interval individually.the various parameter of blast are obtained by using following formula.

$$\text{Scaled distance } x = \frac{\text{Actual distance}}{W^{1/3}}$$

$$\text{Scaled time } t_o = \frac{\text{Actual time}}{W^{1/3}} \ldots$$

Where,
W = yield of explosion in equivalent weight of the reference explosive measured in tonnes,
x = scaled distance for entering the Table1 in IS: 4991-1968 for reading peak values, and
to = scaled time read from Table 1 in IS: 4991-1968 against scaled distance.

Table 3- Final peak reflected over pressure on front face of building

Charge weight	Distance	Scaled distance	Scaled distance	Pro (KN/m2)	Tq (millisecond)
100 Kg	30	64.655	34.656	79.012	18.857
	40	86.206	22.810	49.807	19.48
	50	107.75	NO EFFECT		
150 Kg	30	56.603	42.815	100.714	17.695
	40	75.471	27.144	60.183	20.195
	50	94.339	19.172	41.285	22.42
200 Kg	30	50.847	52.269	52.269	16.725
	40	67.796	32.162	72.569	19.251
	50	84.745	84.745	51.239	21.232
250 Kg	30	47.619	58.643	145.658	16.061
	40	63.492	35.804	82.062	18.711
	50	79.365	25.046	55.535	20.582

The peak side-on over pressure Pso is obtained from Table 1 of IS:4991-1968 and the corresponding force lasting for about 20 milli-seconds which is calculated manually is applied on sides of the building which are applied using force time history in STAAD Pro for every beam column joint.

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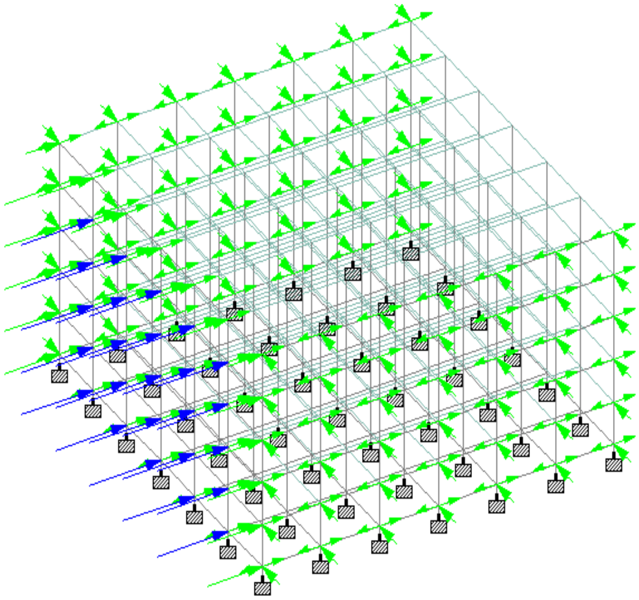

Figure :Representing the Application of Blast load

V. RESULTS

After analyzing each model for blast load, the column forces (bending moment) and beam forces (shear force, bending moment, torsion) are noted down for a distance of 30m, 40m, and 50m . Then then decrease in member forces is calculated for each model.

Table 4- Comparative decrease in member forces with increase in distance between blast and building.

Decrease in	Area(20m x20m)		Area(30m x30m)		Area(40 x40m)	
	Distance (40m)	Distance (50m)	Distance (40m)	Distance (50m)	Distance (40m)	Distance (50m)
Column (My)	25 %	41 %	25 %	40 %	25 %	40 %
Column (Mz)	40 %	61 %	40 %	60 %	41 %	60 %
Beam (Fy)	30 %	45 %	30 %	45 %	29 %	45 %
Beam (Fy)	21 %	34 %	43 %	62 %	25 %	37 %
Beam (Mz)	25 %	40 %	25 %	40 %	25 %	40 %
Beam (torsion)	29 %	44%	32 %	48 %	29 %	45 %

VI.CONCLUSION

A. The significant effect on the building will happen when the charge weight (W) increases and the ground distance decreases.

B. The location and area of building have major effect on minimizing blast pressure on building.

C. Column forces (bending moment) are more when standoff distance is less and vice versa.

D. Beam forces (shear force and bending moment) decreases as the stand off distance increases.

E. The reduction in the effect of moment on the building structure due to blast remains same (i.e, along Y direction in column) approx equal to 25 % at 40m distance and 40% at 50m distance

F. The reduction in the effect of moment on the building structure due to blast remains same (i.e, along Z direction in column) approx equal to 40 % at 40m distance and 60% at 50m distance.

