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ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

Vol 5, Issue 6, June 2020

Effect of Blast Load on Structure

[1]Sumit R. Bhagawat, [2] Prof. Prakash Patil

[1]research scholar, Department of Civil Engineering, G. H. Raisoni College of Engineering Nagpur, Maharashtra India

[2] Assistant Professor Department of Civil Engineering, G.H. Raisoni College of Engineering, Nagpur, Maharashtra, India

***Abstract:*--The terrorist activity are increases day by day specially in our country the effect of blast load are serious damage are causes for designing the process. Discuss the technique to minimized the blast on structure. The blast load are dynamic load which are need to calculate a properly wind load, seismic load, etc. Effecting the blast load are study and understands that improved the better technique in structure. To get a less effect after blast the design the blast load with the help of (IS4991-1968)as well as scale time v/s actual time, scale distance v/s actual distance, displacement v/s time velocity v/s time. The main objective is that to study the loading condition under the blast load . After the blast high amount of explosion should be accurate get large blast effect to control to good technique in design as well as structure the modeling by giving a blast load is done in sap2000 the load is applied as a blast load time triangular function to the structure .the some of major effect of explosion are causes such as overpressure, thermal effect ,energy projectile ,debris damages, cratering and ground shock . the main objective is that study the elucidate on blast building design theories, The improving the building security against the effect of explosive in the process of structural design and the techniques in design that should be carried out.**

Index Terms:-Blast Resistance design, blast load,Explosive Effect, Overpressure

1. INTRODUCTION

The terrorist activities and threats have become a growing problem all over the world and protection of the citizens against terrorist acts involves prediction, prevention and mitigation of such events. In the case of structures an effective mitigation may also be thought in the terms of structural resistance and physical integrity. If the structures are properly designed for these abnormal loads damage can be contained. Additionally, in order to ensure safety of existing structures against such events, an evaluation procedure for their inspection and eventual retrofit

Within the Euro codes these types of loads are not dealt with (EN 1991-1-7) and they need further elaboration as the engineers have no guidelines on how to design or evaluate structures for the blast phenomenon for which a detailed understanding is required as well as that of the dynamic response of various structural elements. There are no guidelines on such topics. On the other hand, this topic is the interesting one in military circles and important data derived from the experience and tests have been restricted to army use. Nevertheless, a number of publications are available in the public domain and

	Squre
Plan dimension	3×3 m
Total height of structure	13.5 m
Height of storey	3 m
Depth of foundation	1.5 m
Size of beam	
B1	0.230×0.300 m
Size of column	
C1	0.400×0.400 m
C2	0.450×0.450 m
Thickness of slab	0.100 m
Wall thickness	0.230 m

published by the US agencies. Analysis of structures under blast load requires a good understanding of the blast phenomenon and a dynamic response of structural elements. The analysis consists of several steps: (a) estimate of the risk; (b) determination of the computational load according to the estimated hazard; (c) analysis of the structural behavior; (d) selection of the structural system and (e) evaluation of the structural behavior.

ISSN (Online) 2456-1290

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	Square
Zone	3
Zone factor	0.16
Soil Types	Medium
Importance factor	1.5
Response reduction factor	3

2. LITRATURE SURVEY

Reinforced concrete structures have the potential to be very durable and capable of withstanding a variety of adverse environmental conditions. However, failures in the structures do still occur as a result of premature reinforcement corrosion. The maintenance and repair of bridges and buildings for their safety requires effective inspection and monitoring techniques for a sassing the reinforcement corrosion[1]

A semi-destructive technique was developed for determining the concrete resistivity and polarization resistance using the apparent resistivity measured on a reinforcement bar, this technique was reviewed for its applicability in evaluating concrete durability is mentioned in this paper[2]

Corrosion is the deterioration of materials by chemical interaction with their environment. The term corrosion is sometimes also allied to the degradation of plastics, concrete and wood, but generally refers to metals. This paper reviews various aspects of corrosion of the reinforcement embedded in concrete by various factors like moisture, permeability pH and temperature etc and also their corrosion controlling methods[3]

3 MODELLING OF STRUCTURE

a blast the modeling of building by giving load is done in SAP 2000.The load is applied as a blast load time triangular function to the structure.

