Performance of Shear wall under Blast Loading

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***Abstract*— The increase in the number of terrorist attacks especially in the last few years has shown that the effect of blast load on building is a serious challenge that should be taken into consideration for designing of structures. This type of loading damages the structures, externally as well as internally. Hence the blast load should be considered with same importance as earthquake load. In recent years, design and analysis of such impulsive loads subjected to structures are studied in detail to find out the performance of the structural elements subjected to sudden type of loading. It is given more importance due to the effect, which is caused by blast due to high magnitude, sometimes blast may be even accidental. Thus it is necessary to understand the effect of blast on the structure and behavior of structural elements due the load. The objective of this study is to shed light on blast resistant building design theories, the enhancement of building security against the effects of explosives in both architectural and structural design process and the design techniques that should be carried out.**

Keyword: ***Blast Resistant structures, Stand-off distance, Blast loading, Scaled distance*.**

I. INTRODUCTION

Damage to the building causing loss of lives is a factor that has to be minimized if the threat of terrorist activities cannot be stopped. This paper gives guideline measures for overcoming the effects of explosions, hence providing protection to the structures and lives. Ductile elements like steel and RCC can absorb a significant amount of strain energy, whereas brittle elements like PCC, timber, brick masonry, glass, etc. fail abruptly. IS 4991-1968 has failed to deal with the different kinds of loads developed in the dynamic response of a building to bomb blast. They need further explanation as the engineers have no guidance on how to design or evaluate structures for the blast anomaly for which an elaborated understanding is required. Though this topic is of prime importance in the military circles and important data derived from tests and experiments have been restricted to army use only. Yet a number of publications are available in the public domain by the US agencies. In this topic, exploration of the literature on blast loading, explanation of special conditions in defining these loads and also the exploration of the vulnerability assessment and risk management of structures with standard structural analysis software having nonlinear capabilities. In the past 2-3 decades, substantial importance has been given to problems related to blasting and earthquake. Problems on Earthquake despite being very old, most of the knowledge on this subject has been agglomerated during the past fifty years but in the case of blast loading, this condition is different. Disasters such as Manchester Arena bombing, UK, 22nd May 2017, at the Ariana Grande's pop concert, Baghdad Bombing, Iraq, 3rd July 2016, terrorist bombings of the 13th November 2015 Paris attacks were a series of coordinated terrorist attacks in Paris and its northern Suburb, Mumbai 26/11 terrorist attack and many more have demonstrated the need for a thorough examination of the structures subjected to blast loads. With the present knowledge and software, it is possible to perform analysis of structures exposed to blast loads and to evaluate their response. Blast loading or impulse loading is a type of load acting for a very short duration of time. Graphically, blast loading is drawn as a triangle, referring as triangular loading.

A. Blast Load

To resist blast loads, the first requirement is to determine the threat. The major threat is caused by terrorist bombings. The threat for conventional bomb is defined by two equally important elements, the bomb size, or charge weight, and stand-off distance- the minimum guaranteed distance between the blast source and the target. Another requirement is to keep the bomb as far as possible, by maximizing the keep out distance. No matter what size the bomb is, the damage will be less severe the further target from the source. Structural hardening should be the last resort in protecting a structure; detention and prevention must remain the first line of defense. As terrorist attacks range from the smaller letter bomb to gigantic truck bomb as experienced in the Oklahoma city, the mechanics of a conventional explosion and their effects on a target must be addressed

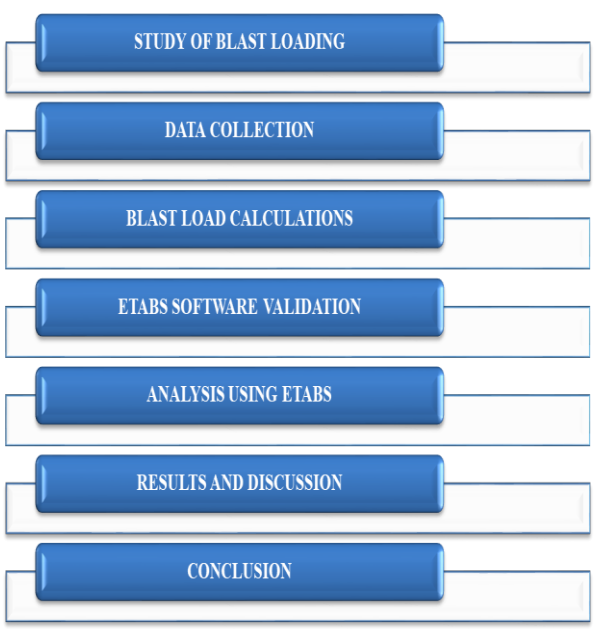
B. Scope of Present Work

In this project, a plan of G+6 storey building is selected with introduction of blast load, the following 2 cases will be considered:

