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"Comparison of Maximum Stress distribution of Long & Short Side Column due to Blast Loading"

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Abstract: *A bomb explosion within or immediately nearby a building can cause catastrophic damage on the building's external and internal structural frames like RC column, slab, beam, collapsing of walls, blowing out of large expanses of windows, and shutting down of critical life-safety systems. The Study conducted on the behavior of structural concrete subjected to blast loads. These studies gradually enhanced the understanding of the role that structural details play in affecting the behavior. The comparison between long side & short side column is made & further result is presented. In final result Percentage of Stress of Reinforced concrete column for long & short side column are presented in this paper. An extensive parametric study was carried out on a series of 8 columns at long & short side to investigate the effect of transverse reinforcement, longitudinal reinforcement due to blast loading. The finite element package ANSYS is used to analysis of RC Column subjected to blast loading.*

Key words: *RC Column, Stress, Blast loading, structure, collapse, ANSYS*

I. INTRODUCTION

In the past few decades considerable emphasis has been given to problems of blast and earthquake. The earthquake problem is rather old, but most of the knowledge on this subject has been accumulated during the past fifty years. The blast problem is rather new; information about the development in this field is made available mostly through publication of the Army Corps of Engineers, Department of Defense, U.S. Air Force and other governmental office and public institutes. Much of the work is done by the Massachusetts Institute of Technology, The University of Illinois, and other leading educational institutions and engineering firms. Due to different accidental or intentional events, the behavior of structural components subjected to blast loading has been the subject of considerable research effort in recent years.

Disasters such as the terrorist bombings of the Taj Mahal Hotel in India in 26 Nov. 2008 U.S. embassies in Nairobi, Kenya and Dares Salaam, Tanzania in 1998, the Khobar Towers military barracks in Dhahran, Saudi Arabia in 1996, the Murrah Federal Building in Oklahoma City in 1995, and the World Trade Center in New York in 2001 have demonstrated the need for a thorough examination of the behavior of columns subjected to blast loads. To provide adequate protection against explosions, the design and construction of public buildings are receiving renewed attention of structural engineers. These models span the full range of sophistication from single degree of freedom systems to general purpose finite element programs such as ABAQUS, ANSYS, and ADINA etc.

II. METHODS FOR PREDICTING BLAST LOADS

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

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

Empirical methods are essentially correlations with experimental data. Most of these approaches are limited by the extent of the underlying experimental database. The accuracy of all empirical equations diminishes as the explosive event becomes increasingly near field.

Semi-empirical methods are based on simplified models of physical phenomena. They attempt to model the underlying important physical processes in a simplified way. These methods rely on extensive data and case study. Their predictive accuracy is generally better than that provided by the empirical methods.

Numerical (or first-principle) methods are based on mathematical equations that describe the basic laws of physics governing a problem. These principles include conservation of mass, momentum, and energy. In addition, the physical behavior of materials is described by constitutive relationships. These models are commonly termed computational fluid dynamics (CFD) models.

2.1 Empirical Methods

Over the years, as a result of research coupled with test programs, a number of analytical methods for predicting blast loading were developed. These analytical procedures are presented in several technical design manuals and reports, are described below.

Technical Manual(TM) 5-1300 (US Department of the Army, 1990) this manual is one of the most widely used publications available to both military and civilian sectors for designing structures to provide protection against the blast effects of an explosion. It contains step-by-step analysis and design procedures, including information on (i) blast loading; (ii) principles of non-linear dynamic analysis; and (iii) reinforced concrete and structural steel design.

The design curves presented in the manual give the blast wave parameters as a function of scaled distance for three burst environments: (i) free air burst; (ii) air burst; and (iii) surface burst.

III. FINITE ELEMENT ANALYSIS

With the advent of digital computers and powerful methods of analysis, such as the finite element method many efforts to develop analytical solutions which would obviate the need for experiments have been undertaken by investigators. The finite element method has thus become a powerful computational tool, which allows complex analyses RC structures to be carried out in a routine fashion.FEM is useful for obtaining the load deflection behavior and its crack patterns in various loading.