Modeling and detail of structure

G+3 Storey structure for square plan are modeled in sap 2000.Square plan has 36sq.m plan area.. Plinth level is 1.5m from the foundation level and typical storey height is 3m. The wall load is calculated as per IS Code and equally distributed on beam. As well as live load is 2.5Kn\m2 is provided. Table 3.1.1 gives the detail the detail in Table.

Table:3.1.1 Details of G+3 Story Building

Square plan and buildings assume to be situated in seismic zone3. models are modeled as simple moment resisting frames of concrete grade M-20 and re-bars of grade Fe-415. Various data consider for modeling as per IS code is given in table 3.2

Table:3.1.1

Table 3.1.2 Dynamic detail of model

3.2 Modeling of Blast load fig.As per IS Code

This fig3.1 is design in sap 2000 software. . Nonlinearity of wan is considered. Mass and weight is assigned are 0.222 Kg and 2.25 Kn. Stiffness is calculated for each bracing element and that much of stiffness is assigned.

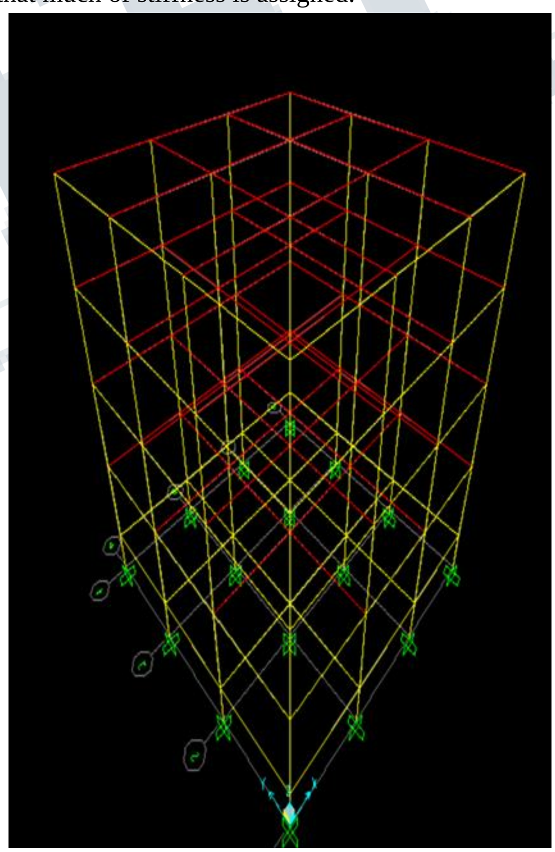

Fig3.2.2 elevation of building (SAP200 DESIGN)

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

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1MAJOR EFFECTS OF EXPLOSION

Different types of effects can occur due to an explosion which can cause damage to the nearby Building. Some major causes of damage are overpressure, thermal effects, energized projectiles, Debris damage, cratering and ground shock.

1Overpressure

It is the pressure caused by a shock wave over and above normal atmospheric pressure. This shock wave is a result of the explosion. The magnitude of overpressure blast wave is inversely proportional to the distance of the receiving object from the center of the explosion. Damage to structures and other objects and injuries to people can be caused by both the positive and negative overpressure of the blast. The damage from a blast wave is related to the magnitude of the peak overpressure, rise time, duration, and impulse. Overpressure in an enclosed spaceis determined by using “We bull's formula”

$\Delta p=2410m/v$

Where:

• 2410 is a constant based on 1 bar

• m = net explosive mass calculated using all explosive materials and their relative effectiveness

• V = volume of given area (primarily used to determine volume within an enclosed space)

