Blast loading on Regular and Irregular RCC Building

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Abstract - *Multi-storey buildings construction by Reinforced Concrete are Subjected to most hazardous seismic waves during earthquakes. The main reason found that RCC building failure is produced due to Irregularity in its plan dimension and lateral force distribution. So, it is important factor to study the effect of blast loading on plan regularity and irregularity. The effects of blast loading on various buildings with regular shape plan and having irregular plan are analyzed for same blast loads and the results were determined. The same blast loads are applied on various models in ETABS using time history analysis. The blast loading on regular and irregular plan shapes RCC buildings was done by using force time history method. The blast analysis was performed and the results were compared for regular and irregular buildings. Analytical modelling was also carried out and finally conclusion was made by using obtained results.*

Key Words: SIMCON, RCC, Blast Loading, Irregular Plan, ETABS,

1. INTRODUCTION

In the previous few years, a structure subjected to blast load added importance due to accidental events or natural events. Mostly conventional structures are not designed for blast load due to the cause that the magnitude of load produced by blast is huge and, the cost of design and construction is very high. Earthquake and wind loads are not applied due to analysis with blast loads because probability of occurring all the three at a time is negligible.

The blast load of 100Kg of TNT (Tri Nitro Toluene) are applied on the structures. The blast loads are calculated by assuming 100 Kg of TNT which is at 40m away from the building and 1.5m above the ground level from center of building by using IS:4991-1968 for every beam column joint that varies with time intervals. The distance for each beam-column joint varies from the main building (source) which are calculated manually by using two-point formula, considering blast source at a point (0, 1.5, 0) at center. The scaled distance is calculated by using above distances and charge weight using following formula.

Scaled distance (m) = Actual distance / Charge weight in tone

The corresponding values of Pro, Pso, tr, td, to are taken from Table 1 of IS:4991-1968, Cl.5.2 for calculation of blast loads. The decrement of blast load varying with every 5 milli-seconds is calculated by using the following equations-

$$P_s = P_{so}\,(1-(t/t_0))\,e^{-t/t_0}$$

$$q = q_o\,(1-(t/t_0))\,e^{-2t/t_0}$$

where, Ps is side-on over pressure

Pso is peak side-on over pressure

to is time for positive phase of side on over pressure

td is time at present q is dynamic pressure

qo is peak dynamic pressure

The peak pressure is developed when the blast waves strike the surface of the building which is perpendicular to the direction of propagation of the wave and gradually decreases to zero. The Peak side-on over pressure develops when blast waves does not have obstruction in their direction of propagation of wave but develop the drag force on the members and the pressures obtained in Table 1 of IS:4991-1968 are converted into force by multiplying with area contributing to beam column joint are acting on front face of the building.

2. Analytical modelling of the G+5 buildings having regular and irregular structures subjected to blast loading.

Model Description:

No. of Stories = G+10

Plan Dimensions = 18 X 22m

Floor to Floor height = 3m

Column Size = 600 X 600mm

Beam Size = 300 X 600mm

Slab Thickness = 125mm

Grade of Concrete & Steel = M35 &

Fe500

Models:

Model 1 - G+5 building with regular plan

Model 2 - G+5 building with irregular plan 1

Model 3 - G+5 building with irregular plan 2

Loading Data:

Dead Load: 4KN/m2 For Slabs

9.38KN/m2 for beams.

Live Load: 2KN/ m2 for slabs

1.5KN/ m2 for top slab

Blast Load: Calculated manually as per IS:4991-1968

Load Combinations:

1.5 (DL + LL)

1.2 (DL + LL)

