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PARAMETRIC STUDY OF STRUCTURES WITH AND WITHOUT BLAST LOAD

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Abstract
The analysis and design of structures subjected to blast loads require a detailed understanding of blast phenomena and the dynamic response of various structural elements. This gives a comprehensive overview of the effects of explosion on structures.In the present thesis, an attempt has been made to carry out the parametric study for analysis of blast load on a building that will be select as- G+8 stories having 4 bays x 4 bays space frame, and G+6 stories having 3 bays x 3 bays space frame. The space frame is subjected to various combinations of gravity and earthquake loads. The space frame is analyzed keeping its base fixed based on the result of analysis, it is designed as per IS: 456 (2000) and IS: 1893 (2002). The space frame will be analysed using the software ETABS. The parameters like displacement, storey drift, base reactions will be studied for with and without blast loads. This will be analyzed for blast charge of 0.1 ton, 0.3 tons and 0.5 tons at ground zero distance of 10m, 20m and 30m each. Blast load will be applied to the front face of the structure considering it as a triangular load (Time-History) as well as attempt will also be made to apply blast load as a normal pressure on the front face of the building. The expected results will be then compared with the building without blast load and with blast load.

Keywords:- ETABS,BLAST LOADS

I. INTRODUCTION

A bomb explosion within or around a building can have catastrophic effects, damaging and destroying internal or external portions of the building. It blows out large framework, walls and doors/windows and shuts down building services.Bomb damage to buildings depends on the type and layout of the structure, material used, range of the located explosive device and the charge weight. Early attempts at blast-resistance design necessarily relied on judgment, test, and trial-and-error construction to find the best solutions. As technology improved, designers became better able to predict the influence of explosions and the resistive responses that they strove to impart into their designs.

Need for Study

More recently, in the past several decades chemists, physicists, blast consultants, and structural engineers have been empowered by technologies and computational tools that have enhanced the precision of their analysis and the efficiency of their designs.

At the same time, the need has increased. The small contingent of designers skilled in the art and science of creating structural designs that will resist explosive forces has been joined by a larger group of architects, engineers, blast consultants, and security consultants who are trying to respond to the There are several good references on some of the aspects of designing for blast resistance. Some of these references support military purposes or for other reasons have government-imposed restrictions against dissemination.

As such, they are not widely available to consultants working in the private sector. Nearly all those references and the references that are public each treat an aspect of blast phenomenology, security systems, and structural design for blast resistance, but few, if any, bring together in one place discussions of the breadth of the issues that are important for competent designs.

II. METHODOLOGY

Methods for applying the Blast charge

Two different methods were selected for applying the blast load to the front face of the building. Pressure on side and back faces were neglected. The methods are :

1. **Blast Load as a Normal Pressure :**
   Here, considering the effect of blast waves critically on the first three stories of the building, the blast charge was applied directly in terms of KN/m2.
2. **Blast Load as a Time History Function :**
   In this method, blast charge was considered as a triangular load based on the assumption of IS 4991 and the blast charge and it's corresponding time of travel were defined as a Time History Function.

G+8 Story Space Frame

1. **Geometry:**
   4Bays x 4Bays in X and Y directions respectively
   Spacing of Bays : 5m in X as well as Y Direction

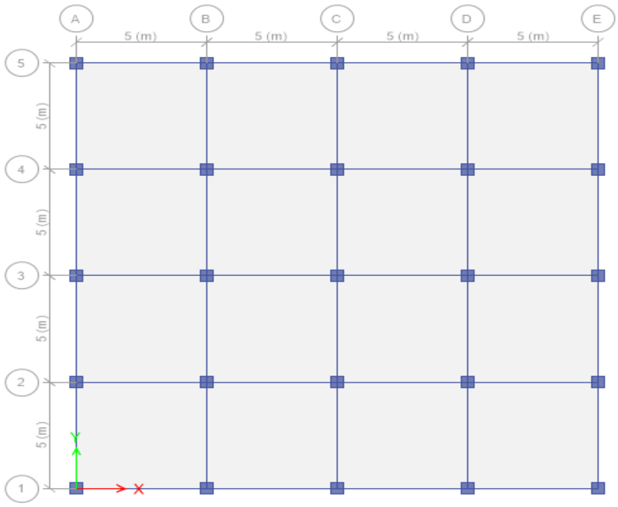

Fig. 1 Plan of the building

2. **Loading Parameters:**

Seismic Load (IS: 1893 -2002)	
Zone Factor	0.24
Importance Factor	1.5
RR Factor	5
Soil Type	Type II

Dead Load (IS: 875 Part 1 - 1987) (Slab Thickness =150 mm)	
Floor Load	3 kN/sqm
Floor Finish Load	1 kN/sqm
Total Dead Load	4 kN/sqm
Live Load (IS: 875 Part 2 - 1964)	
Floor Live Load	3.5 kN/sqm
Wall Load	
External	15.6 kN/m
Internal	7.8 kN/m

