STUDY OF MULTISTORY BUILDING SUBJECTED TO BLAST LOADS

Nilakanta Yumnam[1], Raghavendra N B[2], Vishwanath Okram[3], William Samukcham[4]

[1,2,3,4]*Student, Department of Civil Engineering,*

Alvas Institute of Engineering and Technology, Karnataka, India

ABSTRACT

The investigation and design of structures when exposed to explosion loads require an understanding of the air explosion phenomenon and the dynamic response of structure. Usually the structures will experience the blast loading owed to armed actions, unplanned outbursts or terrorist actions In this project an attempt is made to analyze a G+4 storied symmetrical building which is subjected to blast loading. A comparative analysis is given when the structure is fitted with X bracings, diagonal bracings. For the analysis ETABS is used along with RC Blast software. A case study is performed in unsymmetrical building taking the reference of our college AIET Main Building with G+4. A comparative analysis is given when the structures are fitted with different types of bracings. The plan of the building is to be drawn using AutoCAD and for the analysis ETABS is used along with RC Blast software. Computation of blast loading for G+4 storied framed building has been carried out for different cases, in which one is Normal G+4 storey building, X-Braced type building, Diagonal type braced building i.e. inclination along forward and backward direction In all the cases the equivalent SEMTEX charge weight W has been taken as 50 kg and the actual effective distance from explosion R is taken as 10 m.

Keyword: *blast loading, bracings, plan, semtex, multistoried, stand off distance, etabs, rcblast.*

I. INTRODUCTION

Many terrorists have used the technique of vehicle bombing attacks against buildings. The use of vehicle bombs is a very common type of terrorist attack on structures. It is very important to protect some special buildings against the blast loadings. These developments have led to the scheme of critically evaluating the structures against blast loading and designing them for the same. The investigation and design of structures when exposed to explosion loads require an understanding of the air explosion phenomenon and the dynamic response of structure. Analysis of structures exposed to blast loading is difficult because the uniform transient loads produced by the nearby detonation, combined with the localized structural response results in an extremely complex structural analysis problem. When the blast happens, an exothermic chemical reaction takes place in a period of milliseconds. The explosive material which is in the solid form or liquid form is transformed to dense, very hot, high pressure gas. The high pressure gas or compacted air travels outward on or after the source at supersonic velocities which is called the shock wave front. This compressed air enlarges at very enormous speeds and eventually influences steadiness by means of the adjacent air.

Fig 1: US embassy bombing in April 1983

II. OBJECTIVE

In this project an attempt is made to analyze a G+4 storied symmetrical building which is subjected to blast loading. A comparative analysis is given when the structure is fitted with X bracings, diagonal bracings. For the analysis ETABS is used along with RC Blast software. A case study is performed in unsymmetrical building taking the reference of our college AIET Main Building with G+4. A comparative analysis is given when the structures are fitted with different types of bracings. The plan of the building is to be drawn using AutoCAD and for the analysis ETABS is used along with RC Blast software. The results in the form of displacements and storey drift are compared for all the different cases are considered for the typical building and AIET Main building.

III. COMPUTER MODEL AND ANALYSIS

Using the finite element software the Computer modeling of the building was accomplished ETABS. The G+4 storey reinforced concrete building were frame structure composed of columns, beams, bracing system and slabs. The columns, beams and bracing were modeled as frame elements whereas the slabs were modeled as shell elements. The building model was assigned with fixed bottom support at the base of the building. No wind load and seismic load is considered for the design, as per the IS code "4991:1968 for blast resistant design of structures", Wind or earthquake forces shall not be assumed to occur simultaneously with blast effects: Computation of blast loading for G+4 storied framed building has been carried out for the five cases, in which one is Normal G+4 storey building, X-Braced type building, Diagonal type braced building i.e. inclination along X and Y direction. The buildings are considered as per IS Code 4991:1968 for blast resistant designing purposes. In all the cases the equivalent SEMTEX charge weight W has been taken as 50 kg and the actual effective distance from explosion i.e. R is taken as 10 m..

