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DYNAMIC ANALYSIS OF EFFECT ON STRUCTURES SUBJECTED TO BLAST LOAD

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ABSTRACT

The blast loading gained its importance when the terrorist attacked on the Twin Towers of America. Many software's are available to structural engineers and thus enable one to analyze the structure for the blast loading and design accordingly. The present paper deals with the study of a blast load applied on a G+6 storied symmetrical building. A comparative study is done when the structure is fitted with different bracings. SAP 2000 Version 18 and RC Blast Software's are used for the analysis. Push over analysis is carried out for all the different cases.

Keywords— Blast load, Bracing system, Storey displacement, Storey drift, Standoff distance, SAP 2000, RC Blast, Terrorist attack.

I. INTRODUCTION

The analysis and design for the blast loading gained its importance when terrorist attacked the twin towers of America on 11th September 2001. The vehicle bombing attack on the twin towers of America was used by the terrorist against buildings. The common method used by the terrorist is the vehicle bombing on the structures. It is very important to protect some special buildings against the blast loadings. The investigation of structures subjected to impact loading becomes difficult, because it has to take into account the localized nature of the structure, the large variation of pressure over a relatively small area and the fact of the blast pressure not arriving at every point on the structure at the same time.

Usually the structures will experience the blast loading owed to armed actions, unplanned outbursts or terrorist actions. These type of blast loading may result in severe destruction or failure of the structure due to their very high intensity and dynamic nature. Failure of one important member in the locality of the source of the blast may generate critical stress redistribution and lead to failure of other members, and ultimately the entire structure.

II. RELATED WORK

The blast features define a transient pulse of pressure which is discharged from the source of the blast. The transient pulse consists of positive phase during which incident pressure in the environment considerably go beyond the ambient pressure, often followed by a negative phase during which the incident pressure falls underneath the ambient pressure. It is the relation between the transient pulse and an affected structure which

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governs the dynamic response of a specific structure.

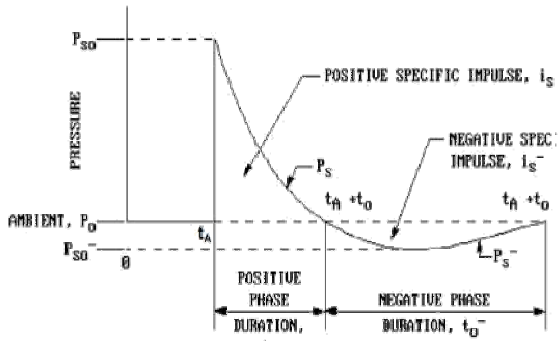

Fig1. Typical blast pressure with time

Blast wave scaling laws

The standardized explanation of the blast effects is given by scaling distance relative to $(E/Po)^{1/3}$ and scaling pressure relative to Po, where E is the energy release (kJ) and Po the ambient pressure (typically 100 kN/m^2). In general the basic explosive input or charge weight W is expressed as an equivalent mass of TNT. Outcomes are then given as a function of the dimensional distance parameter. Scaling laws provide parametric connections between a specific explosion and a standard charge of the same substance.

$$\text{Scaled distance}(Z) = \frac{R}{W^{1/3}}$$

Where, R is the actual effective distance on or after the blast W is expressed in pounds or kilograms.

