DESIGN AND ANALYSIS OF BLAST LOAD ON STRUCTURES

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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.

Key Words: *blast load, etabs2015, time-history,analysis.*

1. INTROUDUCTION

In the past few years, a structure subjected to blast load gained importance due to accidental events or natural events. Generally conventional structures are not designed for blast load due to the reason that the magnitude of load caused by blast is huge and, the cost of design and construction is very high. As a result, the structure is susceptible to damage from blast load. Recent past blast incidents in the country trigger the minds of developers, architects and engineers to find solutions to protect the occupants and structures from blast disasters..

The explosion of bombs in and around buildings can cause catastrophic impacts on the structural integrity of the building, such as damage to the external and internal structural frames and collapse of walls. Moreover, loss of life can result from the collapse of the structure, direct blast effect, debris impact, fire and smoke. Some terrorist organizations have targeted buildings around the world. The consequences of those attacks proved the vulnerability of buildings to explosion. Many countries have become victims of bomb explosion attacks in the last decades. There are many deliberate explosion incidents that occurred in many different places such as the bombing of Alfred P. Murrah Federal Building, Khobar Towers Bombing, World Trade Center Bombing, among others

1.2 PROBLEM STATEMENT

Understanding the performance of high-rise buildings under explosion is of great importance to provide buildings which eliminate or minimize damage to building and property in the event of explosion, especially with the recent surge in extreme activities targeted at structures with viable commercial values. Design consideration against explosions is very important in high-rise facilities such as public and commercial tall buildings, because there are many buildings that may be under threat of blast loading although not originally designed for the same. The analysis and design of blast-resistant structures require a detailed understanding of explosives, blast phenomena and blast effects on buildings. Therefore, it is important to gather the available literature review on explosives, blast phenomena, blast wave interaction and the response of structures to blast loads.

2. GENERAL

The analysis of the blast loading on the structure started in 1960's. US Department of the Army, released a technical manual titled "structures to resist the effects of accidental explosions" in 1959. The revised edition of the manual TM 5-1300 (1990) most widely used by military and civilian organization for designing structures to prevent the propagation of explosion and to provide protection for personnel and valuable equipments.

The methods available for prediction of blast effects on buildings structures are:

- Empirical (or analytical) methods
- Semi-empirical methods
- Numerical methods.

2.1. EXPLOSION AND BLAST PHENOMENA

Explosive blast is quite different from other types of severe loads resulting from extreme events such as earthquake, impact or high wind. Blast loads are applied extremely rapid and may last within a fraction of second. Blast loads cause damage that is limited to a very few structural response mechanisms, and they are applied globally such that the entire structural system responds to resist the load. Explosive blast activates many structural response mechanisms because of its extreme spatial and time vari ations in magnitude and duration.

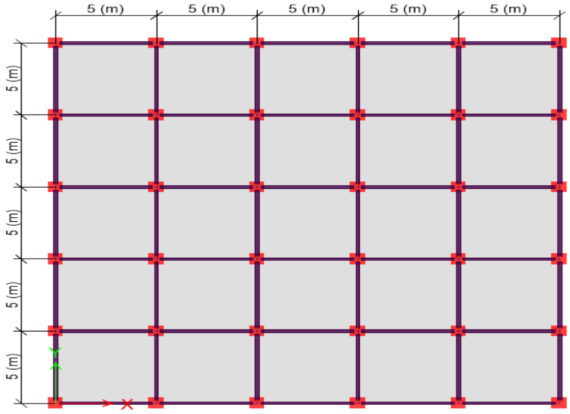

Fig -1: Regular frame

Blast analysis can be carried out in ETABS 2015 by performing a time history analysis in which the blast loading is applied, typically using a triangular time function (i.e. function that varies linearly from full value to zero). The behavior of the structure under the effect of blast loading can be studied from the output generated by the ETABS 2015.The general approach for solving the dynamic response of structural system is Non-linear modal analysis. For most realistic results a very small time step is required to obtain a stable solution. Reducing the time step size will increase the accuracy, the time step size of 0.001s with 4000 time steps is taken for all models.

Table -1: Damage Approximations (Kinney and Graham, 1985)

Damage	Incident Overpressure (psi)
Typical window glass breakage	0.15 - 0.22
Minor damage to some buildings	0.5 - 1.1
Panels of sheet metal buckled	1.1 1.8
Failure of concrete block wall	1.8 - 2.9
Collapse of wood framed building	Over 5.0
Serious damage to steel framed buildings	4 -7
Severe damage to reinforced concrete structures	6 – 9
Probable total destruction of most buildings	10 - 12

2.2. RESPONSE OF A BUILDING TO BLAST LOAD

The Dynamic response of a building to blast loading is very complex for it involves the effect of high-strain rates, nonlinear inelastic behavior of materials, uncertainties of blast load calculations and time-dependent deformations. Therefore, there are some assumptions that are made to simplify the analysis of the response of a structure to blast loading. The structures are normally idealized as a single degree of freedom (SDOF) system and a link is established between the positive duration of the blast load and the natural period of vibration of the structure. This leads to blast load idealization and simplifies the classification of blast load regimes.

