© IJEDR 2019 | Volume 7, Issue 2 | ISSN: 2321-9939

A review on study and analysis of blast resistance structure

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Abstract—**As the terrorist activities increasing day by day and which are mainly occurring in crowded places is a rising problem in all over a globe. The buildings are not generally designed for the blast load which lead to the structural damage of building element or collapse of building.Thus it is important to understand the effect of blast on building. The present paper reviews the literature on blast effect on building. This paper will help to understand the effect of blast on building.**

Index Terms— **Blast loading,explosives, charges,standoff distance, RC framed structure.**

I. INTRODUCTION

Bomb explosions in buildings have occurred relatively more frequently around the world in recent decades.The emerging threat of bomb blast has made all civil engineers aware of the fact that they need to have the expertise to assess the vulnerability and design blast resistant buildings where necessary. An explosive is a solid or liquid substance, or mixture of substances, which,on the application of a suitable stimulus to a small portion of its mass, is converted in a very short interval of time into other more stable substances, largely or entirely gaseous, with development of high temperature and pressure. As we know that several types of hazards can affect the building systems.These systems are subdivided into two general categories: man made (blast,impact) and natural (wind and earthquake, etc). So, it is important to understand the nature of the hazards. Blast loading and its effects on a structure is influenced by a number of factors including charge weight (W), location of the blast (or standoff distance) (R), and the geometrical configuration and orientation of the structure (or direction of the blast). Structural response will differ according to the way these factors combine. Thus it is important to understand the effect of building under blast load in order to protect a structure.

II. LITERATURE REVIEW

[1] **T. Ngo et. al.(2007), in t**his paper they studied the use of vehicle bombs to attack city centers has been a feature of campaigns by terrorist group throughout the world. A harmful damage to the building's external and internal structural frames additionally leading in the collapsing of walls, blowing out of enormous expanses of windows, and shutting down of essential life-safety systems caused due to bomb explosion within or adjacent to a building. Loss of life and injuries to occupants may result from several causes, together with 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, gas-chemical explosions result in large dynamic loads, more than the original design loads, of many structures. Due to such extreme loading conditions, an importance is given to develop methods of structural analysis and design to resist blast loads during past three decades. The analysis and design of structures subjected to blast loads require a detailed understanding of blast phenomena and the dynamic response of various structural elements. This paper presents a comprehensive overview of the effects of the explosion on structures. An explanation of the nature of explosions and the mechanism of blast waves in free air is given. This paper also introduces different methods to estimate blast loads and structural response.
[2] **Z. Koccaz et.al. (2008) , t**his paper says that in the last few year the number of terrorist attacks increases which shows 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, to make the building more secure 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 result, it is important to study the explosives and characteristics of explosions which will help us to make blast-resistant building design much more efficiently. Important techniques for increasing the capacity of a building to provide safety against explosive effects are discussed both with an architectural and structural approach.
[3] **B.M. Luccioni et. al. (2004) ,**carried an analytical study using AUTODYN software on the failure of RC building subjected to blast load . Then they compared the numerical results with the photograph of real damage caused by explosion has been included. Assuming that 400 kg of TNT placed in the entrance hall of the building. A Lagrange processor is used to solve the columns, beams and slabs which are modeled with 3D solid elements. The results show that the numerical analysis accurately reproduces the collapse of building under blast load confirming the location and magnitude of explosion. They concluded that for this type of analysis simplifying assumptions is to be made for the structure and materials.

[4] S.**Ahmad et.al. (2012), i**n this paper, 4 distinct RCC wall are taken with varying thickness. These walls are tested with different explosive loads and scaled distance.To measure air blast and ground shock parameters pressure sensors, accelerometer, dynamic strain amplifiers, data acquisition board and strain gauges were used. In conclusion, it was stated that, for accurate analysis of structural response air blast and ground shock pressure must be considered .

[5] **T.D. Ngo et. al. (2002)**, carried an analytical study on RC column subjected to blast loading and progressive collapse analysis of a mulit-storied building were carried out. The 3D model of the column was analyzed using the nonlinear explicit code LS-Dyna 3D (2002) which takes into account both material nonlinearity and geometric nonlinearity. It was observed that the increase in flexural strength was greater than that of shear strength. Thus, the increase in the material strengths under dynamic conditions may lead to a shift from a ductile flexural failure to a brittle shear failure mode. In the progressive collapse analysis study which is based on the local damage assessment due to bomb blast at ground level, progressive collapse analyses was performed on the example building. The structural stability and integrity of the building were assessed by considering the effects of the failure of some perimeter columns, spandrel beams and floor slabs due to blast overpressure or aircraft impact. In addition to material and geometric nonlinearities, the analyses considered membrane action, inertia effects, and other influencing factors. The results show that the ultimate capacity of the floor slab is approximately 16.5kPa which is 2.75 times the total floor load (dead load plus 0.4 live load).