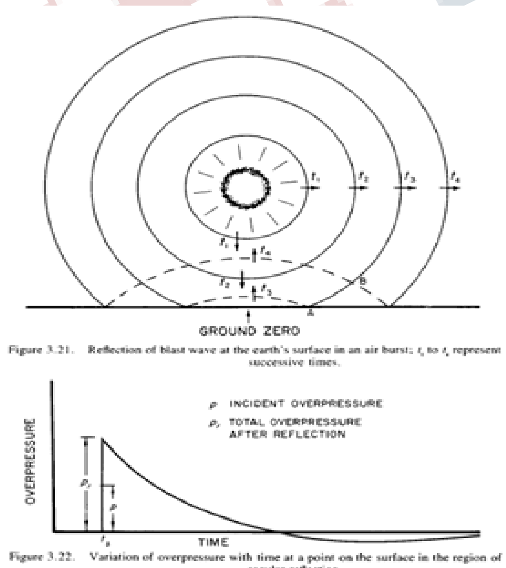

Fig4.1.1. Graph of overpressure

2 Thermal Effects

Thermal impact is another major effect. It occurs when a fireball, or a volume of hot gases, is generated. If the fireball impact and overpressure impact damage a structure’s fire-resisting system by knocking off columns, fire coating, and intense heat from the explosion can weaken structural members, which can assist in the failure of those members, leading to potential localized or progressive collapse. Thermal energy can also injure people, and ignite variousObjects in a structure such as a furniture. The strength of the fireball is determined by the fuel mass, fireball diameter, duration of the fireball, and the thermal emissive power.

4.1.3 Energized Projectiles

Energized projectiles consist of fragments, debris, and missiles, which can strike structures and people, causing significant impact damage. These objects are thrown by the explosion with varying levels of force depending on the object, the object’s proximity to the explosion, and the explosion strength.

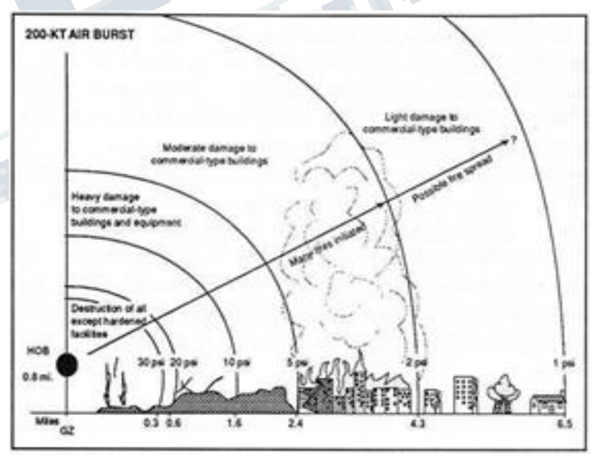

Fig 4.1.3 Thermal Impact

. Debris Damage

When an explosion occurs, debris and fragments are thrown through the air which causes severedamage to a structure. Fragments can be classified into two types: Primary or Secondary. Primary fragments are actually parts of the explosion container having a mass of around 1 gram,Which is thrown at high speeds when the explosion occurs. Secondary objects are either constrained or unconstrained objects (e.g. shards from windows) which are thrown by the

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)

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Explosion. Their velocity and trajectory depend on their shape, size and the strength of the constraint. The damage caused by these objects depend on their velocities, the distance between their initial location and the target, angle of incidence and physical properties of the fragments and the target.

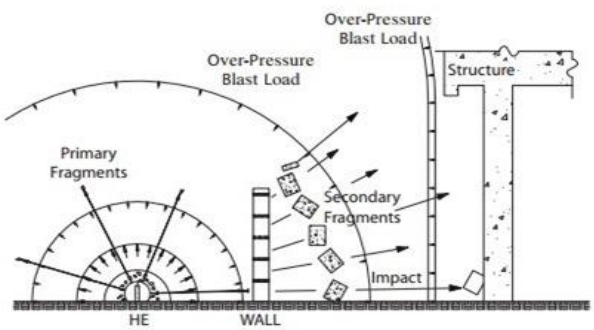

Fig4.1.1 Debris and broken fragment

2 Applying of Blast Load

Initially, the structure is design to resist the live load and dead load and also the wind loads.Blast loads apply on the structure at a distance for a charge of 100kg TNT. The minimum distance at which the building system tends to be estimated. The responses (story displacement and story shear) of the building at their critical distance are studied. Blast load generated from a weapon charge of 100kg TNT is estimated for the distance of 30m away from the building. Loads can be calculated for each and every joint front face of where blast is occurring. The load is applied as blast load time triangular function to the structure. shows the overpressure and time duration at different standoff distance of beam column joints. Each structural element blast pressure is assuming to acting unit area. Pressure is multiplied with unit area to obtain corresponding blast pressure for particular standoffdistance. Blast load is defined as triangular time history function in SAP2000.

