STUDY OF RESPONSE OF VARIOUS BLAST LOADING ON THE STRUCTURE BY USING ETABs

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ABSTRACT

Blast loading and earthquake excitations can be regarded as the most destructive events a building structure can experience during its life. For studying the response of the blast loading on structures the seven story building has been taking that is modeled in the ETABs. The response of different loading are studied on the structure. IS 4991-1968 are used for comparable study of the behavior of the structure on different applied loads. The results show that the lateral story drifts produced by blast loading are significantly larger than the corresponding seismic drifts. The study concludes that consideration of the global response of a building to blast loads is important, and response parameters, such as the lateral drifts and floor responses, should be paid attention in the design and response assessment procedures for blast loading. First, a quick explanation of explosives and their various varieties has been provided. Furthermore, the general characteristics of the explosion process have been studied on different loadings

Keywords: Blast load, blast waves, High explosive effects, TNT

INTRODUCTION

Two of the most destructive events that a building structure could experience are earthquake and blast. In designing a building structure to resist the forces induced by an earthquake, both the local response at the element level and the global response are considered.

The 1947 division of the subcontinent into India and Pakistan based on religious grounds is partially to blame for India's struggle with terrorism and violent extremism. The two countries have been at odds for a long time over this geographical dispute, with each fiercely disputing the other's claims. It is now crucial to include blast load impacts from the design stage of a structure, just as we consider earthquake loads, wind loads, etc., because of the surge in terrorism and other threats in the world in recent years. The threat of terrorism has grown to be a serious issue, and citizens now prioritize preventing and mitigating terrorism.

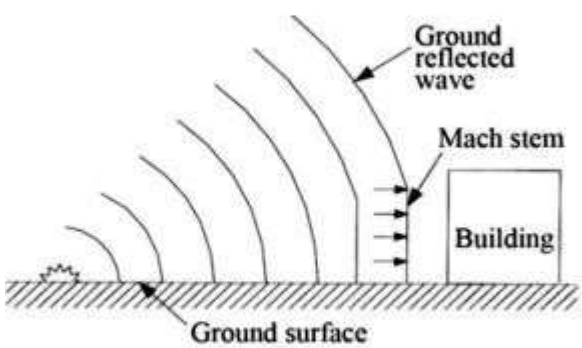
This review's primary goal is to provide insight into how blast-induced effects are managed during the design and planning phases of a structure, as well as how the structure responds to blast loading. Using ETABS software, particular attention is paid to various impact standoff separations and charge loads (TNT) in accordance with ISO 4991. Since the impact concept contributes to the construction of a highly built structure that can demonstrate improved blast resistance in addition to aesthetic appeal, it should be considered at the idea level. A strategy for evaluation, investigation, and retrofitting needs to be put into action in order to guarantee the security of current structures against impacts.

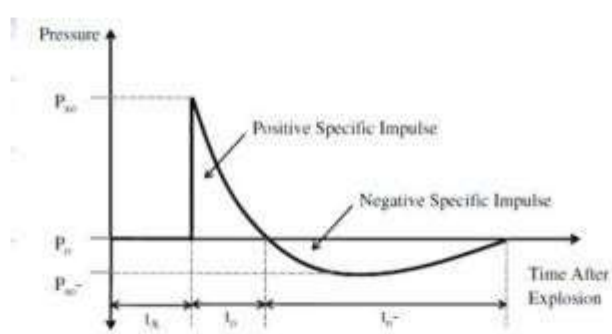
By comprehending the properties of explosion, we may more effectively design buildings to withstand blasts. Architectural and structural concepts should serve as the foundation for basic techniques aimed at enhancing a building's resistance to blast damage. With an emphasis on the range of standoff distances of the blast on a building and different charge weights of TNT in accordance with IS'Code 4991, the study's main objective is to provide guidance for the design of blast-resistant buildings and the use of ETABS software for determining a structure's response to blast load. According to IS'Code 875-1987, dead loads, partition wall loads, and live loads are all included in the construction study depending on the needs and function of the structure.

The main objective of this study is to provide guidance to engineers and architects in circumstances when high explosive detonation explosion protection is needed. The rules include protective procedures to mitigate the effects of explosions, safeguarding individuals, assets, and valuable machinery. The report also includes information on explosives, blast loading specifications, and enhancements for blast-resistant building design from an architectural and structural standpoint.

