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REVIEW ARTICLE

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EFFECTS OF BLAST LOADING ON STRUCTURES: A CRITICAL REVIEW

KAPIL DODWANI[1]*, Dr. SAVITA MARU[2]

[1]Post Graduation student (Computer Aided Structural Designing and Drafting), Ujjain Engineering College, Ujjain, M.P. India

[2]Professor and Head of Civil Engineering Department, Ujjain Engineering College, Ujjain, M.P. India

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ABSTRACT

A bomb explosion within or immediately nearby a building can cause catastrophic damage on the building's external frames, collapsing of walls and internal structural frames. Many of the existing buildings which are not designed for blast loads get damaged or even fully collapsed when subjected to such loadings. Loss of life and injuries to occupants can result from many causes, including direct blast-effects, structural collapse, impact-fire, debris, and smoke. The main aim of this study is to review the work already done till now on the effect of blast loading on structures. In addition, major catastrophes resulting from gas-chemical explosions result in large dynamic loads, greater than the original design loads, of many structures. If the structures is designed to resist the blast load impact the cost of the structure tends to be very high. These studies gradually enhanced the understanding of the role that structural details play in affecting the behavior. For this dynamic analysis is performed in order to determine the effects of blast impact on the structures.

Keywords: Blast loading, Time-history, SDOF(single degree o freedom), SIFCON(Slurry Infiltrated Fiber Reinforced Concrete).

INTRODUCTION

In recent years due to different accidental or intentional, blast all over the world resulted in number of initiatives to study the resistance of structures to blast and to develop system to reduce the hazard of such attacks. In the past few decades considerable emphasis has been given to problems of blast, but most of the knowledge on this subject has been accumulated during the past years. Due to different accidental or intentional events, the behavior of structures components subjected to blast loading has been the subject of considerable research effort in recent years. Structures particularly that above grade, normally are not to designed to resist blast loads and magnitude of design loads are significantly lower than those produce by most explosions, Structures are susceptible to damage from explosion.

Single degree of freedom models have been widely used for predicting dynamic response of concrete structures subjected to blast loading. The popularity of the SDOF method in blast resistant design lies in its simplicity and cost-effective approach that requires limited input data and less computational effort. SDOF models gives reasonable good result if the response mode shape is representative of the real behavior. Accuracy of the dynamic analysis calculations significantly depends on whether the adopted resistance function resembles the actual hysteretic behavior of the structure.

REVIEW

J. M. Dewey [1] (1971), studied the properties of the blast waves obtained from the particle trajectories. First time introduced the effect of spherical and hemispherical TNT (trinitrotoluene) in blast waves and determined the density throughout the flow by application of the Lagrangian conservation of mass equation which used for calculating the pressure by assuming the adiabatic flow for each air element between the shock fronts. The temperature and the sound speed found from the pressure and density, assuming the perfect gas equation of states.

M. V. Dharaneepathy et al. [2] (1995), studied the effects of the stand-off distance on tall shells of different heights, carried out with a view to study the effect of distance (ground-zero distance) of charge on the blast response. An important task in blast-resistant design is to make a realistic prediction of the blast pressures. The distance of explosion from the structure is an important datum, governing the magnitude and duration of the blast loads. The distance, known as 'critical ground-zero distance', at which the blast response is a maximum. This critical distance should be used as design distance, instead of any other arbitrary distance.

T. Krauthammer, A. Altenberg [3] (1999), studied the assessment of blast waves negative phase effects on glass panels. Study conclude that glass panels would exhibit different response at different scaled range and for different charge sizes.

Alexander M. Remennikov [4] (2003) studied the methods for predicting bomb blast effects on buildings. When a single building is subjected to blast loading produced by the detonation of high explosive device. Simplified analytical techniques used for obtaining conservative estimates of the blast effects on buildings. Numerical techniques including Eulerian, Lagrangian, Euler- FCT, ALE, and finite element modelling used for accurate prediction of blast loads on buildings.

Nelson Lam [5] (2004), studied the timehistory analyses of simple cantilevered wall models have been undertaken based on pre-defined pressure functions to study the basic trends. Conclude that the identification of the direct relationship between the corner period and the "clear time" for the blast. A simple and yet realistic capacity spectrum model has been developed for the design and the assessment of cantileverd wall for its performance under blast loads.