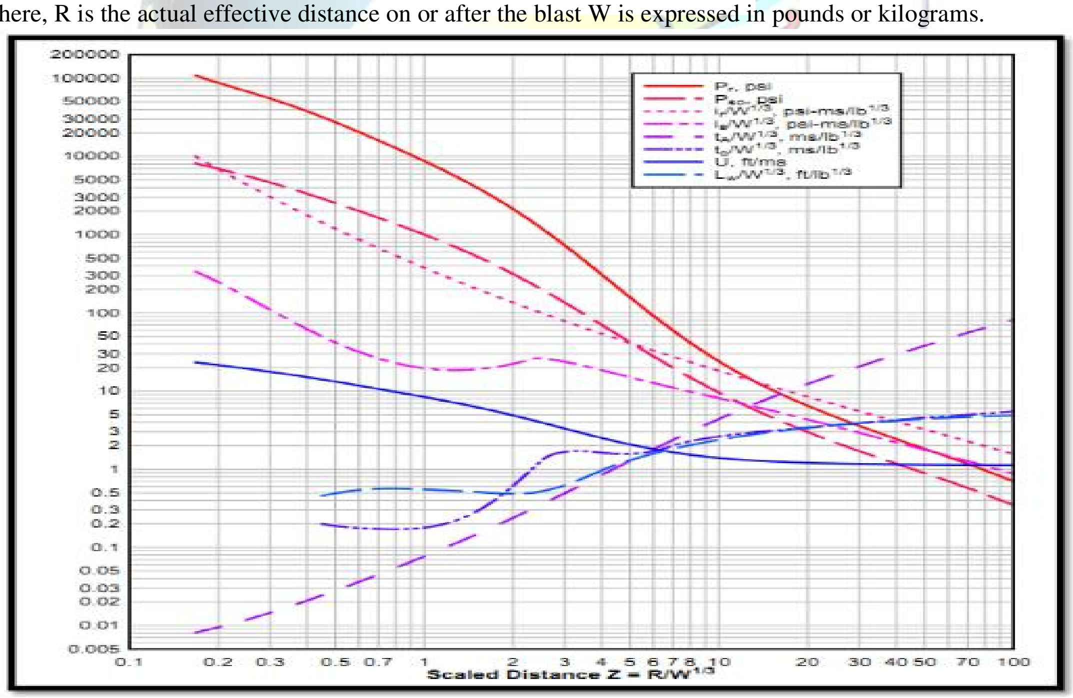

Fig 2. Positive phase shock wave parameters for TNT explosion on the surface at sea level

A. RC Blast

RC Blast software conducts the dynamic inelastic response history analysis of RCC structures exposed to blast loading. RC Blast creates SDOF displacements time-history by numerical integration of the dynamic

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equation of motion. The authenticity of RC Blast software has been verified against varieties of structures by researchers and professionals. [4] proposed a principle in which another NN yield input control law was created for an under incited quad rotor UAV which uses the regular limitations of the under incited framework to create virtual control contributions to ensure the UAV tracks a craved direction. Utilizing the versatile back venturing method, every one of the six DOF are effectively followed utilizing just four control inputs while within the sight of un demonstrated flow and limited unsettling influences. Elements and speed vectors were thought to be inaccessible, along these lines a NN eyewitness was intended to recoup the limitless states. At that point, a novel NN virtual control structure which permitted the craved translational speeds to be controlled utilizing the pitch and the move of the UAV. At long last, a NN was used in the figuring of the real control inputs for the UAV dynamic framework. Utilizing Lyapunov systems, it was demonstrated that the estimation blunders of each NN, the spectator, Virtual controller, and the position, introduction, and speed following mistakes were all SGUUB while unwinding the partition Principle.

The blast loads can be inputted as a sequence of pressure time data points specified by the user. The user may also state the TNT equivalent explosive mass and stand-off distance so that the software calculates the blast pressure distribution.

Plan dimension: 12x18m
Total height of the building: 21.2m
Typical storey height: 3.2
Bottom storey height: 2m

Type of concrete used: M30 Spacing of beams in X-direction: 6m
Type of rebar: HYSD500 Bays in X-direction: 2 bays
Column dimension: 600X600mm Spacing of beams in Y-direction: 6m
Beam dimension: 300X600mm Bays in Y-direction: 3 bays
Thickness of the slab: 200mm Live load considered on slab: 4 kN/m2 (IS 875-Part II)
Thickness of wall: 230mm Super dead load considered on slab: 1 kN/m2
Wall load: 14.72 kN/m
Loads patterns considered: a) Dead load
b) Live load
c) Super dead load
d) Wall load
e) Blast load
Type of steel used for bracing: Fe250
Load combinations: Following load combinations are considered according to IS 456 and IS 4991:1968
i) 1.5DL+1.5SDL+1.5WALL
ii) 1.5DL+1.5LL+1.5SDL+1.5WALL
iii) 1.0DL+1.0LL+0.5BL

Load Pattern: In the design of R.C.C structure, the load pattern considered for the blast load is wave type and the Code referred was API WSD2000.