BASIC PRINCIPLE OF BLAST EFFECT

There are ways to blast happen which will differential the working of severity to effect on any construct structure. So what happen is every blast will generate blast wave that will propagate from blast point to nearby structures as we see in this figure, it will reflect from the ground in the air and collide through the building structure in a phase of Mach stem.





This study's primary objective is to provide guidance to engineers and designers in circumstances when high-explosive detonation safety procedures are necessary to prevent explosions. The instructions contain ways to mitigate the impacts of explosions so that people, buildings, and important systems inside are protected. This study includes information on explosives, blast loading factors, and improvements for the construction of blast-resistant structures, each using a structural and architectural approach. Only explosions brought on by strong explosives (chemical reactions) are taken into account in the analysis. Excessive explosives with a stable form are usually referred to as condensed explosives. TNT, or trinitrotoluene, is the most well-known such. Three categories apply to explosions: those that are unconfined, those that are confined, and those that result from explosives attached to the structure.

Unconfined explosions can occur in two different ways: the air or the floor. The excessive explosive detonates above ground during an air burst explosion, and before the building's initial blast wave appears, floor reflections amplify the wave in the interim.As the surprise wave continues to extend outward alongside the floor, the interplay of the prepared wave and the meditative wave generates a front. However, a surface burst explosion occurs when the explosion occurs on the floor or in close proximity to it. The first surprise wave is reflected and amplified by the floor surface, resulting in a thought wave. The meditation wave, in contrast to the air burst, records an independent wave by merging with the incident wave

Objective of the Blast Proof Building

The two main goals of blast-resistant building design are:

- Controlled shutdown
- Worker safety.

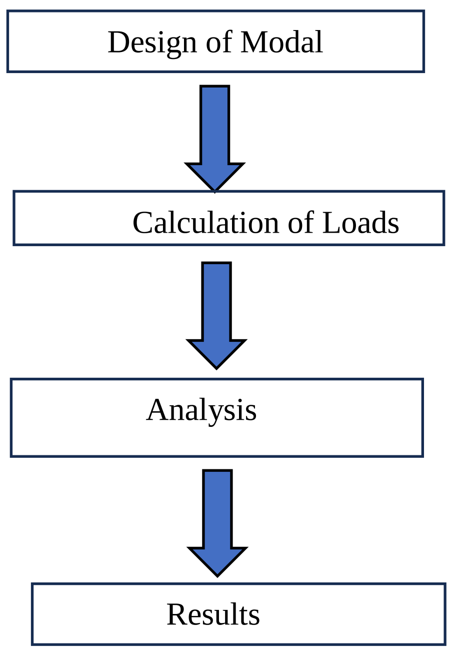
In the case of an explosion, those within the building should have the same level of safety as those outside thanks to blast-resistant architecture. Evidence from earlier instances has demonstrated that a large number of fatalities and significant injuries were caused by buildings collapsing on people who were within them.

The goal is to lessen the likelihood that an explosion will turn the structure into a danger. Another goal of blast resistant design is to prevent cascade events caused by the loss of control of process units not engaged in the incident. The safe operation or orderly shutdown of other units should not be impacted by an event in one of those units.

Another goal of blast resistant architecture is to prevent or minimize financial damages. Structures holding confidential company information, expensive, high-demand equipment, vital or crucial equipment, or equipment that, in the event of destruction, would result in a major disruption or financial loss for the owner should all be safeguard.

Methodology:

Steps involved in Methodology of the proposed project works can be explained through given flow chart:



Detail of Modal

Building	Specification
Bay Frame Structure	G+6
Column	500mm X 500mm
Beam	400mm X 500mm
Wall	480mm
Slab	180mm

