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Research Study on Structural Analysis of Blast Resistant Building

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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 loads on buildings is a serious matter that should be taken into consideration in the design process. Although these kinds of attacks are exceptional cases, man-made disasters; blast loads are in fact dynamic loads that need to be carefully calculated just like earthquake and wind loads. 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. Firstly, explosives and explosion types have been explained briefly. In addition, the general aspects of explosion process have been presented to clarify the effects of explosives on buildings. To have a better understanding of explosives and characteristics of explosions will enable us to make blast resistant building design much more efficiently. Essential techniques for increasing the capacity of a building to provide protection against explosive effects is discussed both with an architectural and structural approach.

KEYWORDS: Blast load, Shear wall, ETABS, Explosive Effects.

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.

II. STATE OF DEVELOPMENT

T. Ngo, P. Mendis This paper tells the use of vehicle bombs to attack city centers has been a feature of campaigns by terrorist organizations throughout the world. A bomb explosion within or adjacent to a building can cause catastrophic damage to the building's external and internal structural frames also resulting in the collapsing of walls, blowing out of large expanses of windows, 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 combine to inhibit or prevent timely evacuation, thereby contributing to additional casualties. In addition, major catastrophes resulting from gas-chemical explosions result in large dynamic loads, greater than the original design loads, of many structures.

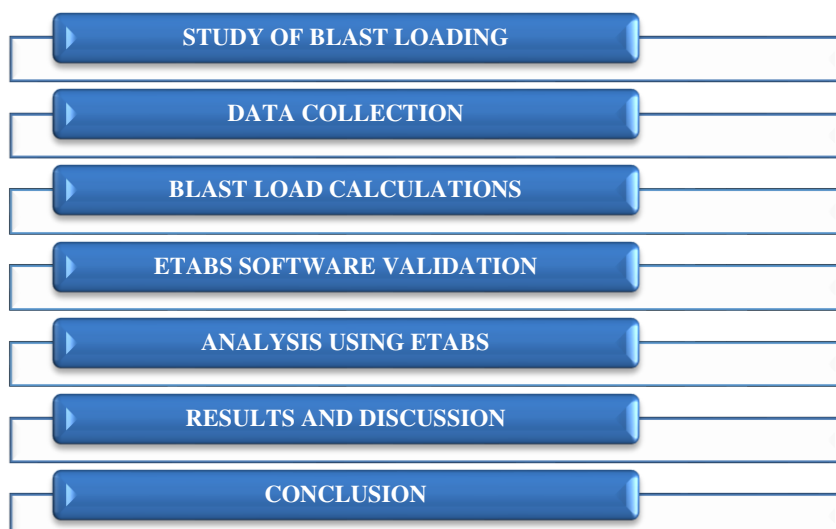
Jon A. Schmidt, P.E. 2003 This paper summarizes the methods available to define an external terrorist bomb threat and estimate structural design loads and element responses using simple dynamic system models and principle. With the increase of the threat of terrorist attacks using explosives over the last decade has created an awareness of building owners and designers. The US government has funded extensive research of blast analysis and protective design methods and has produced a number of guidelines for its own facilities.

Saeed Ahmad In this paper, 4 distinct RCC wall with varying thickness are taken. These walls are tested with different explosive loads and scaled distance. Pressure sensors, accelerometers, dynamic strain amplifiers, data acquisition board and strain gauges were used to measure air blast and ground shock parameters. In conclusion, it was stated that air blast and ground shock pressure must be considered for accurate analysis of structural response.

Zeynep Koccaz, Fatih Sutcu This paper says that the increase in the number of terrorist attacks especially in the last few years has shown that the effect of blast loads on buildings is a serious matter that should be taken into consideration in the design process. Although these kinds of attacks are exceptional cases, man-made disasters; blast loads are in fact dynamic loads that need to be carefully calculated just like earthquake and wind loads. 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. Firstly, explosives and explosion types have been explained briefly.