[6] **Aditya Kumar et. al. (2014),** reviewed different loading which can occur during a blast i.e. the dynamic impact loading, varying rate concentrated loading & transverse blast loading and the methods applied to analyze those loading phenomena i.e. Single Degree of Freedom (SDOF) model, Finite Element Model (FEM) & non-linear dynamic analysis. The analysis shows that while designing the structure in absence of relevant code is the significant concern behind the ignorance of this phenomenon.

[7] **A. Ghani Razaqpur et. al. (2006)**, investigated the behavior of reinforced concrete panels, or slabs, retrofitted with glass fiber reinforced polymer (GFRP) composite, and subjected to blast load on eight 1000 x 1000 x 70 mm panels were made of 40 MPa concrete and reinforced with top and bottom steel meshes. Five of the panels were used as control while the remaining four were retrofitted with adhesively bonded 500 mm wide GFRP laminate strips on both faces, one in each direction parallel to the panel edges. The panels were exposed to blast loads generated by the explosion of either 22.4 kg or 33.4 kg ANFO explosive charge located at a 3-m standoff. Blast wave characteristics, including incident and reflected pressures and impulses, as well as panel central deflection and strain in steel and on concrete/FRP surfaces were measured. The post-blast damage and mode of failure of each panel was observed, and those panels that were not completely damaged by the blast were subsequently statically tested to find their residual strength. It was determined that the reflected blast pressure and impulse measured at the same location during different shots using the same charge size and standoff distance were generally reasonably close, but in some cases significant deviation occurred. The results shows that the GFRP retrofit may not be suitable in every situation and that quantifying its strengthening effects will need more actual blast testing rather than merely theoretical modeling or pseudo-dynamic testing.

[8] **Mohamed S. Al-Ansari (2012),** studied the response of buildings to blast and earthquake loadings. He used several structural models with different dimensions, shapes, and material subjected to different blast loadings, and earthquake loads in different zones and obtained numerical data. A six story building with a 4-meter constant floor height that is subjected to a blast loading with a charge weight of 1000 kg of TNT at a standoff distance of 2 m was taken. Analysis shows that a twenty-story building, which is subjected to earthquake load in zone 5, have the same response as if it is blasted with 128 kg of TNT at a 2 m stand-off distance or 261 kg of TNT at a 10 m stand-off distance.

[9] **Jiji Madonna et.al.(2016),** In this paper the analysis of blast load for high rise building considering two variations of charge weights and standoff distance are consider. Both regular and irregular building models are prepared using ETABS software. Blast load is calculated as per procedure outlined in TM 5-1300. The software named ATBlast was developed by ARA which calculates blast load for given values of charge weights and standoff distances. It calculates blast load dynamic parameters like shock front velocity, impulse, duration and time of arrival. It was concluded that system is affected with increase in charge weight and decrease in standoff distance. As per results found shows that the system was significantly affected with increase in charge weight and decrease in standoff distance. For protecting a structure standoff length is the main criteria which has an impact on the blast pressure. From graphical representation of blast pressure verses storey level, it was observed that intensity of blast pressure reduces with increase in storey height because the explosion occurs at lower storey levels, hence the pressure at this levels were high. From graphs, it's evident that as standoff increase storey drift goes on decreasing and as charge weight increases storey drift increases. It was also observed that, the first storey columns subjected to high pressure undergoes deformation initially and there is a sudden loss of critical load bearing capacity of columns. Hence columns were failed as a result failure of building geometry takes place. The most vulnerable structure is irregular building which shows highest values of Inter-Storey drift. Because of low pressure intensity on upper floors, they were not significantly affected due to increase of standoff distance from lower floors to upper floors. Hence standoff distance would have an impact on the pressure at various floors.

[10] **Sarita Singla et. al. (2015),** studied the blast pressure for different TNT and standoff distance. Blast pressures for different cases are computed using correlation between blast pressure and blast scaled distance based on charts given in U.S manual. Time history loading is also obtained with parameters of reflected total over pressure and duration of positive phase of blast. The result shows that as the distance increases from the building, blast pressure reduces.

III. CONCLUSION

Based on the studies of different researchers on blast loading behavior, following conclusions has been drawn:

1. The magnitude of blast pressure increases on increase in standoff distances.
2. Blast pressure and blast scaled distance is inversely proportional.

3. Blast pressure increases on increase in weight of blast and blast pressure decreases when standoff distance increases.
4. The variation of force in the structural members is such that the blast force must be considered in the analysis.
5. The arrival time of blast wave increases as the standoff distance increases.

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