3 Explosions

Explosive is widely used for demolition purposes in: military applications, construction or development works, demolitions, etc. It is, also, a very common terrorist weapon as it is available, easy to produce, compact and with a great power to cause structural damage and injuries.

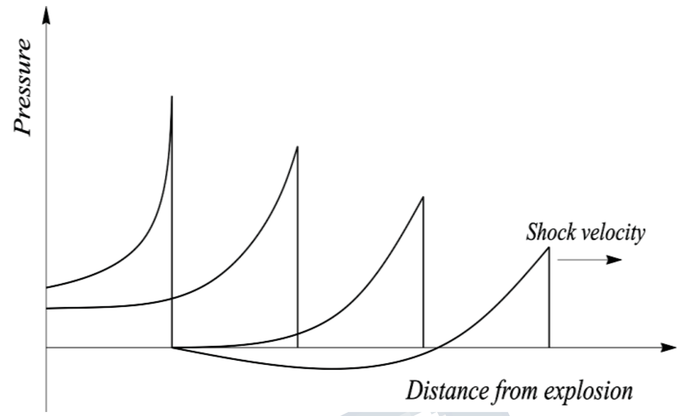

Fig 4.3.1 variation of blast pressure with distance

Their are two types of explosions are :
a)Confined explosion
b)Unconfined explosion

a) Confined explosions

If the explosion occurs inside the structure, the peak pressures associated with the initial wave fronts are extremely high They are enhanced by the refraction within the structure.

b)Unconfined explosions

The open air explosion causes a wave that spreads from the source of detonation to the structure without any wave amplification. These explosions are situated at a given distance and height away from the structure and ground before it contacts the structure. The height limitations of these explosions are two to three times of the height of a one-story or two-story structure. The explosion near the ground is an explosion occurring near or on the ground and the initial pressure is immediately increased as a result of refraction on the ground.

Equation

blast load equation is stated as follow

$$p(\tau) = pr \times \cos 2\theta + pi \times [1 + \cos 2\theta - 2\cos\theta]$$

Methodology

- Dispersion analysis & Determine the explosion Scenarios.

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- CFD Analysis- FLAS output data.
- Data analysis (automation sorting and processing)
- Classify the best load parameter overpressure. Impulse)
- Extraction of idealized blast load.
- Grouping of target area and analysis for blast load data.
- FE analysis (Unified single load and group loads).
- Investigation of structural response (displacement

Behavior, accumulate plastic strain.) & Assessments complete.

Step 1: Determine the weight of the charge, W, charge Distance of the structure, *R*G, charge height, Hc (for Explosions in air) and structural dimensions.

Step 2: Apply safety factor of 20 %.

Step 3: Select several points on the structure (front Facade, roof, side and rear surface) and determine the Explosion parameters for each selected point.

For the explosion near the ground:

a) Determine the scaled charge distance:

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

b) Determine the explosion's parameters using for the calculated scaled distance *Z*G and read:

– peak initial positive overpressure *p*s0

– wave front speed *U*

– scaled initial positive impulse *is*/*W*1/3

– scaled length of the positive phase *t*0/*W*1/3

– scaled value of the wave arrival *t*A/*W*1/3.