3.1 Element Type

There are few assumptions that will be made with this model due to the SOLID65 concrete element capabilities. One assumption is that the base of the column will be fixed due to the rigid foundation on the existing column. The model in this analysis will not be used to accurately depict the results of the displacement or applied forces to the existing column. This is a consequence of not having any concept of the placement, size, and number of reinforcing members of steel being used. The reason we cannot predict the longitudinal or transverse steel orientation is due to the smeared reinforcement associated with the SOLID65 element.

3.2 Modeling Properties

The specimen will be modeled using the SOLID65 concrete element, which is used for modeling three dimensional solid models with or without rebar. The element is capable of cracking, crushing, plastic deformation, and creep in tension and compression using material properties. The material properties (Table I) are as follows:

Table I: Material Properties

Structural	
Young's Modulus	2.e+005 MPa
Poisson's Ratio	0.3
Density	7.85e-006 kg/mm³
Thermal Expansion	1.2e-005 1/°C
Tensile Yield Strength	250. MPa
Compressive Yield Strength	250. MPa
Tensile Ultimate Strength	460. MPa
Compressive Ultimate Strength	0. MPa
Thermal	
Thermal Conductivity	6.05e-002 W/mm·°C
Specific Heat	434. J/kg·°C
Electromagnetic	
Relative Permeability	10000
Resistivity	1.7e-004 Ohm·mm

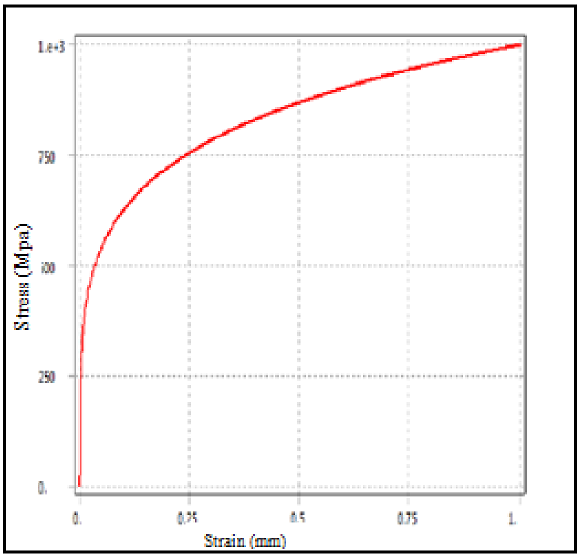

Figure 1: Stress-Strain Graph

3.3 Column Geometry

Using the finite element models discussed above extensive parametric study was carried out with the following cases considered for each columns for which the spacing of the transverse reinforcement is determined in accordance with the requirement in the IS 456-2000 code.

