"REVIEW STUDY ON IMPACT OF BLAST LOAD ON R.C.C. BUILDING"

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Abstract - Engineers are facing a significant issue with regard to structural safety and integrity. The challenge of designing a structure for the majority of complex loads has been simply resolved thanks to technological advancements. High-rise constructions, however, have only been allowed to be designed for seismic stresses. Terrorism has exhibited effects on buildings recently. These consequences raised the significance of designing the structure to withstand blast loads. Large pressures and heat are released into the air during blast explosions. Despite only lasting a few milliseconds, this occurrence has a negative impact on the structures. The primary goal of this study is to review existing literature on the blast loads that a structure might encounter, assess its vulnerability, and offer recommendations to the architect on how to economically reduce the impact of blast on a structure while still protecting people and infrastructure from explosion.

Key Words: **Blast Load, Standoff Distance, RCC structure, Storey drift, Displacement, Storey Shear.**

1. INTRODUCTION

Structures need to be protected against the blast impacts, especially those that are more likely to be the target of terrorist attacks. To lessen the losses brought on by the blast impacts on the buildings, it is crucial to conduct appropriate research in this field. The non-linear behavior of the material makes it difficult to examine the dynamic replica of the structure to blast loading. A thorough understanding of blast and related phenomena is necessary for the analysis and design of blast loading because blast explosions produce massive dynamic loads that are more complex than the initial design loads. The non-linear behavior of the material makes it difficult to examine the dynamic replica of the structure to blast loading. A thorough understanding of blast and related phenomena is necessary for the analysis and design of blast loading because blast explosions produce massive dynamic loads that are more complex than the initial design loads. The prediction, prevention, and mitigation of such events are of primary interest because when an explosion happens, harm may occur directly or indirectly, outside or internally, and it should therefore be potentially safe in all ways.

1.1 BLAST PHENOMENA

When a chemical, mechanical, or nuclear source releases energy suddenly, the situation is commonly referred to as a "blast." Buildings built to withstand blast loads are subjected to entirely different types of loads than are taken into account during regular design. Here, they are struck by a shock wave that is travelling quickly and may exert pressure that is several times greater than that felt during storms. A blast load is the force that a blast wave applies to a structure or object. It is made up of overpressure, which is the increase in pressure above atmospheric pressure caused by the shock wave from an air blast, and either impulse or duration, which results in catastrophic damage to the building's exterior and interior. The harm brought on by the force of an explosive blast is known as the blast effect. Huge quantities of hot gases are generated during an explosion, which compress the surrounding gases and cause them to move away from the blast source more quickly. The standoff distance is the separation between the blast source and the building. The pressure or intensity of the blast wave continues to decrease as it moves away from the blast source. As a result, the effect on buildings with greater standoff distances will be lessened, and it will take less time to reach the building. Depending on the pressure and distance from the explosion or blast source, the blast wave propagation curves change. A shock front or wave is produced when an explosion's blast wave propagates into the surrounding air. The entire building was subjected to blast pressure as a result of the shock wave that was formed. Analysis of the reinforced concrete frame structure is challenging because the impulsive load produced by an explosion is highly nonlinear and causes pressure in a very short amount of time. The weight of the charge (bomb size) and the standoff lengths between the blast source and the impacted structure (target) will determine the pressure intensities.

2. LITERATURE REVIEW

1. **Architectural and structural design of Blast resistant buildings.**

- Authors : Zeynep Koccaz, Fatih Sutcu, Necdet Torunbalci.
- Publication : 14th World Conference on Earthquake Engineering, China – October 2008.

To avoid the building collapsing completely and causing fatal injuries is the goal of blast resistant construction design. Although the size of the explosion and the loads it will produce cannot be accurately predicted, the majority of plausible scenarios will enable the development of the required engineering and architectural solutions. In this paper, mainly architectural and structural design for making building blast resistant. Planning & layout to prevent overall collapse loss of life as well as structure due to blast are discussed. From architectural aspects, structural elements like flooring, walls, cladding & glazing are considered under extreme loading condition. From structural aspects, proper choice of structural system, well-designed beam-column connection, structural parts and moment frames that transfer enough load is required to make building blast resistant. Retrofitting is essential for existing structures.

