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A Review for Blast Analysis and Structural Analysis of Multi-Storied Buildings

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ABSTRACT: Design and Structural Evaluation of the Building systems subjected to blast load form the important task of the present generation. Unlike earthquake design, blast resistant design is a new concept which has gained huge importance in order to make structures safe again blast effect. Due to different accidental and intentional acts, the response of the structures for these high impulses, impact loads form a necessary subject in the recent times.

I. INTRODUCTION

Blast is a pressure disturbance caused by the sudden release of energy. People often think of blasts in terms of explosions such as the detonation of an explosive charge. However, there are many other blast sources that have the potential to cause damage. Blasts are not always caused by combustion; they can also result from any rapid release of energy that creates a blast wave, such as a bursting pressure vessel from which compressed air expands, or a rapid phase transition of a liquid to a gas. As the shock or pressure wave strikes a wall or other object, a reflection occurs, increasing the applied pressure on the surface. This reflected pressure is considerably higher than the incident or free-field pressure wave. As the stand-off distance increases, the duration of the positive-phase blast wave increases resulting in a lower-amplitude. Charges situated extremely close to a targeted structure impose a highly impulsive, high intensity pressure load over a localized region of the structure.

The main target of this study is to provide guidance to engineers and architects where there is a necessity of protection against the explosions caused by detonation of high explosives. The guidance describes measures for mitigating the effects of explosions, therefore providing protection for human, structure and the valuable equipment inside. The paper includes information about explosives, blast loading parameters and enhancements for blast resistant building design both with an architectural and structural approach. Only explosions caused by high explosives (chemical reactions) are considered within the study. High explosives are solid in form and are commonly termed condensed explosives. TNT (trinitrotoluene) is the most widely known example. There are 3 kinds of explosions which are unconfined explosions, confined explosions and explosions caused by explosives attached to the structure.

II. METHODLOGY

The blast load depends upon two major factors defined by the bomb size or charge weight W, and the standoff distance (R) between the blast source and the target. Consider the buildings subjected to a blast equivalent in yield to some kg of TNT at a certain standoff distance. For dynamic analysis of structures, the blast effects are most conveniently represented by a loading-time history that is applied to the structural members as transient loading. The magnitude and the pressure-time history of the blast load is calculated using the Table 1 given in IS 4991-1968 [15]. The method used to calculate the blast load is to divide the front face into a number of well-defined grids and to calculate the total impulse on each grid point. It should be assumed that time varying triangular forces are acting on each beam-column joint on the front face of the buildings. These pulses have zero rise time and decay linearly as shown in Figure 01.

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Figure 1: Effects of explosive device occurrences on buildings)Khobar Tower Figure)

The blast is applied in X direction. The total 20 columnbeam joints are on the front face of building. The forces due to blast loading should be applied to the buildings as triangular loading functions calculated separately for each joint of the front face of the building, taking into account the distance to each joint from the source of explosion. Once the reflected pressure at each beam-column joint is calculated it should be multiplied with Tributary area to get the peak load at that joint. Positive time duration can also be finding out, now we can generate the Load-Time history of each joint as input to SAP-2000.

This paper has shown Blast loading on structures. The paper describes the process of determining the blast load on structures and provides a numerical example of a fictive structure exposed to this load. The blast load was analytically determined as a pressure-time history and numerical model of the structure was created in SAP2000. The results confirm the initial assumption that it is possible with conventional software to simulate an explosion effects and give a preliminary assessment of the structure. And conclusion is made the explosion in or near the structure can cause catastrophic damage to the structure, formation of fragments, and destruction of life - support systems [8].

Finite element package Staadpro is used to perform the analysis in order to validate the use Staadpro for blast analysis following experiment is performed. a study of distant blast on the structure is made to find the variation of forces in foundation like axial force, shear force and bending moment by varying amount of explosive and also by varying the distance of explosion from the building. Buildings of various heights are analyzed so that effect of height to resist blast is also studied. Load is applied in the form of time history loading. And conclusion is made building having more than 6 floors there is less probability of overturning and crushing failure, however great care needs to be taken to resist shear force and bending moment [9].