1. Case 1: RC structure
2. Case 2: RC structure having shear wall

The amount of explosion and the loads caused by it cannot be predicted exactly, the most possible scenarios or cases will let to find the required engineering and architectural solutions for it. For this dynamic analysis with design will be done on all the cases using ETAB software the comparison of parameter like Storey Displacement, Shear Force, Bending Moment is done with respect to standoff distances in above two cases and also comparison for these two cases.

II. METHODOLOGY & PROBLEM STATEMENT



A RCC high rise building of G+ 6 stories with floor height 3m subjected to blast loading has been considered. In this regard, ETABS software have been considered as tool to perform. Hence in this chapter we will discuss the parameters defining the computational models, the basic assumptions and the geometry of the selected building considered for this study. Displacements, shear force and bending moment have been calculated for the RC structure having shear wall and the RC Structure.

Table 1 Models of RC structure

MODEL 1	Standoff Distance- 0m , 5m, 10m, 15m	G + 5 RC Structure
MODEL 2	Standoff Distance- 0m , 5m, 10m, 15m	G + 5 with Shear Wall

Table 2 Model Details

Sr. No.	Parameter	Values
1.	Number of storey	G+5
2.	Base to plinth	1.5 m
3.	Floor height	3 m
4.	Parapet Height	1.5 m
5.	Total height	18 m
6.	Shear wall	200 mm thick
7.	Materials	Concrete M30 and Reinforcement Fe 500
8.	Frame size	60m X 40m building size
9.	Grid spacing	5m grids in X-direction and 5m grids in Y-direction.
10.	Size of column	300 mm x 600 mm
11	Size of beam	300mm x 550 mm
12	Depth of slab	150 mm

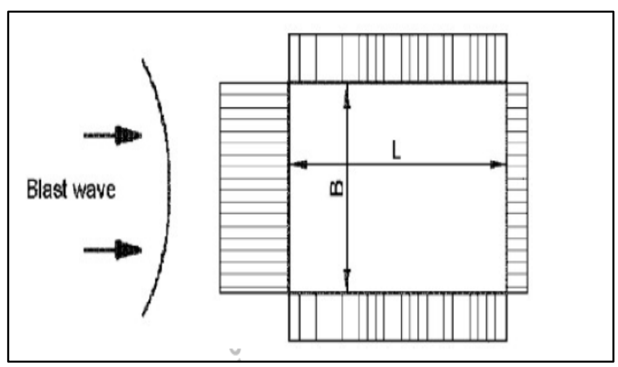


Fig 1 Blast load for Building

Table 3 Total Blast Load in Mpa

Total Blast Load in Mpa			
Standoff Distance (m)	Front Wall Loading	Side Wall Loading	Roof Loading
0	33688851036	5906994453	590699445.3
5	2217389.3	388058.28	388058.28
10	36733.872	6345.3792	6345.3792
15	3480.897	581.0392	581.0392