B. Blast pressure parameters
Sample blast pressure calculations are shown below
Case 1:
W= 100 kg
Stand-off distance at ground level, R = 26
m Scaled distance $Z = R/W^{1/3} = 5.60\ m/kg^{1/3}$
Positive pressure P_r= 80.8 kPa
Positive impulse= 513.3 kPa-ms
Positive duration tA= 18.3 ms
Negative pressure= 15.1 kPa
Negative impulse= 528.8 kPa-ms

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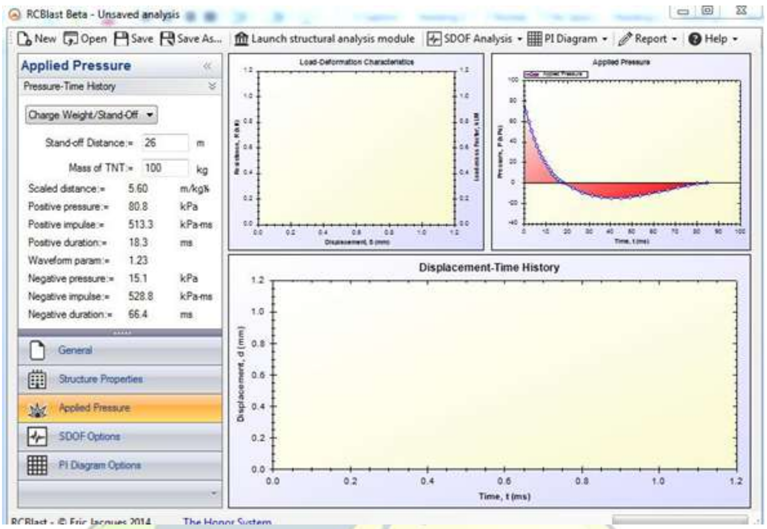

Fig 3. RC Blast software to calculate blast pressure and time

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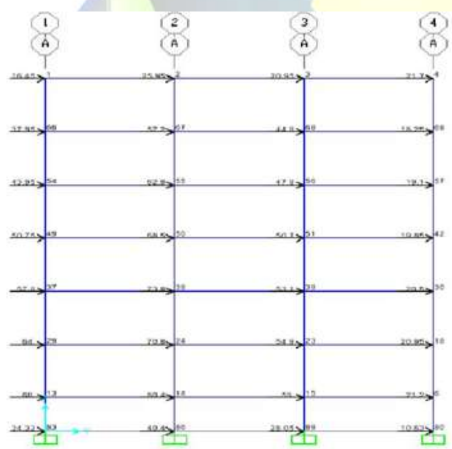
Table 1. Application of Blast loads at end face of the nodes

Node number	Stand off distance, z (m)	Positive pressure (kN/m^2)	Time (ms)	Applied blast load (kN)
83	20.00	1373	16.5	34.32
86	26.00	808	18.3	40.40
89	32.00	561	19.7	28.05
80	38.00	425	20.8	10.63
13	20.09	1360	16.5	68.00
14	26.07	804	18.3	80.40
15	32.06	559	19.7	59.00
6	38.05	424	20.8	21.20
29	20.66	1280	16.7	64.00
24	26.51	780	18.4	70.80

Similarly at all the faces of the nodes the blast load is applied



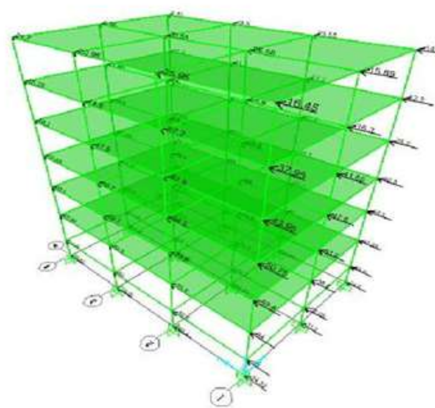


Fig 3. Blast load application on the front side of the structure in SAP2000 fig 4. Three dimensional view of the building with the application of blast loads in SAP2000

GRAPHICAL REPRESENTATIONS

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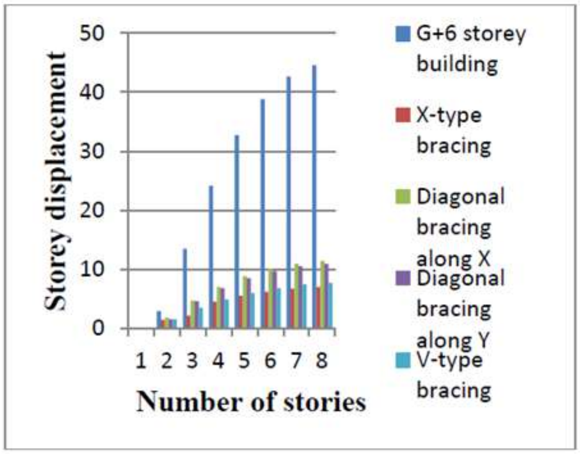