3. RESULTS AND DISCUSSION

From graphical representation of later displacement versus the height of the building it is evident that As standoff distance increases the storey drift goes on decrease and explosive weight increases the storey drift goes on increases.

The maximum storey drift is 10.99mm which is happen in a irregular frame model with the charge weight of 1800 lbs and at a standoff distance of 12m. The next highest storey drift is 8.60mm which is happen in regular frame model with a charge weight of 1800 lbs at a standoff distance of 12m.comes.

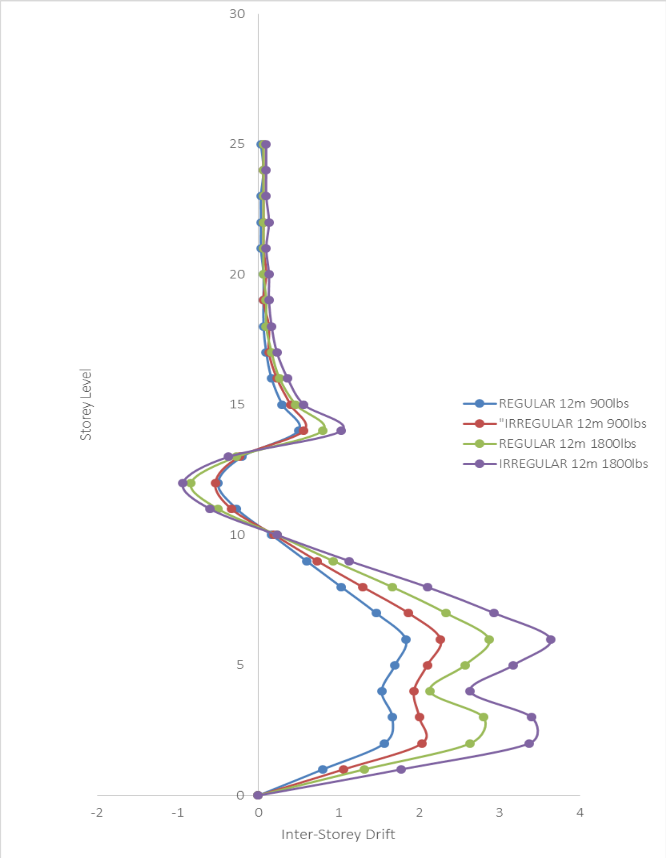

Figure.1Inter–Storey Drift results for the charge weight of 900lbs_12m and 1800lbs_12m standoff distance.

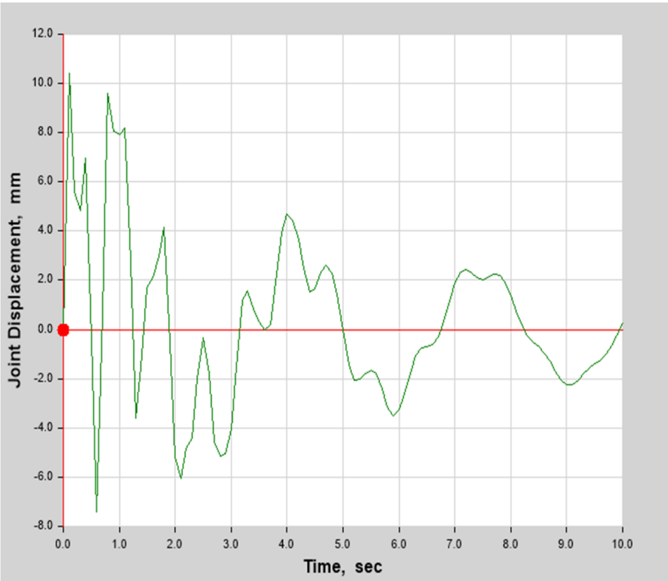

Fig 2. Displacement of the structure due to blast loading with respective to time

4 CONCLUSIONS

According to the results the system affects significantly when the charge weight increases and standoff distance decreases respectively. But the actual charge weight of explosive used by the terrorist, the efficiency of the chemical reaction is not reliably predictable.

In this study it is found that the most optimum model is regular frame which shows the lowest value of storey drift and the structure is very good in lateral stability against blast load. Therefore for economical design consideration the column size can reduce.

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BIOGRAPHIES

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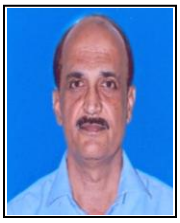

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