Multiply the scaled value with the value of *W*1/3 in order to obtain the absolute values

Step 4: For the front facade:

a) Calculate the peak positive refracted pressure *prα*=*Crα*·*p*s0 and read the coefficient *Crα* for *p*s0 from Figs 2 ÷ 193, from [6].

b) Read the value of scaled positive refracted impulse *irα*/*W*1/3 from Figs. 2 ÷194 (b), from [6] for *p*s0 and *α*. Multiply the scaled value with the value of *W*1/3 in order to obtain the absolute value,

Step 5: Determine the positive phase of the load on the front facade:

a) Determine the speed of sound in the area of refracted overpressure*Cr* using Figs. 2 ÷ 192, for the peak overpressure *p*s0.

b) Calculate the "clearing" time *t*c

$$t_c = \frac{4S}{(1+R)\cdot C_r}$$

c) Calculate the fictitious length of the positive phase tof

$$t_{of} = \frac{2i_s}{p_{s0}}$$

d) Determine the peak dynamic pressure *q*0 from Figs. 2 ÷ 3, from [6] for *p*s0.

e) Determine *p*s0 + *C*D·*q*0. *C*D from Tab. 4.

f) Calculate the fictitious length *t*rf of the refracted pressure

$$t_{rf} = \frac{2i_{r\alpha}}{p_{r\alpha}}$$

g) Define the pressure-time history curve for thepositive phase. The real load is smaller than the valueof impulse pressure due to the refracted pressure (areaunder the curve) or the purified refracted pressureimpulse of the initial pressure.

Step 6: Determine the negative loading phase on thefacade. Read the value of *Z* from Fig. 5 for *prα* accordingto Step 4a) and *irα*/*W*1/3 according to Step 4b).

a) Determine *prα*¯ and *irα*¯/*W*1/3 from Fig. 5 for the valueOf *Z* according to Step 6a). Multiply the scaled valueOf the negative impulse with *W*1/3 in order to obtain anAbsolute value.

b) Calculate the fictitious duration of negative refracted Pressure

$$t_{rf}^{-} = \frac{2i_{r\alpha}^{-}}{p_{r\alpha}}$$

c) Calculate the negative phase time increase by Multiplying the *t*rf¯ with 0, 25.

d) Define the pressure-time history curve for the Negative phase of the load.

Step 7: Determine the positive loading phase on the side Surfaces:

a) Determine the ratio of the wavelength and the range Of *L*wf/*L*.

b) Read the values of *C*E, *t*d/*W*1/3, *t*of/*W*1/3 from Figs. 2 ÷ 196, 2 ÷ 193 and 2 ÷ 194(b), from [6] (peak incident Overpressure × 0,0689 bar).

c) Read *p*R, *t*r, *t*0.

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d) Determine the dynamic pressure *q*0 from Figs. 2 ÷ 3 From [6] using *ps*0.

e) Calculate pR= *CE*·*p*sof + *CD*·*q*0 and determine theCoefficient *C*D according to Tab. 4.

f) Define the pressure-time history curve for thePositive loading phase.

Step 8: Determine the negative loading phase:

a) Determine the values of *CE*¯ and *tof*¯/*W*1/3 for theValue of *L*wf/*L* according to Step 7a) from Figs. 2 ÷196 and 2 ÷ 198, from [6].

b) Calculate *p*R= *CE*·*p*sofit0f.

c) Calculate the negative phase time increase byMultiplying the *t*0f with 0,25.

d) Define the pressure-time history curve for theNegative loading phase.

Step 9: Determine the load on the roof surface byApplying the *Steps* for the side surfaces.

Step 10: Determine the load on the rear surface byApplying the procedure given for the side surfaces and byAssuming that the rear surface is rotated to a horizontalPosition.

Result:

This elevation of blast building which are modeled in (SAP2000). The building generally constructed in medium soil we have to identify their peak pressure and Front face test,scaling test.

In this paper are done test such as:

a) Front Face Test
b) Scalling Test

a)Front Face Test:

The shock wave strike the vertical face of a structure normal reflection occurs and the pressure on the front face instantaneously increases to reflected overpressure p_r0 given by the way

Overpressure	Peak side on overpressure(W) p_{s0}	Peak reflected overpressure Ratio p_{r0}
	8.00	41.60
p_{r0}	5.00	27.50
	3.30	12.94
	2.40	8.48
	1.80	5.81
p_{r0}	1.40	4.20
	1.20	3.45
	1.00	2.75
	0.86	2.28
	0.76	1.97
p_{r0}	0.66	1.66
	0.59	1.46
	0.53	1.28
	0.48	1.14
	0.43	1.01
p_{r0}	0.40	0.93
	0.37	0.85
	0.34	0.77
	0.32	0.72
	0.30	0.67