Investigation of behavior of various bridge components during blast loads through a high-fidelity finite element model of a typical highway bridge Computer programs, such as LS-DYNA offer detonation simulation capabilities to propagate blast loads through air medium. However, blast pressures generated by such programs are significantly different than those by ConWep, a computer program based on semi-empirical equations [10].

Bridges in America are of special importance. The analysis of these bridges should be carried out for different loading conditions. Bridges are normally designed for dead load, live load and other occasional loads. American Association of State Highways and Transportation Officials (AASHTO) have specified for the ship impact, seismic vulnerability and also against vehicular collisions. But there are no definite structural design criteria for the bridges under typical blast loadings. The “progressive collapse” approach of the bridge was also carried out to know the exact behavior with the formation of the plastic hinges under the impact of blast loadings [11].

The application of blast loads on bridge components has been presented. This approach can apply realistic loads and can simulate both reflection and diffraction of blast loads. Using this approach, verification of simulation of blast loads in LSDYNA has been carried out by using available blast tests on two types of beams. A high-fidelity model of a typical three-span highway bridge has been developed for investigation of blast load effects on a three-span reinforced concrete bridge. It is observed that the range of demands imposed on bridge components during blast loads may be significantly higher than those during other extreme hazards [12].

The main advantage of performance-based design is the predictable seismic performance with uniform risk. The reliability of this approach may ultimately depend on the development of explicit and quantifiable performance criteria that can be related to the calculated response parameters such as stress, strain, displacement, acceleration [30]. Performance of a building with soft story at different level along with at GL using nonlinear static pushover analysis.

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From analysis they found that plastic hinges are developed in columns of ground level soft story which is not acceptable criteria for safe design. They suggested retrofitting with shear wall for safe performance of building. They also found that after retrofitting the base shear carrying capacity is increased by 19.22 % to 34.64% [13].

In flat slab building slab is directly supported on column without provision of beam. Because of absence of beam lateral stiffness of building get reduced. For better performance of flat slab building against lateral loading elements like shear wall can be constructed [14].

III. ANALYSIS OF BLAST LOADS

Blast load is defined as a triangular time history function in the ETABS. Hinges are assigned to frame elements (beams and columns) at a relative distance of 0.1 and 0.9. Nonlinearity due to both material and geometry are considered. Hilber-Hughes-Taylor (HHT) time integration method with default values for alpha, beta and gamma are used. Taking 100-time steps of each 0.01 seconds step size a non-linear time history direct integration analysis is carried out.

Analysis of highway bridges under blast loads requires accurate generation and application of blast loads and good understanding of the behavior of components of bridge. The purpose of this paper is to introduce some ideas about blast load generation method like pressure wave method, detonation simulation method, hybrid blast load method and multi-Euler domain method. Also, verification of blast load results using hybrid blast load method and multi-Euler domain method included in this paper [24].

Structural design after an environmental and architectural blast resistant design, as well stands for a great importance to prevent the overall collapse of a building. With correct selection of the structural system, well designed beam-column connections, structural elements designed adequately, moment frames that transfer sufficient load and high-quality material; it's possible to build a blast resistant building. Every single member should be designed to bear the possible blast loading. For the existing structures, retrofitting of the structural elements might be essential. Although these precautions will increase the cost of construction, to protect special buildings with terrorist attack risk like embassies, federal buildings or trade centres is unquestionable.