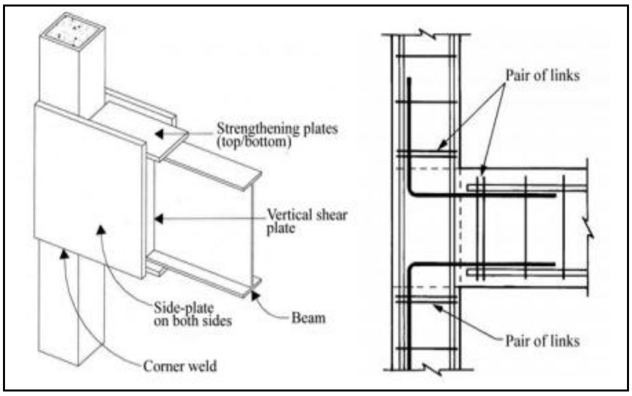

Fig. 1: Structural aspect for blast resistant building

2. **Full-Scale Testing and Analysis of Blast Resistant Design**

➢ Authors : Arup K. Maji, F.ASCE, Jay P. Brown, Girum S. Urgessa

➢ Publication : Journal of Aerospace engineering – ASCE, Oct.2008

This paper represents the result of full-scale test which was conducted on an unreinforced masonry building representing a mailroom. It was shown that an optimally designed Glass Fiber Reinforced Polymers (GFRP) retrofit can easily withstand blast load of known magnitude. It demonstrates the applicability of the BLASTX code for determining blast pressure history on walls. A simple single degree of freedom (SDOF) model was used to predict structural response of a wall with reasonable accuracy. It was demonstrated that the approximation of the blast load had little effect in the prediction of maximum displacement response. A methodology was presented that can be used for designing. Efficient retrofits for any wall using retrofit materials against external and internal blast loads.

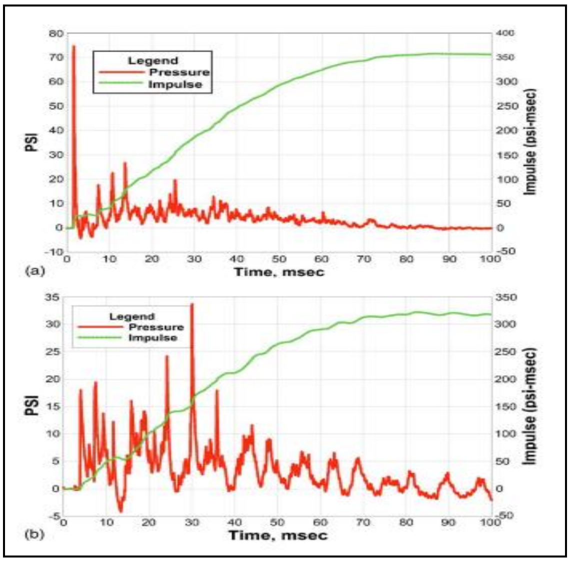

Fig. 2: Measured Blast Pressure history graph

3. **Blast Loading and Blast Effects on the Structures- An Overview**

➢ Authors : T. Ngo, P. Mendis, A. Gupta & J. Ramsay

➢ Publication: EJSE Special Issue, Loading on Structures (2007) University of Melbourne, Australia

Major catastrophes resulting from blast explosion and gas chemical explosion results in large dynamic load which are greater than our original design loads. Therefore, due to such threats from extreme loading, efforts are made from last few decades for developing blast load resisting structural designs. Analysis & design of blast resistant building involves detailed study of blast phenomenon and dynamic response of various structural elements. Effects of explosion on the structures are presented here. This also includes nature of explosions and mechanics of blast wave. Several computer programs to estimate blast load like BLASTX, DYNA3D, ABAQUS are listed. Various modes of failure of blast loaded structures are described. The structure is idealized as a single degree of freedom (SDOF) system in order to lay the foundation for this study, and the relationship between the positive duration of the blast load and the natural period of vibration of the structure is established. This results in the idealization of blast loads and makes the categorization of blast loading regimes simpler.