A. Displacements of structure at different floors of symmetrical building

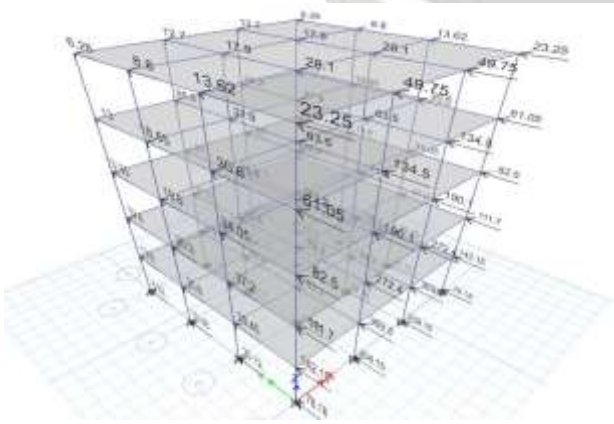

Fig 2: 3-D view of the symmetrical building with the application of blast loadings at the nodes

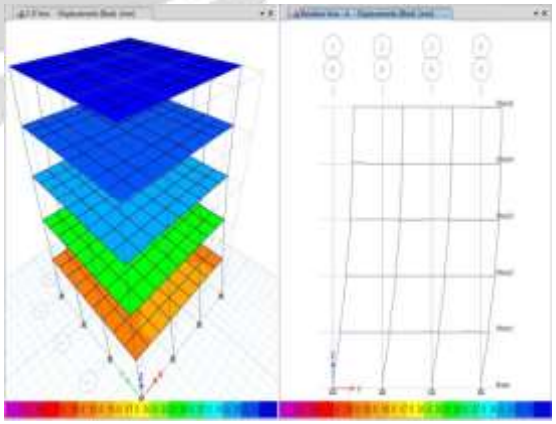

Fig 3: Lateral displacement for G+4 storey building without bracing

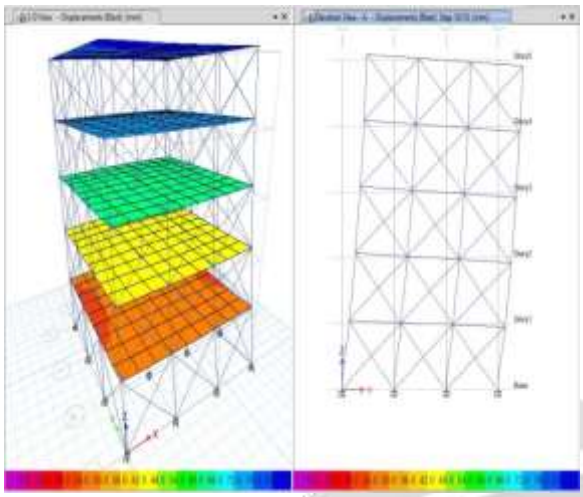

Fig 4: Lateral displacement for X-type braced building

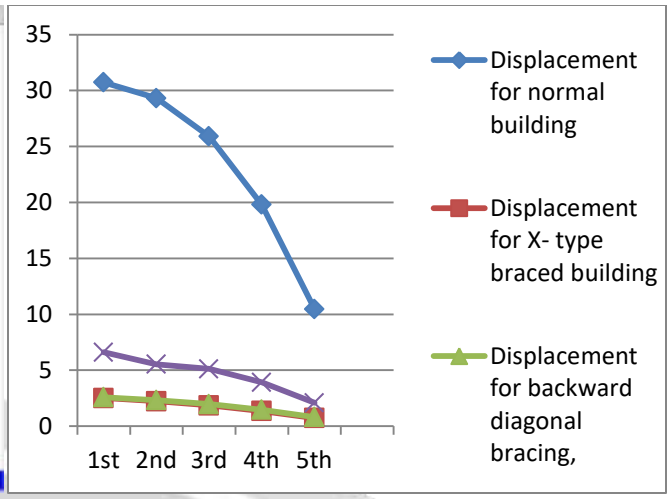

Fig 5: Graph of no. of stories v/s displacements

Floor No.	Normal	X- type	Diagonal	Diagonal
1st	30.732	2.513	2.585	6.6
2nd	29.309	2.237	2.324	5.527
3rd	25.905	1.853	1.968	5.124
4th	19.809	1.354	1.479	3.924
5th	10.461	0.733	0.813	2.094