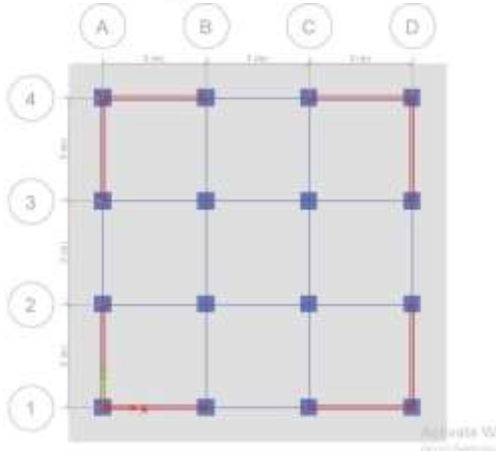


Fig-1 Plan of Building

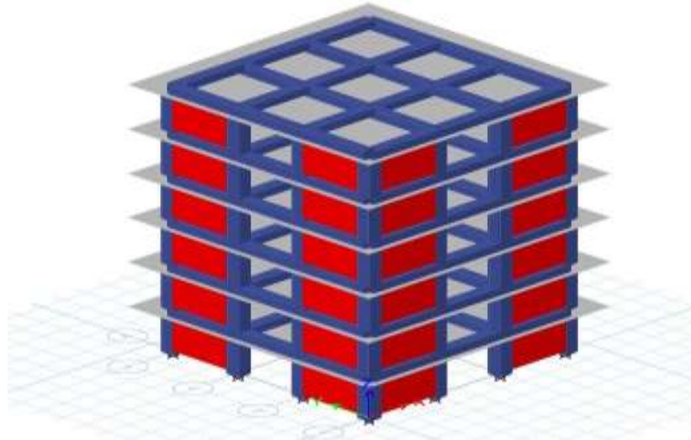


Fig -2 Bay frame structure on ETABs

WALL THICKNESSES AS (IS4991-1968)

For protection against splinters from bombs with equivalent bare charges exploding at a distance of 15 m, the wall thicknesses given in Table 8 will be adequate. Wall thickness taken 48cm for 100kg charge

TABLE 8 MINIMUM WALL THICKNESSES AGAINST FLYING SPLINTERS

Material of Wall	Wall Thickness, cm	
	For Bomb with Equivalent Bare Charge of 50 kg	For Bomb with Equivalent Bare Charge of 100 kg
(1)	(2)	(3)
Reinforced concrete	30	38
Plain concrete or brickwork	34	45

Loads On Building

- **Dead Load (**As per IS 875-I) : 31 KN/m Outer Wall
  : 7.9 KN/m Inner Wall
  : 6.0 KN/m for Parapet Wall
  : 4.5 KN/m^2 for slab
- **Live Load (**As per IS 875-II) :3 KN/m^2 for slab
- **Earthquake Load** :IS 1893 Part -1

- **Wind Load** : IS 875 Part –III

Calculation of blast Load in form Blast Force for a 100 kg charge of explosive (TNT)

The blast masses are calculated by way of the use of this formulation

Scaled distance (m) = actual distance/ Charged weight in lots

Actual distance is received from the code e book IS4991:1968 from table no: 7 primarily based on the sort of constructing The corresponding values of seasoned, Pso are taken from desk 1 of IS: 4991-1968. We adopt the source at a point (0, 1, 0).

Law of scaling

Equation describes how a dimensional scaled distance is given in accordance with Hopkinson-Cranz regulation.

$$Z = \frac{R}{\sqrt[3]{W}}$$

Where,

R = distance from the detonation source to the point of interest [m]

W = weight (more precisely: the mass) of the explosive [kg]

TABLE 1 BLAST PARAMETERS FROM GROUND BURST OF 1 TONNE EXPLOSIVE

(*Clause* 5.1)