III. MODELLING IN ETABS

A. Modelling In ETABS

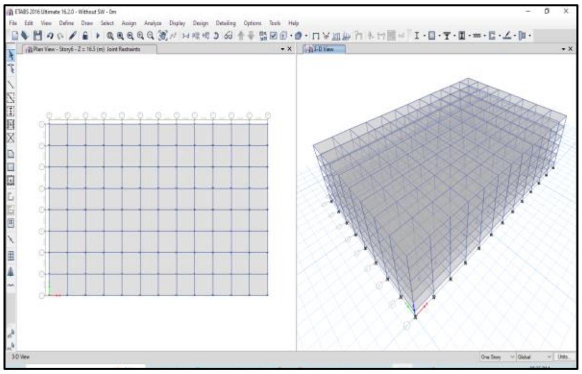


Fig 2 Model 1 G + 5 RC Structure

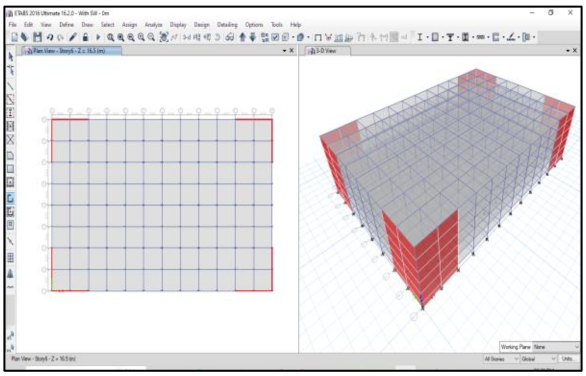


Fig 3 Model 2 G + 5 with Shear Wall

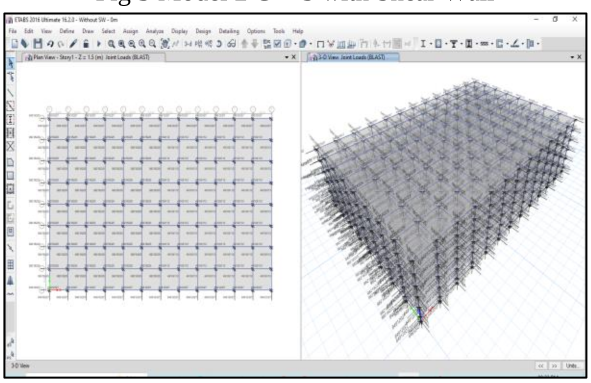


Fig 4 Blast load on RC Structure

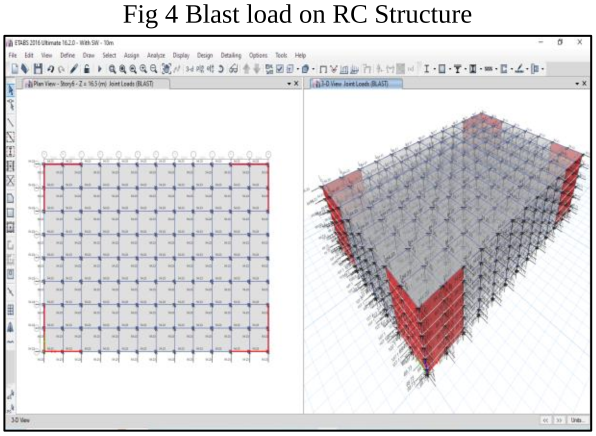


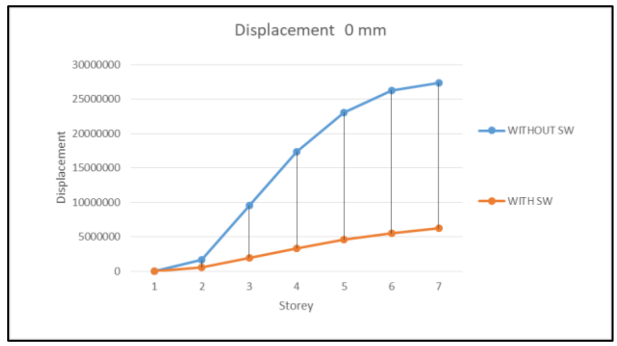
Fig 5 Blast load on RC Structure with Shear Wall

IV. RESULT AND DISCUSSION

A. Results For Blast Load 0m Standoff Distance

Table 4 Displacement for 0 mm

Displacement 0 mm		
Storey	Without SW	With SW
6	27355204.06	6244788.863
5	26262750.8	5494689.256
4	23065920.15	4556786.283
3	17371481.72	3353158.756
2	9549369.217	1954030.844
1	1634106.262	537936.288
0	0	0

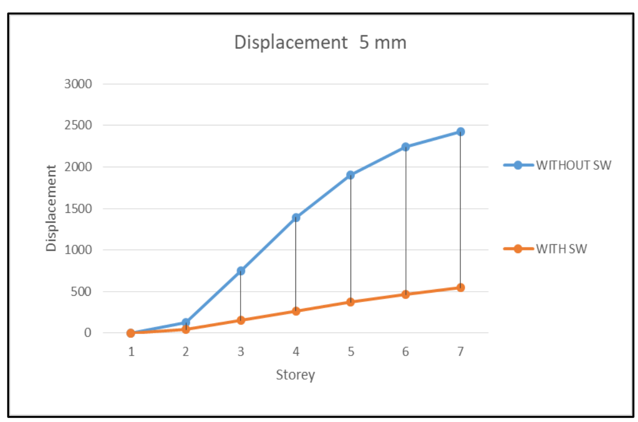


Graph 1 Displacement For 0 mm

B. Results For Blast Load 5m Standoff Distance

Table 5 Displacement for 5 mm

Displacement 5 mm		
Storey	Without SW	With SW
6	2424.367	546.969
5	2240.563	465.475
4	1899.769	372.158
3	1391.408	264.832
2	748.252	149.914
1	125.477	40.334
0	0	0