3. Size of the Elements :

Slab	150mm (All)
Beam	300 X 600 mm (All)
Column	500 X 500 mm (All)

4. Blast load calculation based on IS 4991 - 1968 for various blast charge and corresponding scaled distance

Distance from Ground Zero (m)	Explosive (Ton)	Scaled Distance (m)	Blast Pressure on Front face (kg/sqcm)	Duration of Equivalent Triangular Pulse (millisecond)
10	0.3	15	41.6	3.6
20	0.3	30	4.2	10.3
30	0.3	45	1.66	14.4
10	0.2	18	22.5	4.19
20	0.2	35	3.45	9.5
30	0.2	52	1.28	13.86
10	0.1	22	12.94	4.33
20	0.1	44	1.97	9.37
30	0.1	65	0.85	12.9

III. APPLICATION OF BLAST LOAD

Out of the above selected blast charges, the most critical ground zero distance case of 30m for 0.1 Ton, 0.2 Ton and 0.3 Ton were considered.
Blast Load Combination as (DL+0.35LL+BL) as per IS 800 in the category of Accidental Load was defined.

1. Blast Load as Normal Pressure

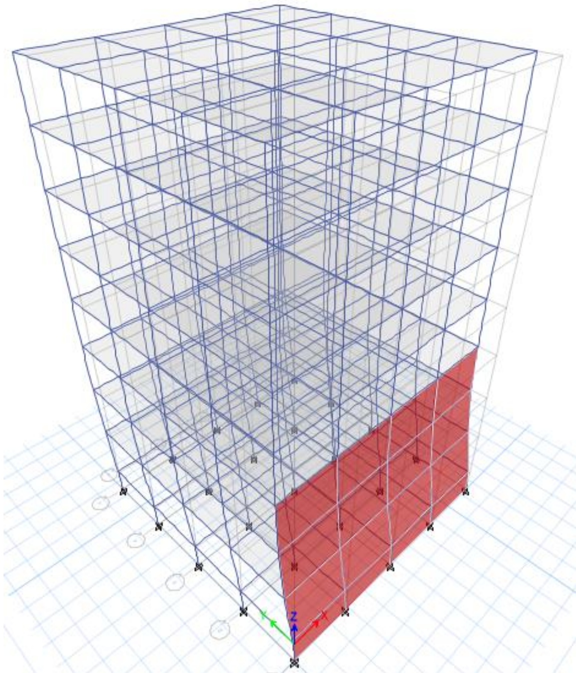

Fig 2. Deformed shape for Blast Load as Normal Pressure

2. Blast Load as Time History Function

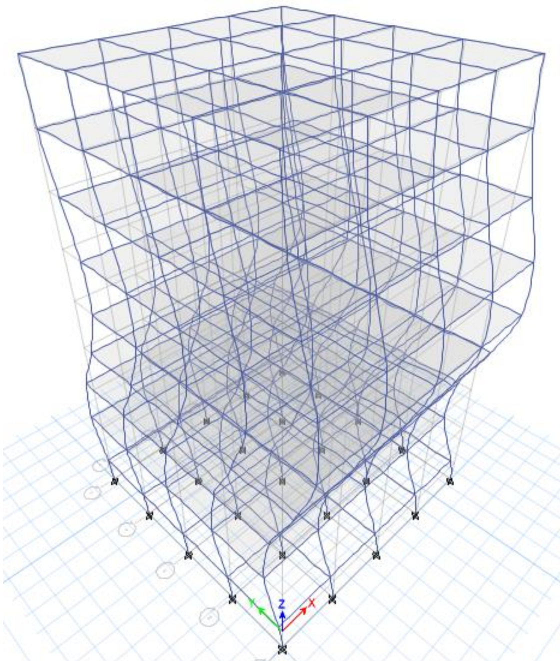

Fig 3. Deformed Shape for Blast Load as a TH Function

3. Building without Blast Load

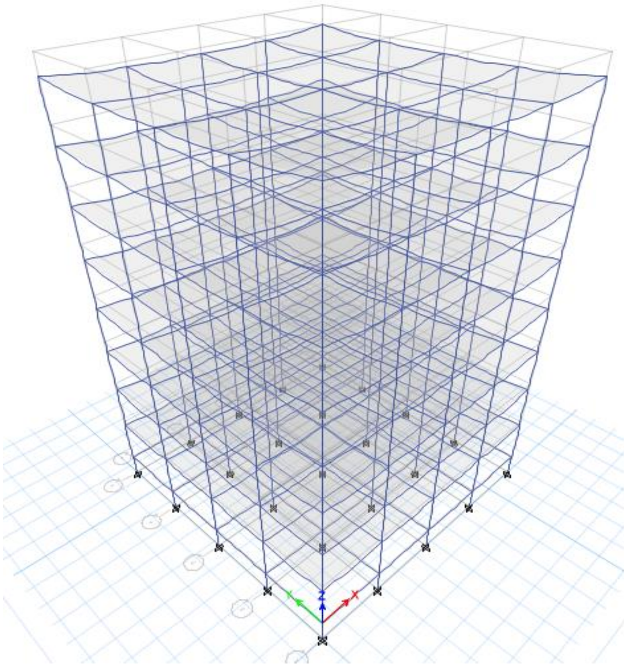

Fig 4 Deformed shape of the building without Blast Load

IV. RESULTS

1. Comparison of Bottom story Column Forces for the Blast Load Combination

For Case 1 – 0.1 Ton Charge at 30m Ground Zero Distance

Type of the Building	**Bottom Story Column Forces**	
	Shear Force P (KN)	**Torsional Moment T (KN-m)**
1. Building without Blast Load	-646.74	18.57
2. Building with Blast Load as a Normal Pressure	-2496.9	616.54
3. Building with Blast Load as TH Function	-1105.9	526.7

For Case 2 – 0.2 Ton Charge at 30m Ground Zero Distance

Type of the Building	**Bottom Story Column Forces**	
	Shear Force P (KN)	**Torsional Moment T (KN-m)**
1. Building without Blast Load	-646.74	18.57
2. Building with Blast Load as a Normal Pressure	-3496.4	816.64
3. Building with Blast Load as TH Function	-2113.6	724.6

For Case 3 – 0.3 Ton Charge at 30m Ground Zero Distance

Type of the Building	**Bottom Storey Column Forces**	
	Shear Force P (KN)	**Torsional Moment T (KNm)**
1. Building without Blast Load	-646.74	18.57
2. Building with Blast Load as a Normal Pressure	4006.25	1123.6
3. Building with Blast Load as TH Function	3214.4	998.6

2. Comparison of Base Reactions

For Case 1 – 0.1 Ton Charge at 30m Ground Zero Distance

Type of the Building	**Base Reactions**	
	Fy (KN)	**My (KN-m)**
1. Building without Blast Load	-751.4904	7514.9039
2. Building with Blast Load as a Normal Pressure	-23338	-431122
