Structures to Resist the Effects of the Accidental Explosions

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ABSTRACT

Currently in the field of civil engineering the requirement regarding knowledge blast loads are essential. Every country in the world are having terrorist threats. As the scenario of terrorist attacks are unpredictable neither location nor blast material used. This provides an outline to analysis and design to resist blast loads. We have taken an example model to illustrate evaluation of blast parameters which are used in the analysis. The analysis and design of structures to resist blast/explosive loads is having utmost importance compared to the conventional type of structures. Where Loading is actually independent of time variation. From past few decades terrorist attacks are becoming a new threat to people lives material used, its quantity, and distance from structure etc. Since we don't know when the blasting activity is going to be happened and type of charge material is used, depends on importance of structure we have to make sure the design of structure should be such that it should resist the failure against blasting activities and to property also. The amount of damage caused to structure is depends upon type of charge. Blast loads, its contribution to structures and other required provisions are opted from Technical Manual 5-1300 and IS 4991-1968.The design method used is Equivalent Static Approach. Analysis of frames of structure is done with software package.

KEYWORDS: Accidental Explosions

I. INTRODUCTION

Other than Earthquake load effects on structure, Blast load effects are one of the major structural damage phenomenon which requires a special care to be taken to design structural elements. Evolution of technology, availability of information and lack of awareness and practice regarding the design of structures to resist blast loads are all come to gather is a chance to the people who actually succeeded in blasting the social and public buildings. These days' terrorist activities are going pretty well. We can easily get trained through Internet on how to prepare blasting materials. We must have to think about it as a human being. Such an intellectually stupid technology!!!

While looking back into the major terrorist activities in history, the attack on The World Trade Centre in New York City in February 1993 and on September 11, 2001 which resulted in thousands of death cases and considerable property loss. Another notable explosion activity is TRUCK Blasting of Alfred Murrah Building. Which resulted hundreds of death cases and includes property loss. There are several notable explosions which resulted in huge structural damages and loss of lives.

With the recent increase in public awareness of possible terrorist attacks around worldwide, many organizations and agencies are currently trying to secure methods of constructing facilities that will survive blast loads due to explosions. A majority of the early academic research in the field of blast design was done at the University of Illionois at Urbana and at the Massachusetts institute oftechnology. This resulted in Tri-Services manual designed by the Army as "TM 5-1300 : Structures to Resist the Effects of Accidental Explosions," which was subsequently revised in 1990[1]. This version incorporates the research conducted over the intervening period. Volume 4 of the manual addresses reinforced concrete design.

In conventional RCC design the structures are actually designed to resist the design loads which are actually doesn't vary with time. The analysis and design of structures comes under static analysis. while coming to blast/explosive loads, the analysis falls under dynamic view where the loads acting on structures are vary with time. In fact the time period considering which is very less (in Milli seconds

A. Impact of Accidental Explosions a Human

S.NO	DATE	LOCATION	DEATHS
1	23\07\1964	Harbour munitions, bone ,Algeria	100
2	21\10\1965	Bridge, Tila Bund, Pakistan	80
3	30\10\1965	Cartagena, Colombia	48
4	25\12\1967	Apartment building, Moscow	20
5	08\04\1970	Subway construction, Osaka, Japan	73
6	27\12\1975	Mine , Chasnala , India	431
7	01\04\1995	Murrah Alfred federal Building	250
8	11\09\2001	World trade center (W.T.C), USA	2630
9	11\09\2001	Pentagon building, Washington D.C, USA	189
10	14\10\2017	Mogadishu, Somalia Table 1:	300

B. Impact of Accidental Explosions over a Structure

Now a day's most of the structures will face the problem due to blast. The structural engineer will gives the more priority in the design how to make the structure with earthquake proof but they are not giving the equal importance to the blast. Because of this the structures will collapse completely when the structure is subjected to blast load which may leads to the loss of lives and pollution.

Let us consider Oklahoma City Alfred P.Murrah federal building bombing. This structure is designed in the early 1970's based on ACI 318-71 and it is earthquake resistant structure. In april 1995 murrah building is attacked by terrorists with 1800kgs high explosives. Because of these explosives 42% of structure is collapsed by blast and progressive collapse.

Therefore it is clear that if the structure is designed for dead loads, live loads and earthquake loads that is not sufficient to resist the accidental explosions. So as a structuraldesigner we have to consider the blast load for the design of premium structures.

II. TYPES OF BLASTING MATERIALS AND THEIR EQUIVALENT WEIGHT

Usually the size the bomb is given in terms of weight of Trinitrotoluene (TNT). When the high explosive is other than TNT, the equivalent energy is obtained by using the charge factor (C.F). The CF of cyclonite (RDX) is the ratio of actual mass of the RDX (5320Kj/kg) and mass of the TNT (4520 Kj/Kg) i.e., 5320/4520=1.185. It means 100 kg of RDX is converted into 118.5 Kg of TNT.

EXPLOSIVES	MASS SPECIFIC	TNT EQUIVALENT
TNT	4560	1
GDN(Glycol dinitrate)	7232	1.6
Pyroxilene	4746	1.05
Dynamite	5876	1.3
Schneiderite	3164	0.7
Dinitrotoluene (DNT)	3164	0.7
Ethylenedinitramine	5650	1.25
Compound B (0.6 RDX)	5190	1.148
RDX(cyclonite)	5360	1.185
HMX	5650	1.256
SENTEX	5660	1.25

Table 2:

A. Blast Wave Parameters
1. Dynamic pressure
It is the pressure effect of air mass movement called blast wind
2. Impulse
Impulse per unit of projected area is the pressure-time product given by the area under the pressure-time curve considered for the positive phase only unless otherwise specified.