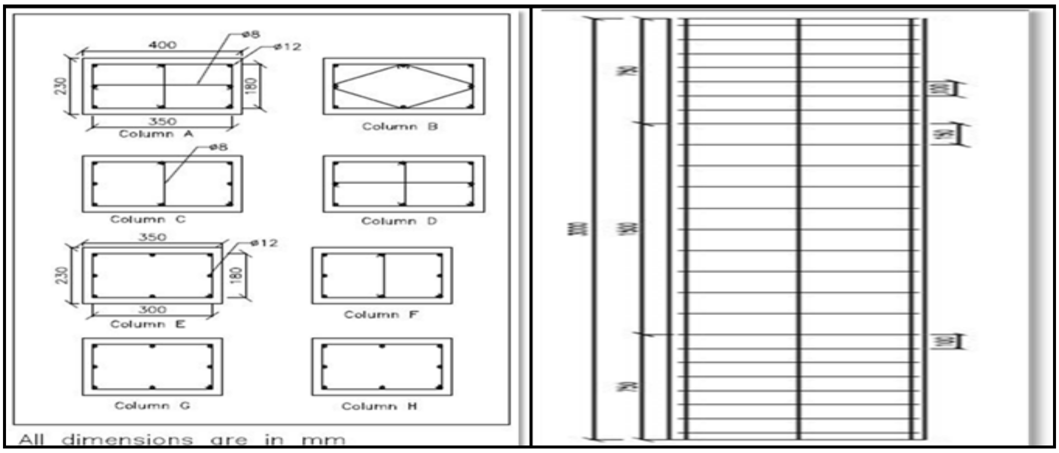

Figure 2: Column Geometry

3.4 Blast Loading

A scaling chart that gives the positive phase blast wave parameters for a surface burst of a hemispherical TNT charge is presented in Figure 2-13. Such scaling charts provide blast load data at a distance R (called the standoff distance) along the ground from a specific explosive. The following step-by-step procedure for determining blast wave parameters for a surface blast is outlined in TM5-1300:

Step 1.Determine the charge weight, W, as TNT equivalent, and ground distance R_G from the charge to the surface of a structure.

Step 2.Calculate scaled ground distance, Z_G:

$$Z_G = R_G / W^{1/3}$$

Step 3.Read the blast wave parameters from Manual TM5-1300 on Page No. 2-13 & Clause No 2-13-3 for corresponding scaled ground distance, Z_G. To obtain the absolute values of the blast wave parameters, multiply the scaled values by a factor $W^{1/3}$.

An extensive parametric study was carried out on a series of 8 columns at long & short side to investigate the effect of transverse reinforcement, longitudinal reinforcement subjected by same blast load. Consider Third-storey building having height 12.5m is analyzed in this study. Standoff distance is considered as 6m, & Charge weight 500 kg which is the closest point to the building as shown in figure.

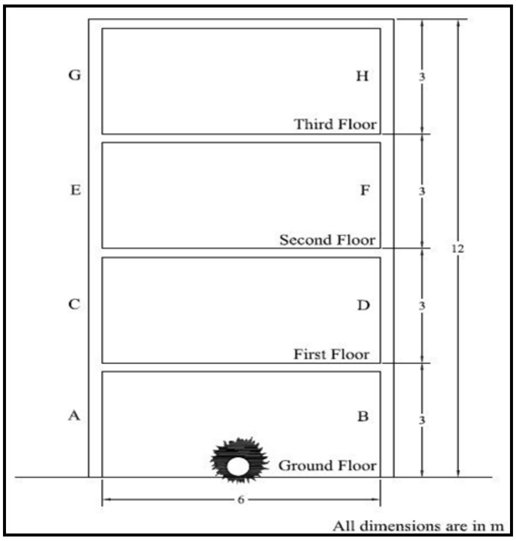

Figure 3: Location of explosion on building

Required: Free field blast wave parameters P_{so}, P_r, U, t_o, t_A for a surface burst of W =500kg at a distance of R_h = 6m.

Table II: Blast Load Parameter

Sr.No.	Floor	Column	Column Size(mm)	P_r (Mpa)	P_{so} (Mpa)	U (M/ms)	t_o (Ms)
1	Ground	A-B	230x400	14.5	2.06	1.46	08.22
2	First	C-D	230x400	8.27	1.31	1.16	16.44
3	Second	E-F	230x350	4.31	0.91	0.97	19.73
4	Third	G-H	230x300	2.06	0.48	0.85	20.83