Ashish Kumar Tiwary This paper says that a bomb explosion within or adjacent to a building causes catastrophic damage to the building's exterior as well as interior structural elements including walls, windows. Loss of lives and injuries to occupants can result from many causes such as direct blast effects, structural collapse, debris impact, fire, smoke, etc. The indirect effects can combine to inhibit or prevent timely evacuation, thereby causing additional casualties. In such cases, one or more columns of the building are damaged which results in the failure of beam slab systems and thereby causing a progressive collapse of the part or the whole structure.

III. METHODOLOGY



A. Problem Statement

A RCC high rise building of G+25 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 having braces.

MODEL 1	G+25 with Shear Wall
MODEL 2	G+25 with Bracing

IV. MODELING IN ETABS

Model 1- G+25 with Shear Wall

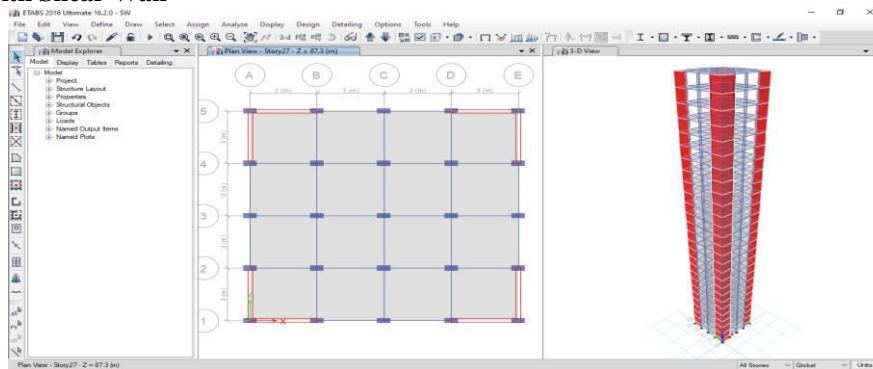


Fig 1 Model 1- G+25 with Shear Wall

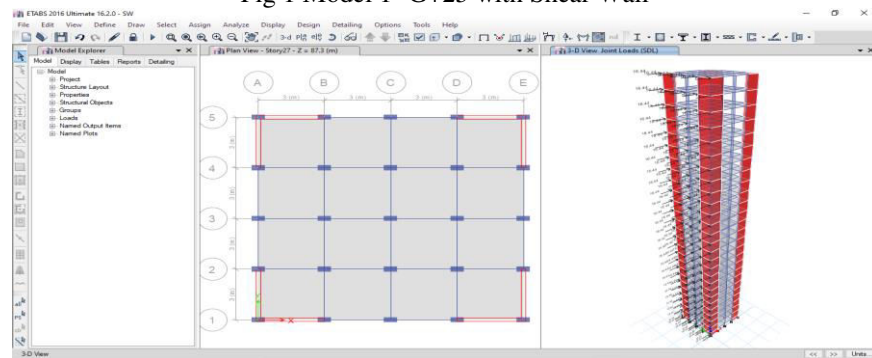