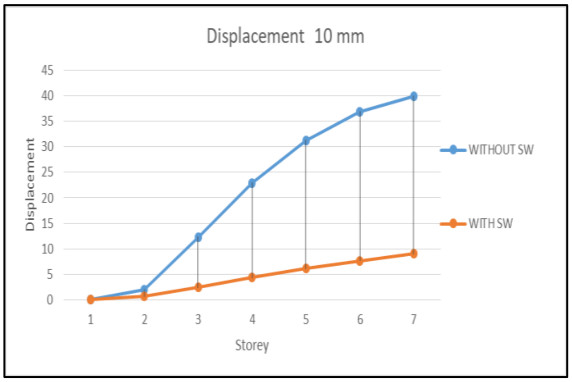


Graph 2 Displacement For 5 mm

C. Results For Blast Load 10m Standoff Distance

Table 6 Displacement for 10 mm

Displacement 10 mm		
Storey	Without SW	With SW
6	39.926	9.012
5	36.91	7.671
4	31.306	6.135
3	22.934	4.367
2	12.335	2.473
1	2.069	0.665
0	0	0

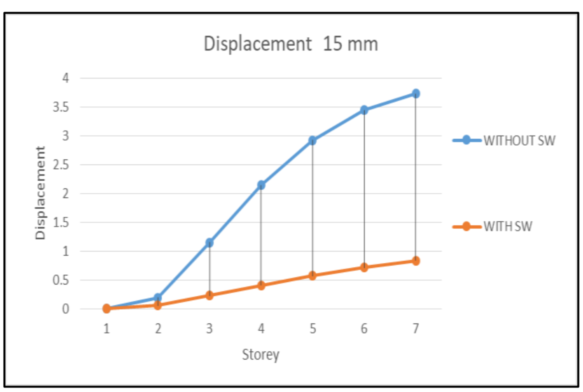


Graph 3 Displacement For 10 mm

D. Results For Blast Load 15m Standoff Distance

Table 7 Displacement for 15 mm

Displacement 15 mm		
Storey	Without SW	With SW
6	3.726	0.842
5	3.447	0.717
4	2.926	0.574
3	2.145	0.409
2	1.154	0.232
1	0.194	0.062
0	0	0



Graph 4 Displacement For 15 mm

E. Angular Results For Blast Load

As per the displacement results, both buildings collapse for blast loads at 0m due to heavy loads, and for loads at 10m and 15 m, there is not much displacement found, so for angular analysis, consider a building with and without a shear wall for blast loads at 5m. The results are as follows.

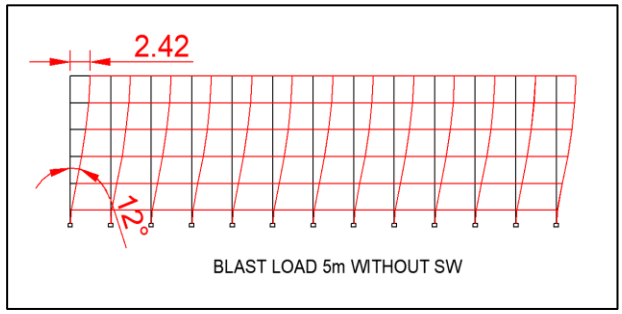


Fig 6 Angular Result for blast load 5m – Without shear wall

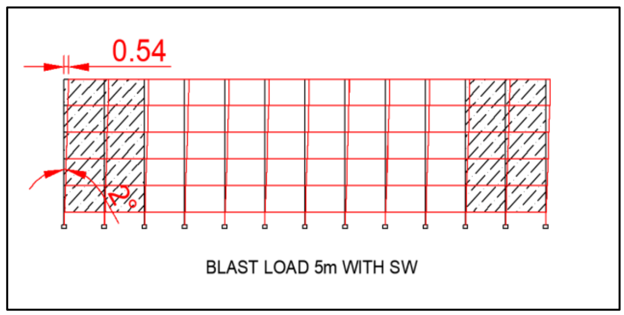
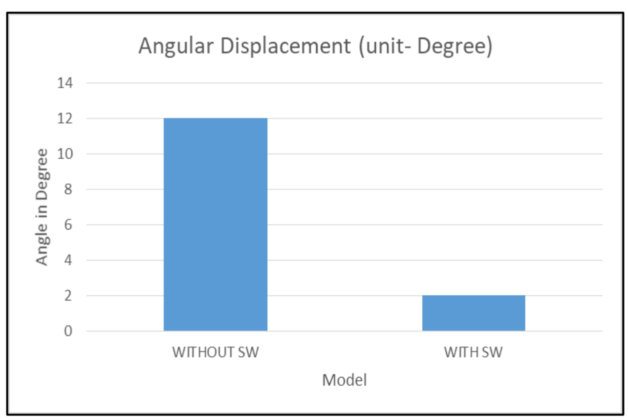