G. The reduction in the effect of shear force on the building structure due to blast remains same (i.e, along Y direction in beam) for approx equal to 30 % at 40m distance and 45% at 50m distance.

H. The reduction in the effect of moment on the building structure due to blast remains same (i.e, along Y direction in beam) approx equal to 23 % at 40m distance and 35% at 50m distance for A(20mX20m) and A (40mX40m) and 43 % at 40m distance and 62% at 50m distance for A(30mX30m)

I. The reduction in the effect of moment on the building structure due to blast remains same (i.e, along Z direction in beam) approx equal to 25 % at 40m distance and 40% at 50m distance.

J. The reduction in the effect of torsion in the beam on the building structure due to blast remains same approx equal to 25 % at 40m distance and 40% at 50m distance.

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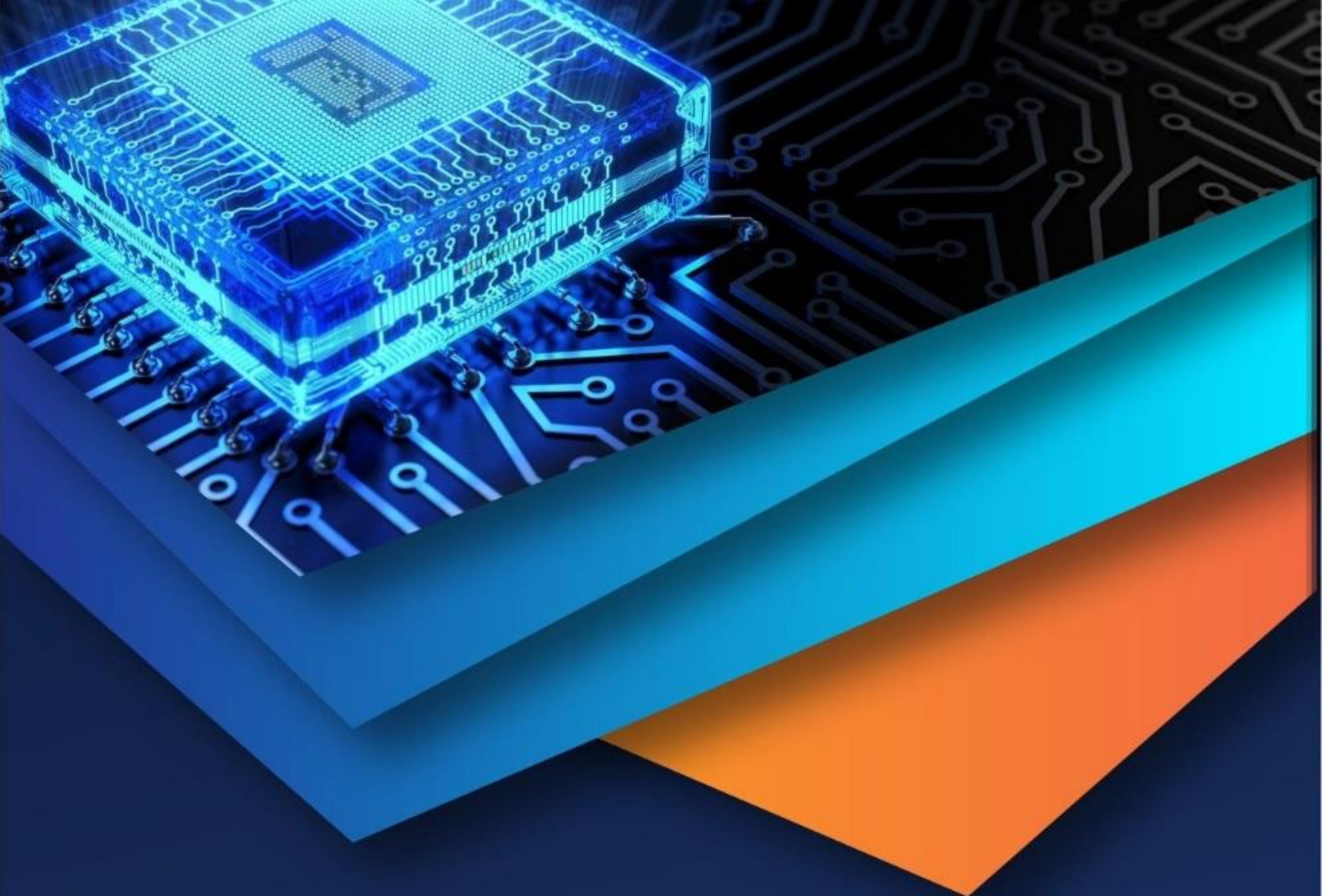

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