Table5. 2.1 Front face test reflected overpressure

$$p_{ro=}p_{so}\left(2+\frac{6p_{so}}{p_{so}+7\,p_a}\right)\text{..eq1}$$

..from (IS4991- 1968) pg. no.11 cl no.6.2.1

Where,

$p_{a=}$the ambient atmospheric pressure. Taking $p_{a=}1$ Kg/cm^2,the value of p_{ro} are given in Table 1(IS 4991:1968)

Now put the value in eq (1)

$p_{ro=}$?

$p_{so=}8$

$$p_{ro} = 41.6$$

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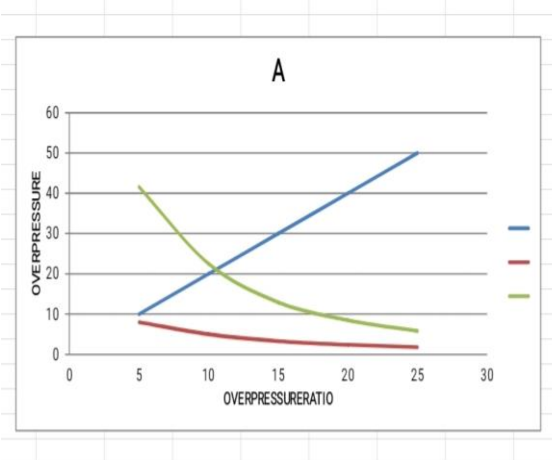
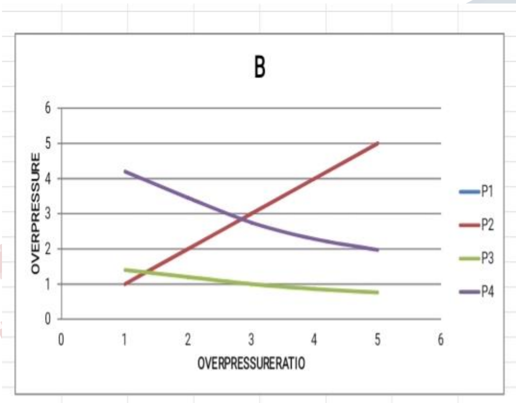
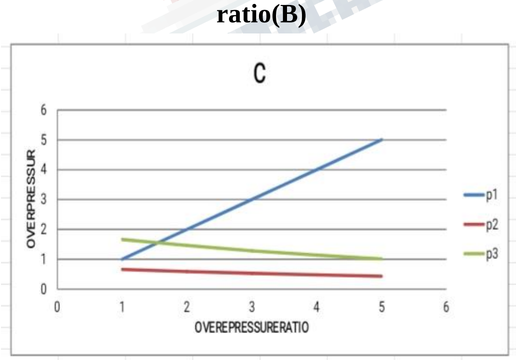
In same Process are done till end



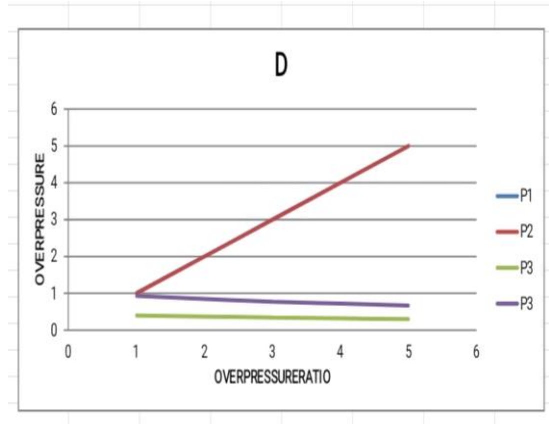
Graph 5.1.1Graph for overpressure v/s overpressure ratio(A)



Graph 5.1.2 Graph for overpressure v/s overpressure ratio(B)



Graph 5.1.3 Graph for overpressure v/s overpressure ratio(C)



Graph 5.1.4 Graph for overpressure v/s overpressure ratio(D)