3. Over pressure
It is the rise in pressure above atmospheric pressure due to shock wave from an air blast

4. Reflected overpressure
It is the over pressure resulting due to reflection of a shock wave front striking any surface. If the shock front is parallel to the surface, the reflection is normal.

5. Shock wave front
It is the discontinuity between the blast wave and surrounding atmosphere. It propagates away from the point of explosion in all directions at a speed greater than the speed of sound in the undisturbed atmosphere.

B. Blast Phenomena

The structures whenever opted for explosion majorly the structure will be influenced by the peak pressure, peak reflected pressure, duration of shock wave, impulse, high temperature. Due to this detonation velocity range will be reaching the structure in the form of pressure immediately after detonation will be from 9000m/sec to 12000m/sec. Whenever the wave that is generated from blast hits the structure then the structure starts dissipating the energy by means of reflection, dissipation,vibration ...etc. when theshock wave starts travelling from the source it expands in the air and induces sudden increase in the pressure as well as heat.

III. CODAL PROVISIONS
1. IS 4991-1968
2. US NAVAY CODE

A. Design Considerations
Structures to resist effects of accidental loads (or) explosive loads (or) blast loads the design consideration s should be taken into the account by structural designer
1. Elastic property
2. Material strength consideration
3. Direction of the wave propagation
4. Inertia force
5. Temperature changes
6. Possible standoff distance
7. Angle of incident
8. Peak reflected pressure
9. Time period

IV. DYNAMIC LOADING ON STRUCTURE
The project work includes the effects of loads resulting from blasting activity takes place outside of the structure. Calculating the design blast load values and assigning them

to the structure is considered from US NAVAL CODE We are designing blast load resistible G+5 residential building with charge weight considered is 1000 lbs acting at a distance of 230ft. From US NAVAL CODE the highest equivalent charge weight of 1000 lbs is considered for design.

Charge weight = 1000 lbs
RG = 70mRG = 230 feet
ZG = $RG/W^{1/3}$
ZG = $230/(1000)^{1/3}$

ZG = 23.06 $Ft/lb^{1/3}$

A. Blat Wave Parameters

Pso = 3.5 psi
$tA/w^{1/3}$ = 6 $ms/lb^{1/3}$
$Lw/w^{1/3}$ = 2.2 $Ft/lb^{1/3}$
$is/w^{1/3}$ = 7 $psi\text{-}ms/lb^{1/3}$
U = 1.2 Ft/ms
$i/w^{1/3}$ = 12 $psi\text{-}ms/lb^{1/3}$
Pr = 15 psi
$to/w^{1/3}$ = 12 $ms/lb^{1/3}$

Conversion from F.P.S system to S.I system of units Pso= 3.5 psi

Pso= 3.5* 6.839
Pso= 23.787 KN/m^2

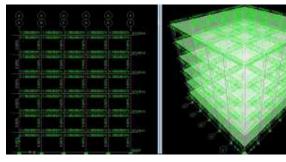Now consider the G+5 building having the plan area of 20*21 m^2
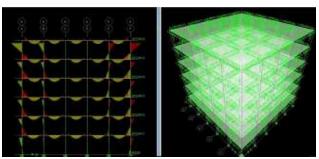
B. Panel Load Calculation

Peak positive incident pressure, Pso = 23.787 KN/m^2
Area of the panel = 20*21 m^2

The total blast load over the structure = 23.787*420
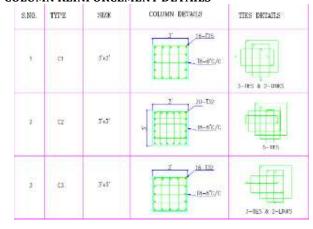= 9990.54 KN

The blast load acting at each and every joint = 60 KN

This project deals with 3 cases they are given below
1. Structure without blast load
2. Structure with blast load of magnitude 60KN (Calculated)
3. Structure with blast load of magnitude 120 KN (Selected)

COLUMN REINFORCEMENT DETAILS

S.NO.	TYPE	SIZE	COLUMN DETAILS	TIES DETAILS
1	C1	5x3'		
2	C2	5x3'		
3	C3	3'x3'		

CONCLUSION

➢ Behavior of structure subjected to blast loads is being evaluated
➢ Case studies of Alfred P. Murrah building as had been taken as a reference to study G+5 residential building subjected to blast load
➢ Three case studies are made to determine the difference.
➢ Mainly observed that reinforcement has been increased about 45% when compared with conventional structures.
➢ Sacrificial wall is good governance towards the safety of the structure. Which effectively minimizes the damage.
➢ Based on research worked carried out by eminent professors being we dealt with majorly focused on the columns
➢ Even though the quantity of blast material cannot be predicted therefore we have to follow worst case scenario of the history
➢ The current research has been focusing towards the safety of human beings against blast. As it is essential as long as terrorist activites continuous
➢ The designers should have a sound knowledge regarding blast loads which will enhance the safety of the mankind
➢ The special structures like defense, administration and confidential zones (like research centers)…etc in these areas it holds effective application.

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