IV. APPLICATION OF BLAST LOAD

Initially, the structure is designed to resist seismic loads. It is then subjected to blast loads at various distances for a charge of 10 kN. The minimum distance at which the building systems tend to be safe is estimated. The Responses (storey displacement and storey shear) of the building at their critical distances are studied. A blast load generated from a weapon charge of 10 kN is estimated for six different standoff distances such as 0.030 km, 0.050 km, 0.070 km, 0.090 km, 0.110 km and 0.150 km. The load is applied as a blast load-time triangular function to the above considered structures. Table 4.4 shows the variation overpressure and duration at different Standoff distances. The overpressure and duration for 10 kN weapon at a various standoff distance is obtained from Fig.2.1 (a) and 2.1 (b) respectively. Blast pressure is assumed to be acting per unit area of a structural element. Therefore, pressure is multiplied with unit area to obtain corresponding blast load for a particular standoff distance. Blast load obtained is applied as point loads at one side of the structure only.

V. CONCLUSION

Based on the studies so far carried out by several researchers following conclusions can be drawn.

1) Blast load varies with time and distance. The behaviour of structure greatly depends on charge of explosive and its standoff distance.
2) Due to sudden released explosive energy causes failure of structure such as collapse the structure, damage of structural elements and crack formation in structure.
3) Blast analysis needs to carry out by keeping in view the terrorist activities in today's scenario for the important structure.

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REFERENCES

[1] M. R. Wakchaure and Seema T. Borole, "Comparison of Maximum Stress distribution of Long & Short Side Column due to Blast Loading", International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.4, pp-1988-1993, Jul - Aug. 2013. [2] Haken Yalciner, "Structural Response to Blast Loading: The Effects of Corrosion on Reinforced Concrete Structures", Hindawi Publishing Corporation Shock and Vibration, Article ID 529892, 2014.

[3] Ahmed Samir Eisa, "Finite element analysis of reinforced concrete columns under different range of blast loads", International Journal of Civil and Structural Engineering, Volume 5 No 2, 2014.

[4] Mays G.C., Smith P.D. (1995). Blast Effects on Buildings, Thomas Telford Publications, Heron Quay, London.

[5] Hinman E. (2008) Blast Safety of the Building Envelope, WBDG, US

[6] Remennikov A. (2003) Essay 1: The HSBC Bank Building Bombing: Analysis of Blast Loading, www.safeguardingaustralia.org.au/Essays/Essay3.html, Australia.

[7] Yandzio E., Gough M. (1999). Protection of Buildings Against Explosions, SCI Publication, Berkshire, U.K.

[8]. H. Draganic, V. Sigmund BLAST LOADING ON STRUCTURES International Journal of Engineering Research & Technology. (ISSN 13303651) (UDC/UDK 624.01.04:662.15)

[9]. Dr. S. C. Potnishave Blast Analysis of Structures Potnis International Journal of Engineering Research & Technology (IJERT) ISSN: 2278-0181(July – 2013)

[10]. Anil K. Agrawal and Zhihua Yi Department of Civil Engineering the City College of New York New York, NY 10031

[11]. THE EFFECT OF DEAD, LIVE AND BLAST LOADS ON A SUSPENSION BRIDGE Kunal Suthar University of Maryland.

[12]. Blast Load Effects on Highway Bridges. I: Modeling and Blast Load Effects Z. Yi, M. ASCE1; A. K. Agrawal, F. ASCE4 DOI: 10.1061/(ASCE)BE.1943-5592.0000547. © 2013 American Society

[13]. BLAST LOAD GENERATION METHODS ON BRIDGES Binol Varghese1* and Ajith M S1 ISSN 2319 – 6009 www.ijscer.com Vol. 3, No. 3, August 2014

[14]. R. V. Surve, Y. P. Pawar, C. P. Pise, S. S. Kadam, D. S. Jagtap, D. D. Mohite, C. M. Deshmukh, "Use of RC shear walls in strengthening of multistoried building with soft storey at different level" International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development, vol.05 pp 79-86,2015.

[15]. Behaviour of Multi-Storied Flat Slab Building Considering Shear Walls: A Review Dhanaji R. Chavan1, Mohite D. D., Dr. C. P. Pise, Pawar Y. P., Kadam S. S., Deshmukh C. M. ISSN: 2248-9622, Vol. 6, Issue 10, (Part -2) October 2016