Scaling Test:

For any explosion other than the reference explosion, the peak pressures and time durations may be found from the peak values given in Table 1 by the cube root scaling laws as given below (IS4991.1968)

Peak Pressure and Time Duration:

scale distance(x) = (actual distance)/W^(1⁄3)

scale distance(x) $=\frac{actual\ distance}{W^{1/3}}$

from (IS4991-1968)

pg. no.11

where,

W=yeild of exposition weight of the reference explosive measured in tonnes

One tonne of explosive referred to in this table is equivalent to 1.5×10^{9}calories

x=Scale distance

$$15=\frac{x}{1.5\times 10^{9}}$$

x= $27.05m$

In same process done at till end

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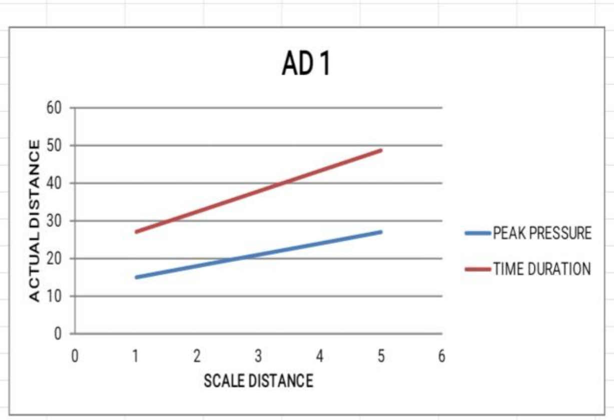
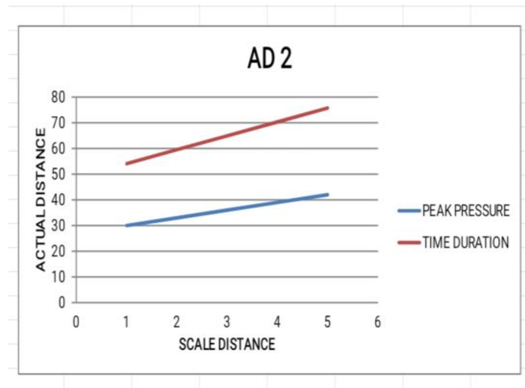
	scale distance(x)m	Actual distance(m)
AD 1	15	27.05
	18	32.46
	21	37.87
	24	43.28
	27	48.70
AD 2	30	54.11
	33	59.52
	36	64.93
	39	70.34
	42	75.75
AD 3	45	81.16
	48	86.57
	51	91.99
	54	97.40
	57	102.81

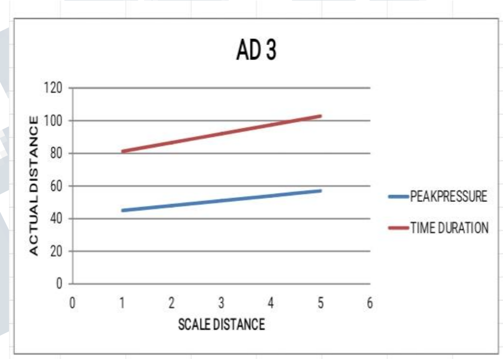
Table 5.4.1 peak pressure and time duration (Distance)



Graph 5.4.1.Graph for Actual distance v/s scale distance (AD1)



Graph 5.4.2.Graph for Actual distance v/s scale distance (AD2



Graph 5.4.3.Graph for Actual distance v/s scale distance (AD3)

CONCLUSION AND FUTURE SCOPE

The Present study of this paper a G+3 RCC building is analyzed for blast load for 100kg TNT placed at a distance of 3m from the point of explosion. Blast load in each point was calculated from IS 4991-1968 and nonlinear time history is carried out of finite element analysis software SAP2000. After nonlinear dynamic analysis structure subjected to blast load, following conclusion were drawn.

1. Variation of displacement is non uniform along the height of building and earth earthquake and wind (building is not behaving as cantilever structure under blast load).

2. Minimum standoff distance performance level of structure is reached to collapse. Much load will be acting on the near beam column joints.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
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