Distance, m x	Peak Side on Over-pressure Ratio p_{so}/p_a	Mach No. M	Positive Phase Duration t_o, milli-secs	Duration of Equivalent Triangular Pulse t_d, milli-secs	Dynamic Pressure Ratio q_o/p_a	Peak Reflected Overpressure Ratio p_{ro}/p_a
(1)	(2)	(3)	(4)	(5)	(6)	(7)
15	8·00	2·80	9·50	5·39	10·667	41·60
18	5·00	2·30	11·00	7·18	5·208	22·50
21	3·30	1·96	16·38	9·33	2·643	12·94
24	2·40	1·75	18·65	11·22	1·532	8·48
27	1·80	1·60	20·92	13·30	0·920	5·81
30	1·40	1·48	22·93	15·39	0·583	4·20
33	1·20	1·42	24·95	16·31	0·439	3·45
36	1·00	1·36	26·71	17·94	0·312	2·75
39	0·86	1·32	28·22	19·20	0·235	2·28
42	0·76	1·28	29·74	20·20	0·186	1·97
45	0·66	1·25	31·25	21·60	0·142	1·66
48	0·59	1·23	32·26	22·70	0·115	1·46
51	0·53	1·20	33·52	23·70	0·093	1·28
54	0·48	1·19	34·52	24·70	0·077	1·14
57	0·43	1·17	35·53	26·40	0·062	1·01
60	0·40	1·16	36·29	26·60	0·054	0·93
63	0·37	1·15	37·30	27·80	0·046	0·85
66	0·34	1·14	38·05	28·76	0·039	0·77
69	0·32	1·13	38·81	29·25	0·035	0·72
72	0·30	1·12	39·56	29·87	0·031	0·67
75	0·28	1·11	40·32	30·71	0·027	0·62
78	0·26	1·104	40·82	31·85	0·023	0·58
81	0·25	1·100	41·58	31·92	0·022	0·55
84	0·24	1·098	42·34	32·00	0·020	0·53
87	0·23	1·095	42·84	32·26	0·018	0·50
90	0·22	1·086	43·60	33·39	0·016	0·47
93	0·20	1·082	44·35	34·70	0·014	0·43
96	0·19	1·077	45·46	35·37	0·013	0·41
99	0·18	1·072	45·61	36·22	0·012	0·40

NOTE 1 — The value of p_a the ambient air pressure may be taken as 1 kg/cm^2 at mean sea level.

NOTE 2 — One tonne of explosive referred to in this table is equivalent to $1{\cdot}5 \times 10^{9}$ calories.

NOTE 3 — Velocity of sound in m/s may be taken ($331{\cdot}5 + 0{\cdot}607\ T$) where T is the ambient temperature in centigrade.

Blast parameters from ground from IS 4991-1968

Table for Presentation of distance from the detonation source to the point of interest

Coordinates of point of interest			Distance between source to target	SLAB
40	1	0	40.0	SLAB -1
40	1	6	40.4	
40	1	9	41.0	
40	4	0	40.1	SLAB -2
40	4	6	40.6	
40	4	9	41.1	
40	7	0	40.4	SLAB -3
40	7	6	40.9	
40	7	9	41.4	
40	10	0	41.0	SLAB -4
40	10	6	41.4	
40	10	9	42.0	
40	11	0	41.2	SLAB -5
40	11	6	41.7	
40	11	9	42.2	
40	14	0	42.1	SLAB -6
40	14	6	42.5	
40	14	9	43.0	
40	17	0	43.1	SLAB -7
40	17	6	43.5	
40	17	9	44.0	

Table for (Pro) Blast load on front face of the building

SLAN	SCALED DISTANCE	Pro (kg/cm²)	Pro (KN/m²)	A (m²)	Force (KN)
SLAB -1	75	0.62	61	3	182
	76	0.61	60	3	179
	77	0.59	58	3	174
SLAB -2	75	0.62	61	3	182
	76	0.61	60	3	179
	77	0.59	58	3	174
SLAB -3	76	0.61	60	3	179
	77	0.59	58	3	174
	78	0.58	57	3	171
SLAB -4	77	0.59	58	3	174
	78	0.58	57	3	171
	79	0.57	56	3	168
SLAB -5	78	0.58	57	3	171
	78	0.58	57	3	171
	79	0.57	56	3	168
SLAB -6	79	0.57	56	3	168
	80	0.56	55	3	165