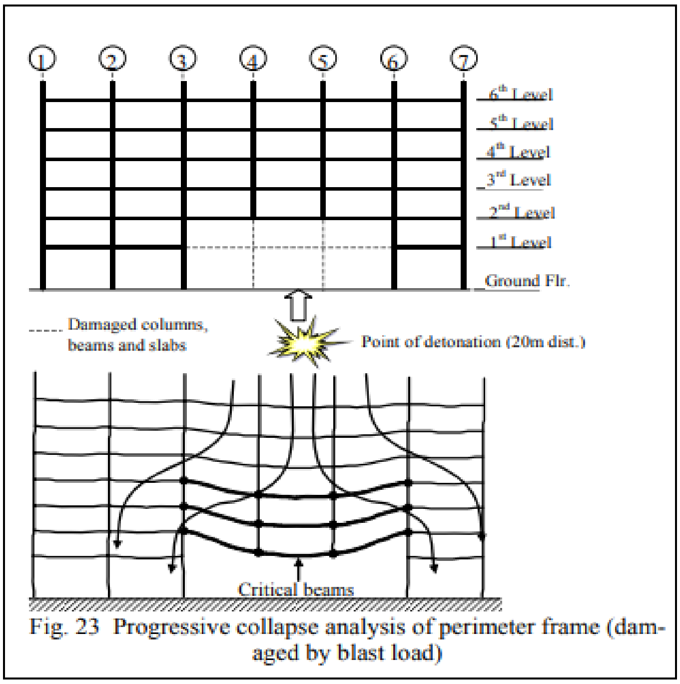

Fig. 3: Progressive collapse analysis of perimeter frame

4. **Analysis of Blast Resistant Structure**

➢ Authors : Shreya Vedpathak, Prof. Ajay Hamane

➢ Publication : IRJET (2022)

The goal of the study of blast-resistant buildings is to stop the building's general collapse and further damage. It demonstrates how storey displacements and storey drifts dramatically rise as the blast load rises and the standoff distance falls. The values of the charge weight and standoff distance determine the blast characteristics and their effects. The findings indicate that construction will enhance resistance if column and beam diameters are raised, however due to the high cross section required, this won't be achievable in many cases. It is possible to think about designing the structure for blast resistance when shear walls are added to the structure's corners because the results reveal a significant improvement in the resistance. The results reveal an increase in resistance when the steel bracings are added to the structure's corners, and this can be taken into consideration while designing the structure for blast resistance. It has been found that adding steel bracing and a shear wall produces good results and reduces storey displacement and storey drift. But it is evident that adding shear walls produces good results and results in the structure having less storey displacement and storey drift than the other models.

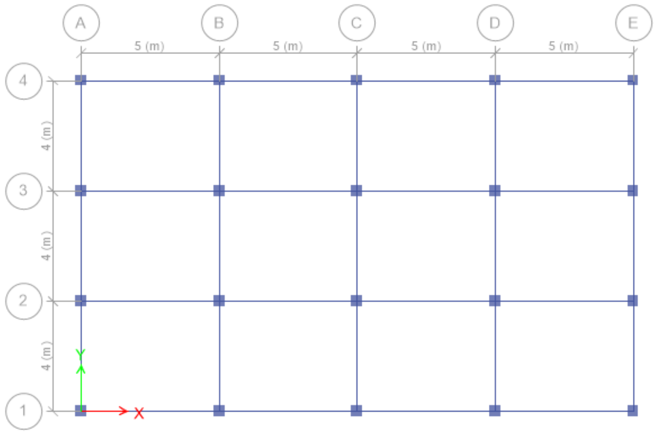

Fig. 4: Plan of the building

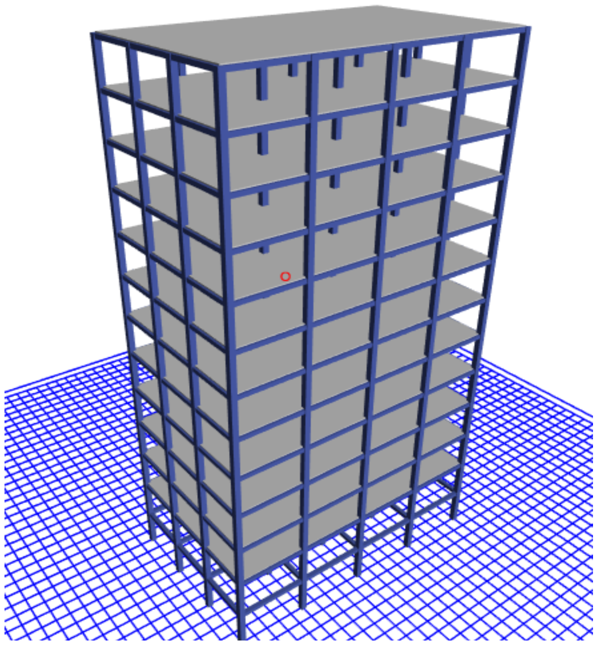

Fig. 5: 3D view of the building

5. **Performance of Earthquake-resistant RCC Frame Structures under Blast Explosions**

➢ Authors : Zubair I. Syed, Osama A. Mohamed, Kumail Murad, Manish Kewalramani

➢ Publication : Elsevier (2016)