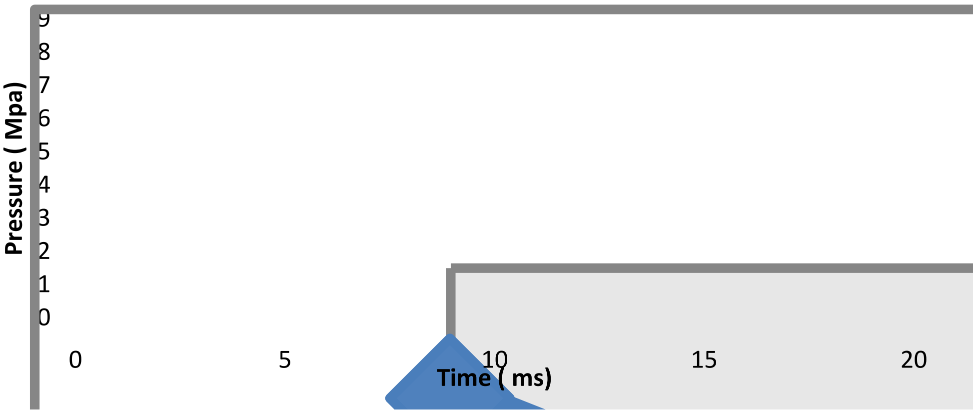

Figure 4: Blast loading of column C & D

IV. RESULT & DISCUSSION

According to the results, the system affects significantly, the actual charge weight of explosive used by the terrorist, the efficiency of the chemical reaction and the source location are not reliably predictable. The stand-off distance is the key parameter that determines the blast pressure so for protecting a structure is to keep the bomb as far away as possible by maximizing the stand-off distance. Blast has a characteristic of high amplitude. The results showed that if the member subjected to high pressure, they could cause big deformation on the element and cause to be exceed the support rotation so the elements which are close to explosion are damaged.