	81	0.55	54	3	162
SLAB -7	81	0.55	54	3	162
	82	0.54	53	3	159
	83	0.54	53	3	159

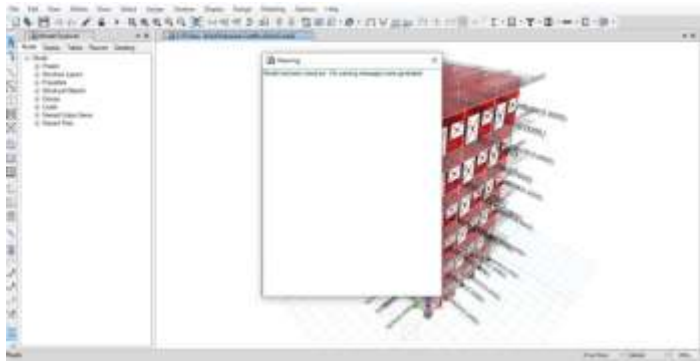


Fig-3 Modal check on ETABs

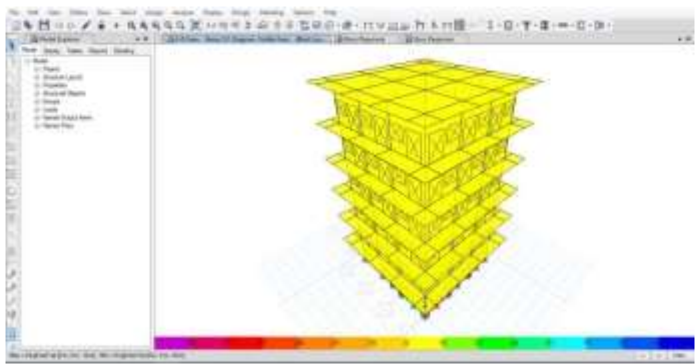


Fig -4 Story displacement due to blast load building

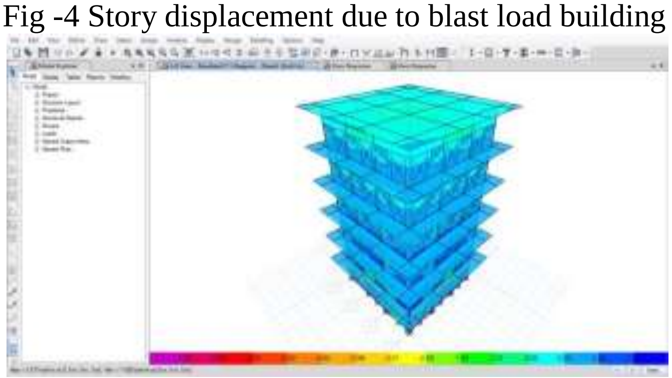


Fig-5 Resultant force diagram

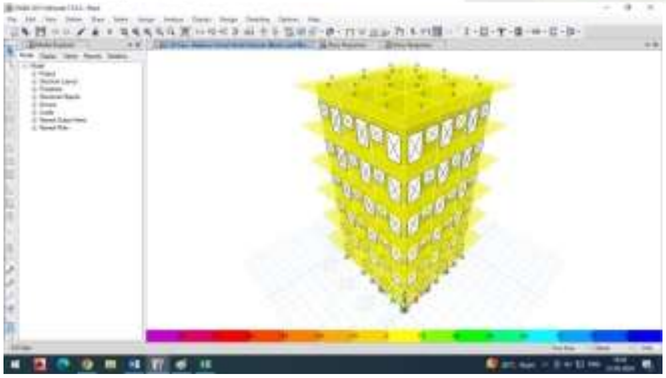


Fig-6 Energy diagram of story

CONCLUSION

The term "blast resistant diagram" describes an improved structural design. The goal of a blast resistant building format is to prevent fatal damages and the fundamental collapse of the structure. Even if it is impossible to precisely forecast the size of the explosion and the hundreds of casualties it would cause, the most likely scenarios will enable the identification of the most suitable engineering and architectural solutions.
The goal of this research is to design buildings that are resistant to explosions, to be the first in implementing the rules required to prevent structural and human casualties from explosions and other human-caused hazards, and to raise public awareness of the possibility of explosions in daily life. This analysis should take structural and architectural design into account.
The behavior of the structural form under excessive compression stress, such as walls, flooring, and secondary structural elements like cladding and glazing, should be carefully taken into account during the architectural design process

The underlying premise of conventional design is that every structural component can bear the load. But it's crucial to keep in mind that blast loads can be sudden, severe, and unpredictable. It is obvious that a structure with a selected safety level and blast-resistant architectural design will withstand damage better, and these kinds of structures are also less likely to be the target of terrorist attacks.

The structural design that follows an architectural and environmental blast-resistant design is also crucial to preventing the building's complete collapse. A blast-resistant building can be constructed with the proper structural system selection, well-planned beam-column connections and structural elements, suitably designed moment frames that transfer sufficient load, and high-quality materials. It can be necessary to retrofit the structural elements of existing constructions. Even while these precautions would raise the cost of construction, they are essential to safeguard particular structures—like embassies—that are vulnerable to terrorist attacks

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