This study aims to investigate how earthquake-resistant reinforced concrete (RCC) frame structures perform structurally under blast loads. In this study, typical reinforced concrete frame buildings that were built to withstand earthquakes in accordance with the Abu Dhabi city-specific standards of ACI 318-11 and the International Building Code (IBC 2009) were examined. The findings from this study's simplified analysis were used to determine the structural reaction and safe standoff distance needed for an earthquake-resistant structure in order to prevent the failure of a column subjected to blast loading. A minimum safe standoff distance was discovered beyond which none of the structural parts will fail owing to the effect of the blast for each individual blast weight that was taken into consideration in this research. The parametric study's findings indicate that standoff distances of 6 to 12 m are necessary to prevent a column loss caused by a typical explosion on an earthquake-resistant structure. The shear and moment capabilities of the columns and beams are enhanced by using high strength concrete, but the minimum safe standoff distances are not significantly affected. Additionally, when the number of floors rises, the crucial column is subject to somewhat more additional gravity stresses, which causes the minimum safe standoff distance to rise as well.

Weight of TNT blast (kg)	Shear force on critical column, kN						
	14-story	15-story	16-story	17-story	18-story	19-story	20-story
50 kg at 6 m	634	658	678	713	743	775	800
100 kg at 8 m	705	735	760	788	818	832	860
200 kg at 12 m	763	788	810	836	866	901	930
500 kg at 15 m	750	780	806	840	869	892	915

Fig. 6: Table showing shear force on critical column for different storey heights.

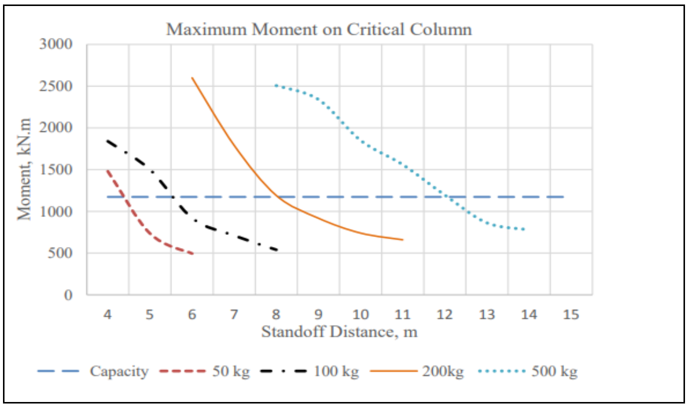

Fig. 7: Maximum moment in the nearest column for various TNT blasts at different standoff distances.

3. OBJECTIVES OF STUDY AND SCOPE OF STUDY

3.1 OBJECTIVES OF STUDY

- Increasing safety of significant structures by minimizing blast effects.
- To comprehend how blast progression and its consequences on structure work.
- To investigate how structures react to blast loads.
- • To understand how structures react to blast loads delivered at varied standoff distances and charge weights.
- To investigate the structure's dynamic reaction and characteristics under blast loading.

3.2 SCOPE OF STUDY

- Performance-based examination of a multi-story R.C.C. building affected by a bomb is included in this study.
- Varying examples are taken at varying standoff distances and charge loads.
- IS: 4991-1968 guidelines are used for blast load calculations.
- Modelling and analysis are done using ETABS 20, a computer programme.
- Time history analysis is used to analyse structure.
- The application of the blast load caused displacement, storey drifts, and storey shear, which are reported.
- Different graphs are plotted to analyse various results.

4. METHODOLOGY

- The study makes use of ETABS software.
- For differing standoff lengths, different charge weights are considered.
- For the analysis, dead load, live load, and blast load are taken into account.
- According to the charge weights and standoff distances, different cases are taken into consideration.
- For different situations, the IS Code 4991-1968 is used to determine each of the blast parameters.
- Blast load is estimated by multiplying the peak reflected overpressure measured for the front and side faces of the structure by the joint's tributary area.
- Software is used for the analysis, and the calculated blast load is applied as the joint load or UDL to every level of the structure.
- In response to different occurrences of storey displacement and storey drift, the structures' responses are observed.

- Different models are created for further investigation in the programme to track their responses in terms of storey displacement and storey drift.

5. CONCLUSION

The primary aim is to provide the method for calculating the blast loads on structures with or without apertures and frame structures based on studies that have been published in the literature. Therefore, it should be clear that a building with a chosen safety level and a blast-resistant architectural design will sustain less damage. Furthermore, to research the dynamic characteristics of concrete and steel reinforcement under high strain rates often brought on by blast loads. Preventing the building's general collapse and damage is the goal of blast proof building design. People must have to always search for the most economical approaches to be able to appropriately withstand the blasts to be anticipated as improved methods are discovered and put into practice. The study of blast-resistant building design is expanding quickly. Opportunities for research and development are being created by the increased demand for blast-resistant buildings. Better materials and construction methods will be discovered with concentrated efforts in the construction of protective structures.

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