3. Building with Blast Load as TH Function	1314.7	-430988

For Case 2 – 0.2 Ton Charge at 30m Ground Zero Distance

Type of the Building	**Base Reactions**	
	Fy (KN)	**My (KN-m)**
1. Building without Blast Load	-751.4904	7514.9039
2. Building with Blast Load as a Normal Pressure	-36547	-512693
3. Building with Blast Load as TH Function	2016	-536954

For Case 3- 0.3 Ton Charge at 30m Ground Zero Distance

Type of the Building	**Base Reactions**	
	Fy (KN)	**My (KN-m)**
1. Building without Blast Load	-751.4904	7514.9039
2. Building with Blast Load as a Normal Pressure	-445961	-623152
3. Building with Blast Load as TH Function	-3325.2	-645236

3. Comparison of Max. Story Displacement

For Case 1- 0.1 Ton Charge at 30m Ground Zero Distance

Type of the Building	Max. Story Displacement (mm)	
	Displacement X	**Displacement Y**
1. Building without Blast Load	-0.001464	21.7
2. Building with Blast Load as a Normal Pressure	0.000483	151
3. Building with Blast Load as TH Function	1.64	0.01181

For Case 2- 0.2 Ton Charge at 30m Ground Zero Distance

Type of the Building	Max. Story Displacement (mm)	
	Displacement X	**Displacement Y**
1. Building without Blast Load	-0.001464	21.7
2. Building with Blast Load as a Normal Pressure	0.005263	160
3. Building with Blast Load as TH Function	1.92	0.0221

For Case 3- 0.3 Ton Charge at 30m Ground Zero Distance

Type of the Building	Max. Story Displacement (mm)	
	Displacement X	**Displacement Y**
1. Building without Blast Load	-0.001464	21.7
2. Building with Blast Load as a Normal Pressure	0.06213	193
3. Building with Blast Load as TH Function	2.4	0.04125

V. CONCLUSION

When blast load was applied as a normal pressure directly to the front face of the building, assuming it to be acting severely on the first three stories, the amount of bottom story column forces suffered a very high shear force and as a result it leads to collapse of the bottom story columns. When the blast load is applied in terms of Time History Function, the total story displacement for the top story exceeded the permissible limits and as a result, it would lead to major damage to the bottom stories of the structure. Blasting also leads to increase in the base shear of the structure which causes failure of the bottom stories of the structure. Conventionally, a building is not designed for blast loads, but in cases where the important buildings like schools, banks, Govt. buildings, army buildings etc. blast load has to be considered to ensure safety of the property as well as lives.

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