Fig 2 Model 1- Blast Load Applied

Model 2 G+25 with Bracing

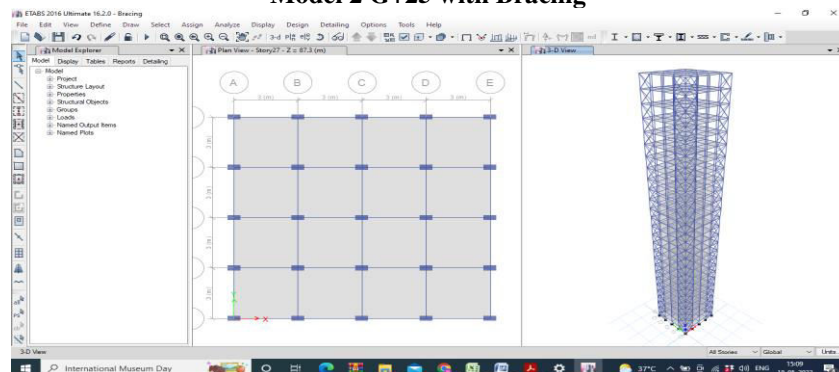


Fig 3 Model 2 G+25 with Bracing

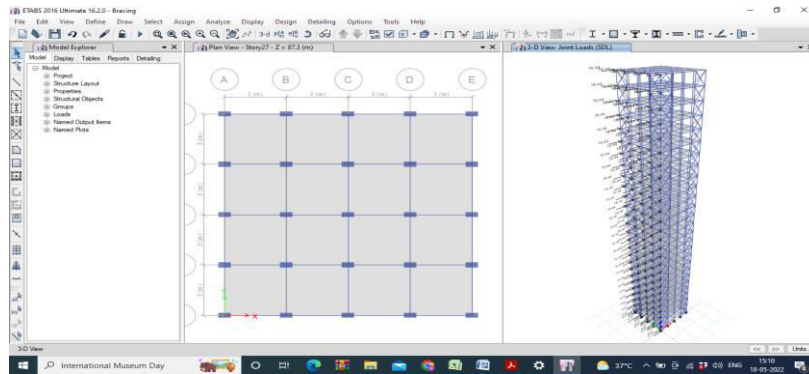
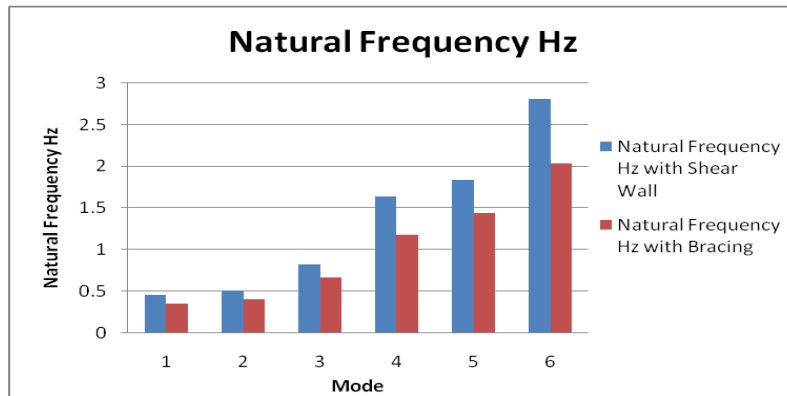


Fig 4 Model 2- Blast Load Applied

V. RESULTS FOR BLAST LOADING

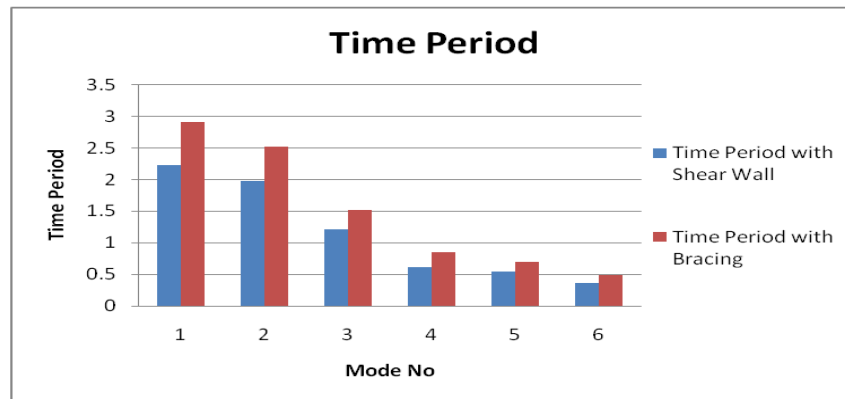
A. Natural Frequency Hz

Natural Frequency Hz		
Mode	With Shear Wall	With Bracing
1	0.448	0.343
2	0.503	0.397
3	0.817	0.658
4	1.636	1.171
5	1.834	1.433
6	2.811	2.036



B. Time Period

Time Period		
Mode	with Shear Wall	with Bracing
1	2.23	2.91
2	1.98	2.517
3	1.22	1.52
4	0.611	0.854
5	0.545	0.698
6	0.356	0.49



C. Buckling Restrained Braces (BRB)

Buckling-Restrained Braces (BRBs) are a relatively recent development in the field of lateral load resisting structures. A braced frame is a structural system commonly used in structures subject to lateral loads such as wind and seismic pressure. The members in a braced frame are generally made of structural steel, which can work effectively both in tension and compression.