4.1 RC Column Responses to Blast Loading

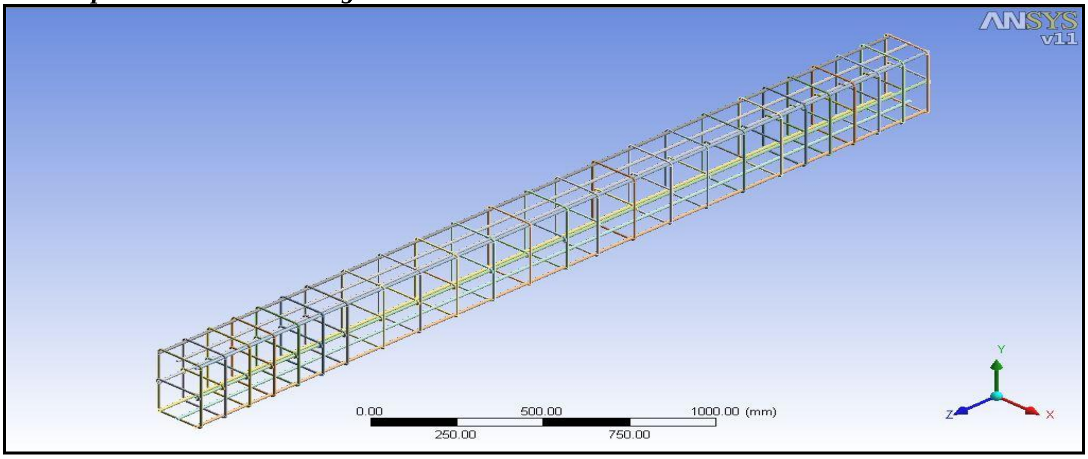

Figure 5: Rebar Structure of column in ANSYS Software

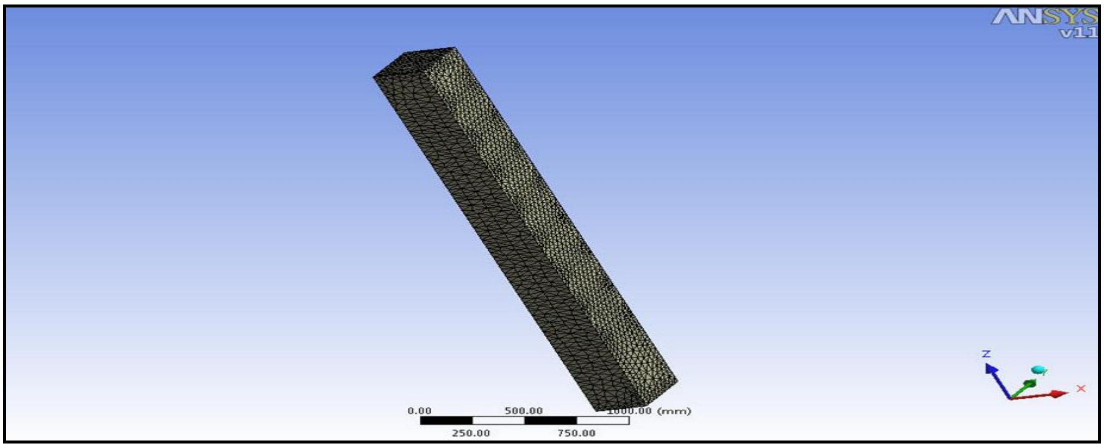

Figure 6: Meshing of Column

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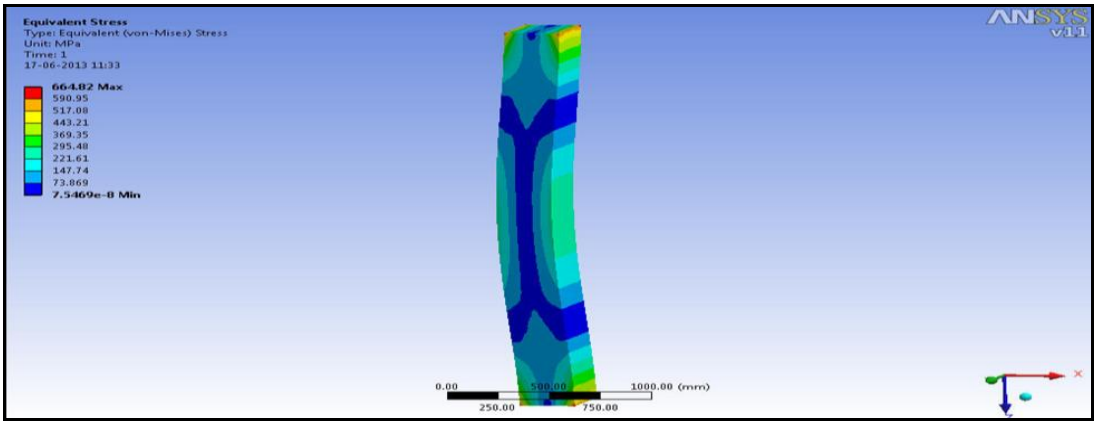