Table 1 Displacement of structure at different floors

B. Displacements of the AIET Main building at different floors

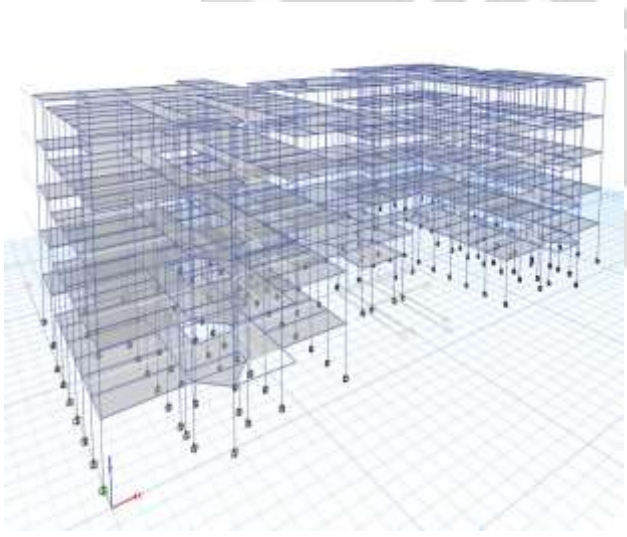

Fig 6: 3D model of AIET Main building

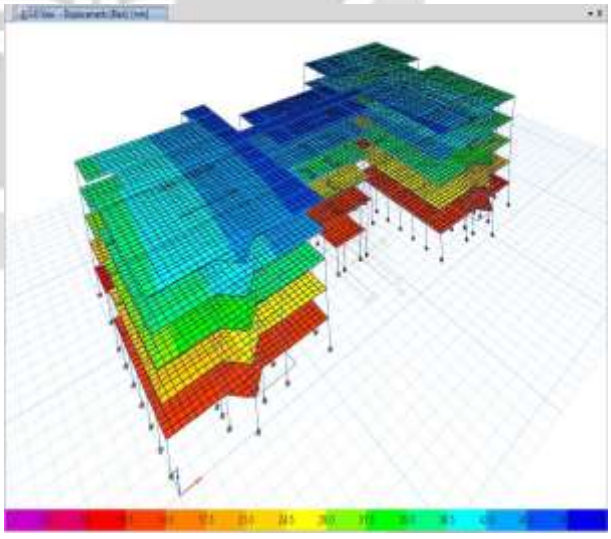

Fig 7: Lateral displacement for AIET Main building without bracing

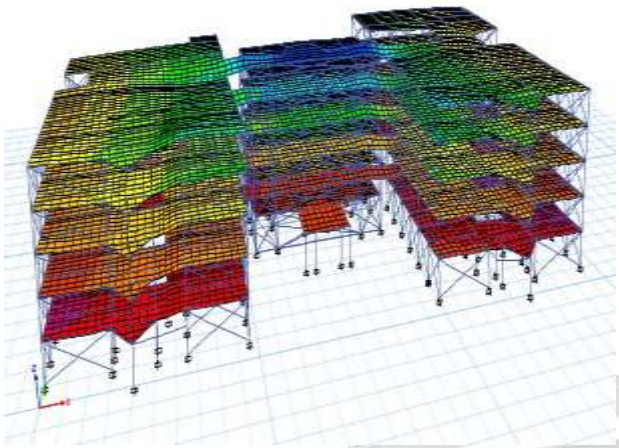

Fig 8: Lateral displacement for AIET Main building X bracings

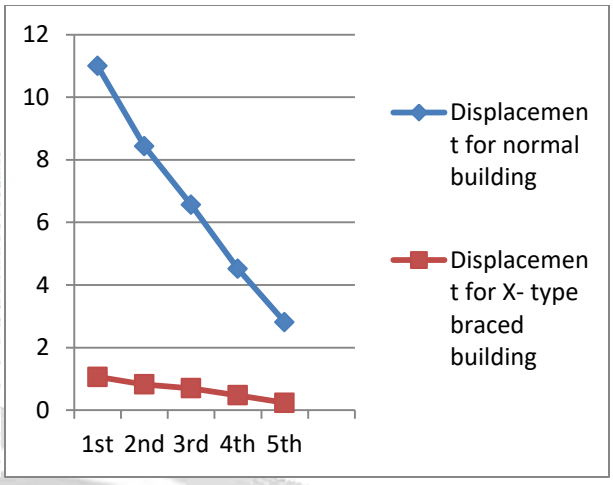

Fig 9: Graph of no. of stories v/s displacements

Number of floors, from top	Number of floors, from top Displacement for normal building (mm)	Displacement for X- type braced building (mm)
1st	10.995	1.065
2nd	8.435	0.825
3rd	6.563	0.698
4th	4.520	0.475
5th	2.811	0.235

Table 2: Displacement of AIET Main building at different floors

IV. CONCLUSION

1. As the standoff distance increases the positive pressure decreases i.e. at 10 meter standoff distance, the positive pressure is 312.7 kN/m^2 , but as the distance increases i.e. at 43.51 meter the positive pressure becomes 25.1 kN/m^2. From the above values it can be noted that stand off distance is inversely proportional to pressure.
2. Contribution factor of 0.25 is considered for outer nodes but for inner nodes it is taken as 0.5 at the ground level and at the top floor, whereas the contribution factor of 0.5 is considered for outer nodes and for inner nodes it is taken as 1 for all other floors. Therefore at the outer nodes the application of blast load is lesser compared to that of the inner nodes.
3. As the positive pressure decreases the time taken for the blast load to reach the structure also decreases.
4. The displacement for the G+4 storey normal building was found to be more as compared to that of the other type of braced structure.