Kirk A. Marchand et al. [6] (2005), reviews the contents of American Institute of Steel Construction, Inc. for facts for steel buildings give a general science of blast effects with the help of numbers of case studies of the building which are damaged due to the blast loading i.e. Murrah Building, Oklahoma City, Khobar Towers , Dhahran, Saudi Arabia and others. Also studied the dynamic response of a steel structure to the blast loading and shows the behavior of ductile steel column and steel connections for the blast loads.

Ronald L. Shope [7] (2006), studied the response of wide flange steel columns subjected to constant axial load and lateral blast load. The finite element program ABAQUS was used to model with different slenderness ratio and boundary conditions. Non-uniform blast loads were considered. Changes in displacement time histories and plastic hinge formations resulting from varying the axial load were examined.

A.K. Pandey et al. [8] (2006), studied the effects of an external explosion on the outer reinforced concrete shell of a typical nuclear containment structure. The analysis has been made using appropriate non-linear material models till the ultimate stages. An analytical procedure for nonlinear analysis by adopting the above model has been implemented into a finite element code DYNAIB.

T. Ngo, et al. [9] (2007), for there study on "Blast loading and Blast Effects on Structures" gives an overview on the analysis and design of structures subjected to blast loads phenomenon for understanding the blast loads and dynamic response of various structural elements. This study helps for the design consideration against extreme events such as bomb blast, high velocity impacts.

A. Khadid et al. [10] (2007), studied the fully fixed stiffened plates under the effect of blast loads to determine the dynamic response of the plates with different stiffener configurations and considered the effect of mesh density, time duration and strain rate sensitivity. He used the finite element method and the central difference method for the time integration of the nonlinear equations of motion to obtain numerical solutions.

T. Borvik et al. [9] (2009) studied the response of a steel container as closed structure under the blast loads. He used the mesh less methods based on the Lagrangian formulations to reduce mesh distortions and numerical advection errors to describe the propagation of blast load. All parts are modelled by shell element type in LS-DYNA. A methodology has been proposed for the creation of inflow properties in uncoupled and fully coupled Eulerian–Lagrangian LS-DYNA simulations of blast loaded structures.

Andrew Sorensen & William L. McGill [10] (2012), discuss the result of a review of existing blast analysis software packages for their ability to be used as a forensic tool supporting postblast investigation. Conclude that the software packages do not show the much promise as such a tool, but that when used concurrently, they may have some value to the postblast investigator.

Saeed Ahmad [11] (2012), in this paper four different RC walls with varying thickness are taken these walls are tested with different explosive loads and scaled distance. Pressure sensor, accelometers, dynamic strain amplifier, data acquisition board and strain gauges were used to measure air blast and ground shock parameters. Concluded that air blast and ground shock pressure important for accurate analysis of structure response of structures.

Jayashree.S.M [14] (2013), in this paper an attempt has been made to use Slurry Infiltrated Fiber Reinforced Concrete (SIFCON), a type of FRC with high fiber content as an alternative material to Reinforced Cement Concrete (RCC). Conclude that SIFCON has high energy absorption capacity, higher strength and it is highly ductile.

Seema T. Borole [15] (2013), discuss the comparision between long side and short side column is made and percentage of stress of Reinforced concrete column for long and short side is presented ana analysis is done in ANSYS. Conclude that the critical impulse for the long column case is significantly higher.

Subin sj. [16] (2013) the finite element package ansys version 12 was used to model R.C.C. and masonry building subjected to blast. Blast pressure acting on each wall face and roof were calculate corresponding to charge weight and distance of building from detonation. Transient non linear analysis was is done in ansys for dynamic blast loading and response time history from ansys. A seismic loading was applied on RCC building to get response of the structures and comparison is done with the blast load. Concluded that Effect of seismic loading on low rise buildings are smaller compared to blast load. But for high rised multi storied building effect of seismic loading will be larger when compared with local blast load.

CONCLUSION

Based on the studies available in the literature, the ultimate objective is to make available the procedure for calculating the blast loads on the structures. Two types of blast load wave simple and bilinear pulse applied to study the non-linear behavior of SDOF system. Result of NON-SDOF program showed the effect of type of wave on the time history analysis result and computed energy of blast load. Many parameters used for obtained time history plots computed energy and Hysteresis analysis results.

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