Figure 7: Max. Stress of Long Side Column C

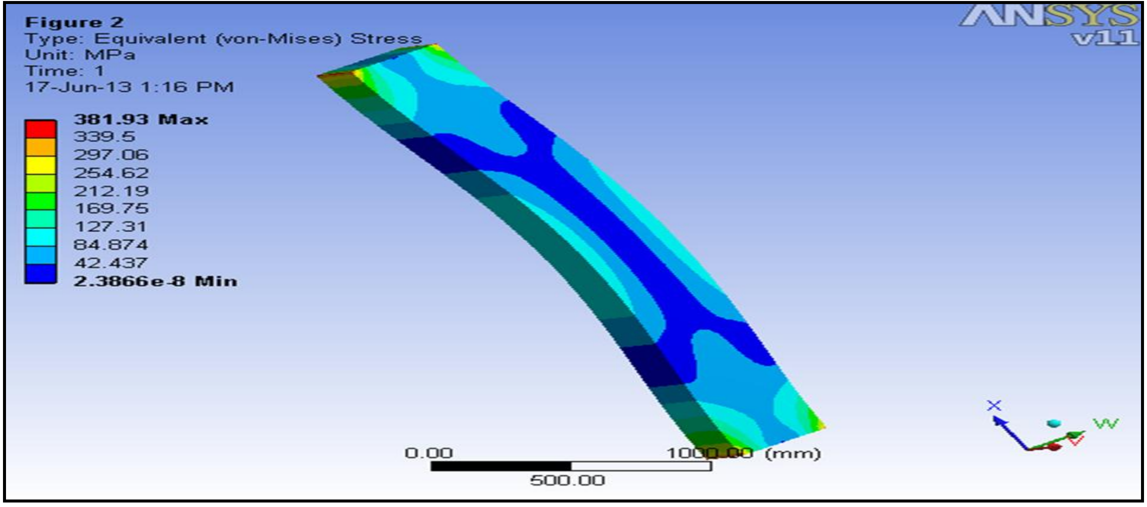
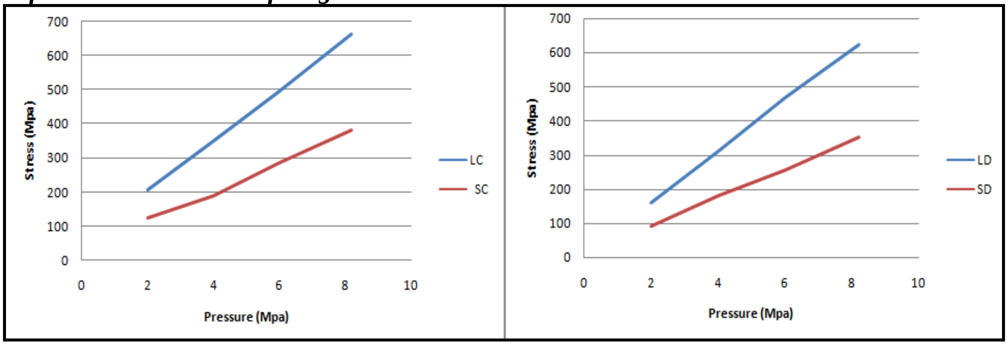


Figure 8: Max. Stress of Short Side Column C

4.2 *Comparison of Pressure Vs Stress of long side & Short side Column C & D*



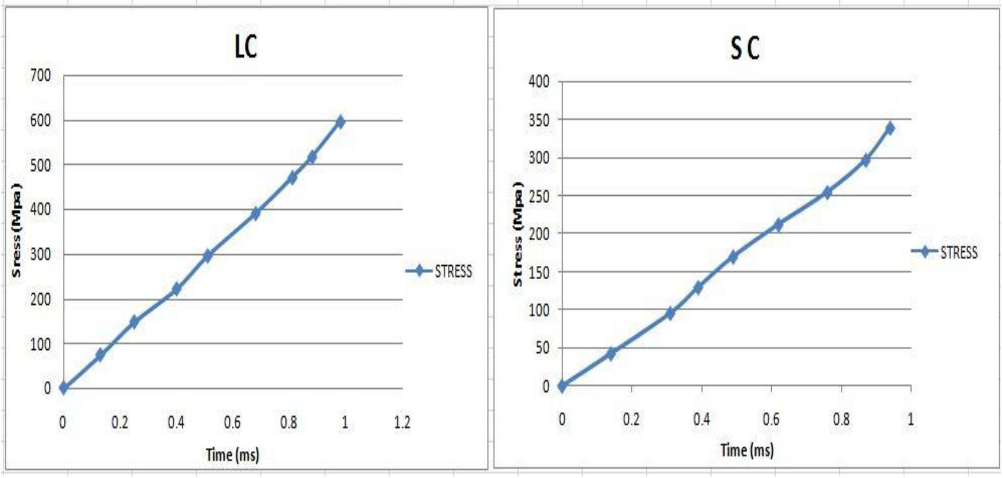
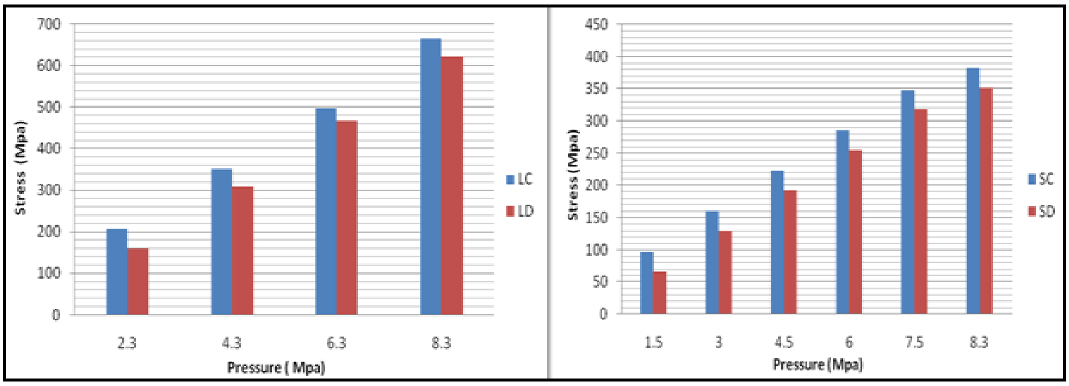