5. Among all the braced type of structures the X-type bracing is found to be efficient when the blast load was applied laterally. For the normal storey building the displacement was found to be 30.372 mm whereas in case of X-type bracing the displacement was found to be 2.513 mm.
6. Subsequently X-type bracing showed less displacement compared to other two type of diagonal bracing, the displacement was found to be 2.513 mm.
7. The displacement for the existing AIET building was found to be more as compared to that X braced AIET structure.
8. The proposed bracing type for AIET main block is X type bracing for blast resistance.

5. REFERENCES

[1] Investigation Of Multistory Building subjected to Blast Load using SAP2000 Version 18,Rashmi H,T S Sahana, K.P.Thejaswi, Sachin

[2] Analysis of high rise RCC building subjected to blast load,Jiji Madonna, Mrs. Vijaya G S, and Er. Kirankumar K L

[3] Behavior and Design of Commercial Multistory Buildings Subjected to Blast, Mike P. Byfield

[4] 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

[5] Blast Loading on Structures, Technickivjesnik, volume: 19,3(2012), pp 643 652;Vladimir Sigmund,HrvojeDraganic

[6] Blast Effects on Buildngs, G.C.Mays, P.D.Smith, Thomas Telford, Londan, 2003

[7] Blast loading and blast effects on structures—an overview, Tuan Duc Ngo, University of Melbourne

[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] Z.A.Siddiqi, Rashid Hameed, UsmanAkmal, Comparison of Different Bracing Systems for tall Buildings, Pak J.Engg&Appl.Sci. Volume:14, Jan (2014), pp 17-26

[10] PankajSingla, SaritaSingla, AnmolSingla, Computation of Blast Loading for a Multistoreyed Framed Building, International Journal of Research in Engineering and Technology, volume:04, pp 759-766