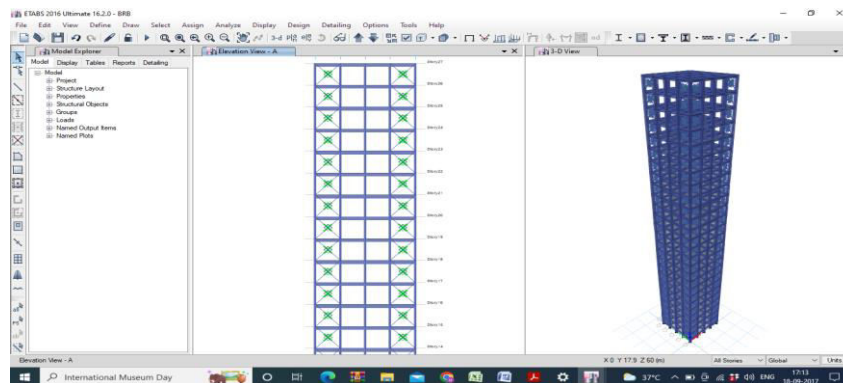
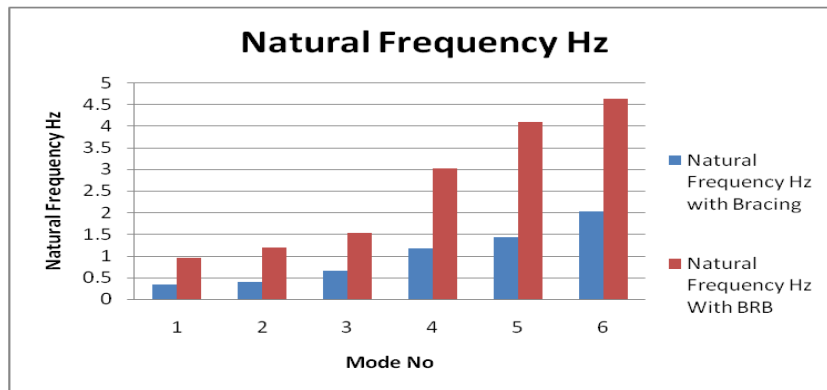


Fig 4 Bracing replacement with BRB

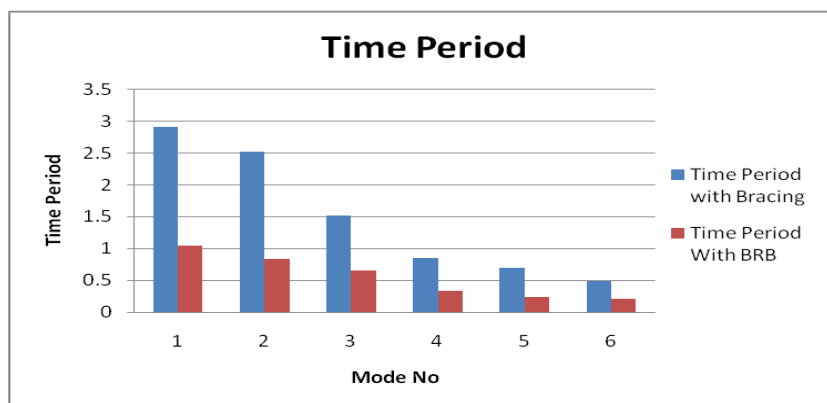
D. Natural Frequency Hz

Natural Frequency Hz		
Mode	with Bracing	With BRB
1	0.343	0.95
2	0.397	1.19
3	0.658	1.53
4	1.171	3.03
5	1.433	4.10
6	2.036	4.64



E. Time Period

Time Period		
Mode	with Bracing	With BRB
1	2.91	1.052
2	2.517	0.841
3	1.52	0.652
4	0.854	0.33
5	0.698	0.244
6	0.49	0.215



VI. 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 different 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 shear walls and bracing. According to the findings of the study, shear walls produce better economic results than bracing. For bracing, we replaced bracing with BRB and analyzed blast loads again because BRB delivers economic results when compared to bracing. As a consequence of the study, we must recommend that if you only use bracing, use BRB instead of conventional bracing to minimize blast effects on the building.

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