Figure 9: Comparison of Time Vs Stress for Long &Short side Column C



(i) Long column C & D **(ii) Short column C & D**

Figure 10: Graph of Pressure Vs Stress

Table III: Comparison of the Maximum Stress Distribution of Long & Short side columns,

Sr. No.	Floor	Element	Stress (Mpa)
1	GF	LA	841.06
2	GF	SA	661.63
3	GF	LB	701.06
4	GF	SB	434.30
5	FF	LC	664.82
6	FF	SC	381.93
7	FF	LD	622.50
8	FF	SD	351.63
9	SF	LE	540.26
10	SF	SE	262.77
11	SF	LF	512.44
12	SF	SF	238.79
13	TF	LG	401.35
14	TF	SG	131.60
15	TF	LH	390.11
16	TF	SH	170.90

V. CONCLUSION

Based on the results of the parametric study, the following main conclusions can be drawn. The ultimate objective is to make available the Procedure for calculating the blast loads on the structures. The comparison between the Long side column and short side column showed that the critical impulse for the long column case is significantly higher. From result shows Maximum stress distribution ratios of short side to long side for the Column A, B, C, D, E, F, G, and H are 0.78, 0.61, 0.57, 0.56, 0.48, 0.46, 0.32, and 0.30 respectively. The effect of blast load is more critical in the case of columns with a low transverse reinforcement ratio.

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REFERENCES

[1]. A. Khadid et al. (2007), “Blast loaded stiffened plates” Journal of Engineering and Applied Sciences, Vol. 2(2) pp. 456-461.
[2]. A.K. Pandey et al. (2006) “Non-linear response of reinforced concrete containment structure under blast loading” Nuclear Engineering and design 236. pp.993-1002.
[3]. Alexander M. Remennikov, (2003) “A review of methods for predicting bomb blast effects on buildings”, Journal of battlefield technology, vol 6, no 3. pp 155-161.
[4]. American Society for Civil Engineers 7-02 (1997), “Combination of Loads”, pp 239-244.
[5]. ANSYS Theory manual, version 5.6, 2000.
[6]. Biggs, J.M. (1964), “Introduction to Structural Dynamics”, McGraw-Hill, New York.
[7]. Dannis M. McCann, Steven J. Smith (2007), “Resistance Design of Reinforced Concrete Structures”, STRUCTURE magazine, pp 22-27, April issue.
[8]. Demeter G. Fertis (1973), “Dynamics and Vibration of Structures”, A Wiley-Interscience publication, pp. 343-434.
[9]. D.L. Grote et al. (2001), “Dynamic behavior of concrete at high strain rates and pressures”, Journal of Impact Engineering, Vol. 25, Pergamon Press, NewYork, pp. 869-886,
[10]. IS 456:2000 Indian Standard Plain and Reinforced Concrete Code of Practice.
[11]. J.M. Dewey (1971), “The Properties of Blast Waves Obtained from an analysis of the particle trajectories”, Proc. R. Soc. Lond. A.314, pp. 275-299.
[12]. J.M. Gere and S.P. Timoshenko (1997.), “Mechanics of materials”, PWS publishing company, Buston.