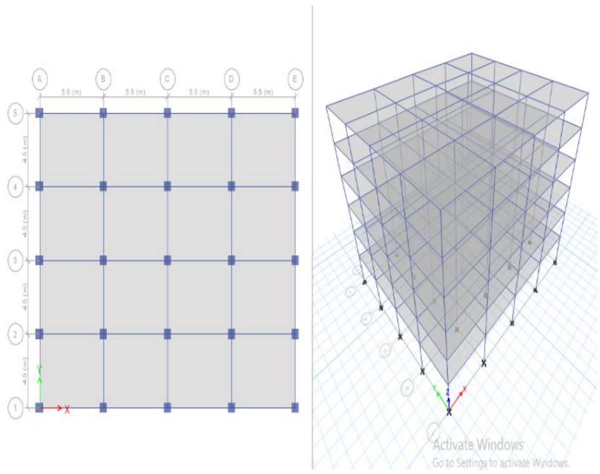

Fig.2.1: Plan and 3D view of Model 1

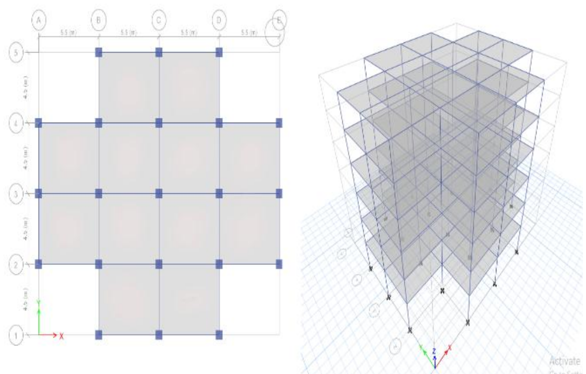

Fig.2.2: Plan and 3D view Model 2

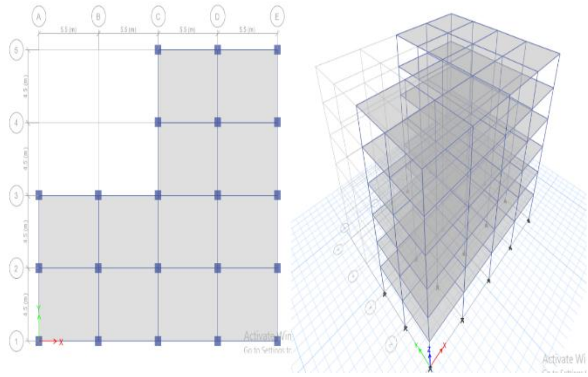

Fig.2.3: Plan and 3D view Model 3

The above figures show the plan and 3D elevation of typical analytical model of G+5 RCC buildings having plan regularity and plan irregularity which are used for the study.

2.1 Result discussion for analysis of the G+5 buildings having regular and irregular plans subjected to blast loading.

2.1.1 Modal Time Period

Table 1.2.1: Modal Time Period Values

Mode	Model 1	Model 2	Model 3
1	0.729	0.796	0.991
2	0.679	0.744	0.917
3	0.619	0.668	0.854
4	0.213	0.226	0.260
5	0.201	0.214	0.245
6	0.184	0.194	0.226

The modal time period for 6 various modes is observed and listed. The time period for model 01 is less than other two models. This shows that the model 01 is more stiff than other two models. So, it is seen that the irregular shape building has more modal time period and that are not much stiffer building structures.

2.1.2 Storey Displacement

Joint displacement for all the three models were compared with each other. It is seen that the joint displacement of model 02 and model 03 are greater than model 01. So, the model 01 is more stable structure than other two models. i.e. the buildings with irregular plan are not stable during blast.

The joint displacement is observed maximum at model 02 and it is maximum at top storey and minimum at bottom storey. So, it shows that, the irregular buildings are not stable during blast loading. Hence cause more damages to the building structure.

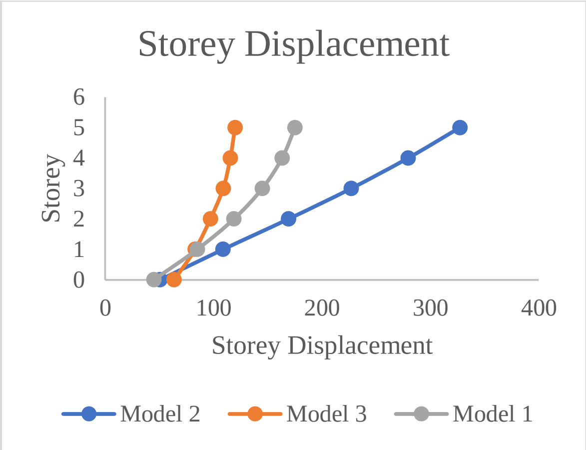

Fig.2.1.2.1: Graph for Joint Displacement

2.1.3 Storey Drift

Storey drift is observed maximum for model 02 and minimum for model 01. The maximum value of storey drift is found at 2nd storey.

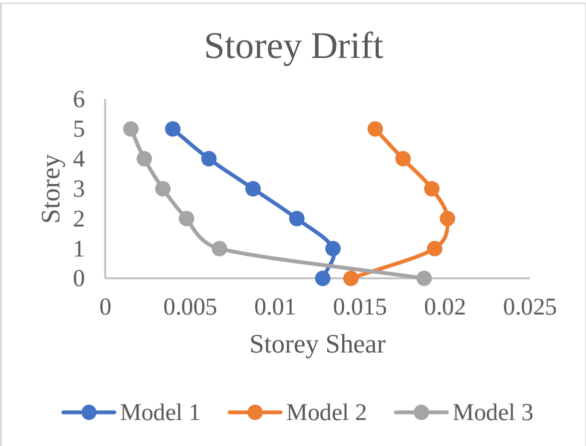

Fig.2.1.3.1: Graph for Storey Drift

The curve shows that the values of storey drift goes on increasing up to 2nd level and again goes on decreasing slightly towards top floor. This shows that, the irregular buildings are not stable during blast loading and causes more damage to the structure.

2.1.4 Base Shear

The storey shear for each storey of G+5 building is calculated. The maximum storey shear is observed at the base storey and minimum at top storey. The values for storey shear go on deceasing from bottom storey to top storey. The base shear obtained from pushover analysis is maximum for model 01 as compared with other two models of irregular structure. As the base shear value of regular model is more, it indicates that, the building is stiffer.

3. Conclusions

- A regular RCC bare frame provides somewhat of a higher-level resistance to blast loading than irregular structure. Geometric irregularity has an impact on the structure subjected to blast. All structure types perform better when the source of the blast was on the side of the setback.
- In this study it is found that the most optimum model is regular frame which shows the lowest value of storey drift and the structure is very good in lateral stability against blast load. Therefore, for economical design consideration the column size can reduce.
- The most vulnerable structure is irregular frame which shows highest value of storey drift of 16.5mm which is exceed the storey drift limitation as per IS 1893 (part -1) the storey drift which shall not exceed 0.004 times the storey height.
- There is no significant effect on the upper floor because of low intensity of pressure on the upper floor due to increase of standoff distance from bottom floors to upper floors, therefore increase of standoff distance will reduce pressure on the upper floors.

4. References

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