Fig 7 Angular Result for blast load 5m – With shear wall

Table 8 Angular Displacement (unit- Degree)

Angular Displacement (unit- Degree)	
WITHOUT SW	WITH SW
12	2



Graph 5 Angular Displacement

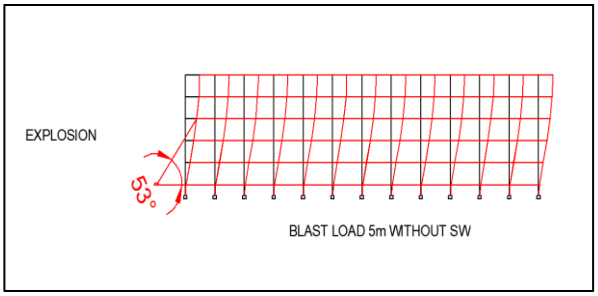


Fig 8 Blast Angular Result for blast load 5m – Without shear wall

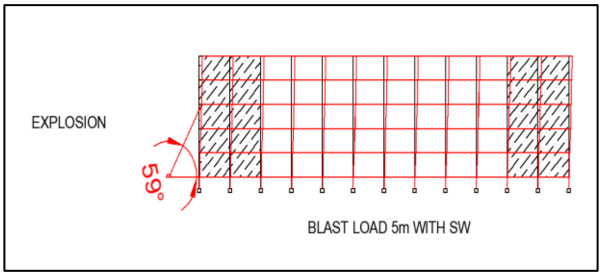
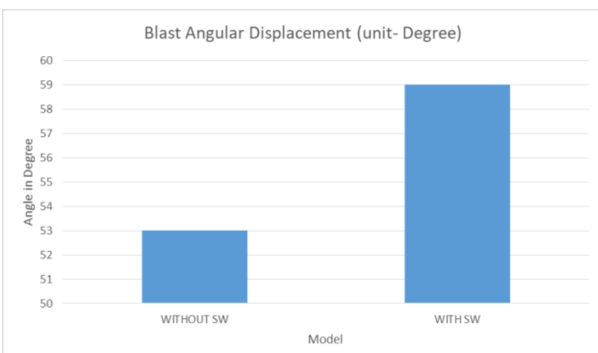


Fig 9 Blast Angular Result for blast load 5m – With shear wall

Table 9 Blast Angular Displacement (unit- Degree)

Blast Angular Displacement (unit- Degree)	
WITHOUT SW	WITH SW
53	59



Graph 6.10 Blast Angular Displacement (unit- Degree)

V. CONCLUSION

- Structural damages caused by blast loading are the combination of both immediate effects and consecutive hazards, among which is progressive collapse.
- This catastrophic failure mode occurs when the initial failure of one or several key load-carrying members causes a more widespread failure of the circumventing members what leads to consummate collapse of the whole structure.
- Consequently, it is of great paramount to investigate and ameliorate the replication of structures to blast loading.
- A bomb explosion nearby a building can cause catastrophic damage to the building's external and internal structural frames, collapsing of walls and shutting down of critical life-safety systems.
- Loss of life and injuries to occupants can result from many causes, including direct blast-effects, structural collapse, debris impact, fire, and smoke. The indirect effects can cumulate to inhibit or avert timely avoidance, thereby contributing to supplemental casualties.
- The main intent of this Study is to through light on the design of blast resistant buildings and to know the response of a structure when subjected to blast loads utilizing ETABS software with prominence given on 0m 5m 10m 15m Standoff distances of the blast and incorporating different charge weights of TNT according to the IS CODE 4991.
- This study examined at blast loads applied to buildings with and without shear walls.
- According to the findings of the study, shear walls produce better economic results than conventional building.

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