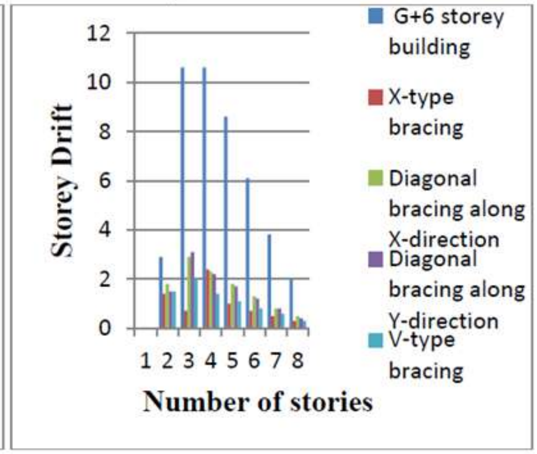

Fig 5. Graph showing No. of Stories V/S Storey displacement

Fig 6. Graph showing No. of stories V/S Storey drift

III. CONCLUSIONS

1. As the positive pressure decreases the time taken for the blast load to reach the structure also decreases.
2. The displacement for the G+6 storey normal building was found to be more as compared to that of the other type of braced structure.
3. Among all the braced type of structures the X-type bracing is found to be efficient when the blast load was applied laterally.
4. The storey displacement is found to be more at the top floor, where as the storey drift is found to more at the middle floors as compared to top floors.
5. As the standoff distance increases the positive pressure decreases.
6. X-type bracing the V-type bracing showed less displacement compared to other two type of diagonal bracing.

REFERENCES

[1] API WSD 2000, Recommended Practice for Planning, Designing and Construction Fixed offshore Platforms-Working Stress Design, December (2002).
[2] Donald O. Dusenberry, Handbook for Blast-Resistant Design of Buildings, (2010).
[3] G.C.Mays and P.D.Smith, Blast Effects on Buildngs, G.C.Mays, P.D.Smith, Thomas Telford, Londan, 2003.
[4] Christo Ananth,"A Novel NN Output Feedback Control Law For Quad Rotor UAV",International Journal of Advanced Research in Innovative Discoveries in Engineering and Applications[IJARIDEA],Volume 2,Issue 1,February 2017,pp:18-26.
[5] IS: 4991-1968, Criteria for Blast Resistant Design of Structures for Explosions above Ground, Reaffirmed (2003).
[6] Jon A. Schmidt, Blast Design-Equivalent Static Methods, Structural Engineers Association of Kanas and Missouri, Kanas City, Mo.,2007.
[7] Logaraja.R, Blast Resistant Structure, International Journal of advanced technology in engineering and science, volume:02,October(2014), pp 261-264.
[8] Madhekar.S.N and Qureshi.Z.A.L, Response of 45 Storey High Rise RCC Building Under Blast Load, Advances in Structural Engineering, Springer India 2015V. Matsagar (ed.), pp 435-448.
[9] Mendis .P, Gupta.A , Ngo.T and Rmasay.J, Blast Loading and Blast Effects on Structures–An Overview. EJSCE International journal Loading on Structures (2007), pp 76-91.
[10] Pankaj Singla, Sarita Singla, Anmol Singla, Computation of Blast Loading for a Multistoreyed Framed Building, International Journal of Research in Engineering and Technology, volume:04, pp 759-766.
[11] PIP STC01018, BLAST Resistant Building Criteria, Process Industry Practices (PIP), Construction Industry Institute, The University of Texas at Austin, Texas, 2006.
[12] TM 5-1300, Structures to Resist the Effects of Accidental Explosions, TechnicalManual TM 5-1300, Department of the

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Army,Navy, and Air Force, Washington, DC, 1990.
[13] Vladimir Sigmund, Hrvoje Draganic, Blast Loading on Structures, Technicki vjesnik, volume: 19,3(2012), pp 643-652.
[14] Z.A.Siddiqi, Rashid Hameed, Usman Akmal, Comparison of Different Bracing Systems for tall Buildings, Pak J.Engg & Appl.Sci. Volume:14, Jan (2014), pp 1