Blast Assessment of Load Bearing Reinforced Concrete Shear Walls

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Abstract— Assessment of a structure's blast capacity has become an important focus in structural engineering. In response to heightened terror awareness numerous existing structures must be evaluated for conformance with security standards. Determining the blast resistance of a structure is a first step towards evaluating the potential need for retrofit construction. Numerous methods can be employed to determine the blast resistance of a structure, oftentimes over-simplified or too complex. A common lateral load resisting system that is particularly vulnerable to blast loads is a reinforced concrete shear wall. The purpose of this paper is to see the variation in storey deflection and storey drift under the effect of blast over the structure with or without the shear wall and when the shear wall is at different position with respect to the blast direction.

Keywords: Shear wall, Standoff Distance, Blast Yield, Storey Displacement, Storey Drift

I. INTRODUCTION

Blast explosions have become more dreadfully common all over the world due to terrorism and other human activities. Apart from the obvious danger posed on lives and properties whenever blasts occur, a worrisome ambiguity seems to exist in fully reporting blast induced threats. Only agreeable threat levels are arrived at after a detailed load assessment. There is therefore need for engineers to be provided with detailed experimented and simulated data in order to mitigate the alarming trend of loss during blast explosion.

When considering mitigation measures for explosive blast threats, the primary strategy is to keep explosive devices as far away from the building as possible (maximize stand-off distance). This is usually the easiest and least costly way to achieve a desired level of protection. In cases where sufficient stand-off distance is not available to protect the building, hardening of the building's structural systems may be required, as well as design to prevent progressive collapse.

A. *Type of Case Analyzed*

1) Case 1: Without infill structure with no shear wall
2) Case 2: Structure with 150 mm thick shear wall at face perpendicular to blast loading face
3) Case 3: Structure with 150 mm thick shear wall at face parallel to Blast loading face
4) Case 4: Structure with 150 mm thick shear wall at all four faces

In above all three cases blast load is applied of 300kg TNT at 30m standoff distance.

II. STRUCTURAL MODELING

A G+3 storey symmetrical models have been made in Etabs 2015. Model is 12m x 12m in plan and height of building is 14m. Height of each storey is 3.5m and height of plinth is 1.5m.Beam having size of 300x400mm and column having size of 450x450 mm have been provided. Slab of 200mm thickness have been provided. Shear wall of thickness 150mm is provider. Grade of steel and concrete are fe500 and M30 respectively.

1) *Case 1: Without infill structure with no shear wall*

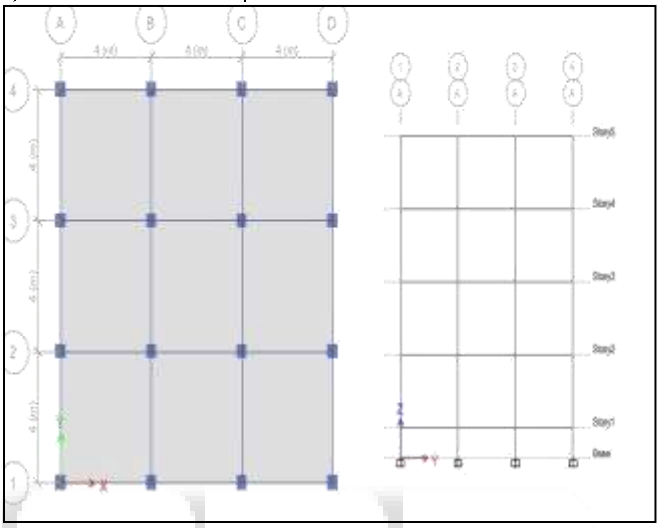


Fig. 1: Plan and elevation of model

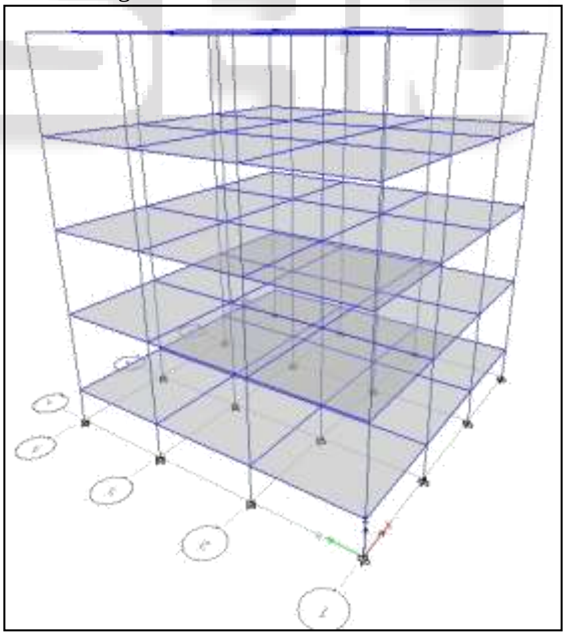


Fig. 2: 3D view of model

2) *Case 2: Structure with 150 mm thick shear wall at face perpendicular to blast loading face*

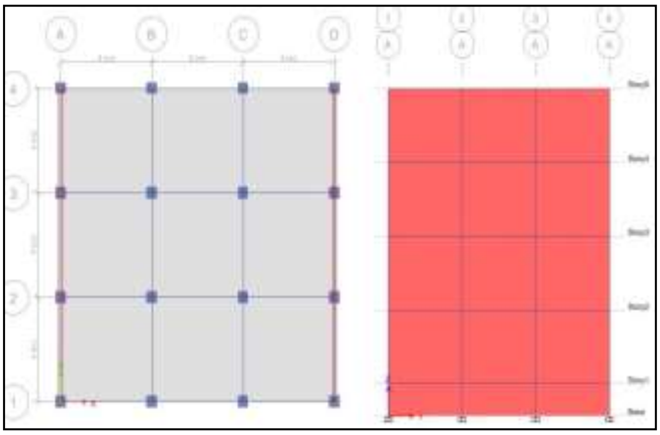


Fig. 3: Plan and elevation of model

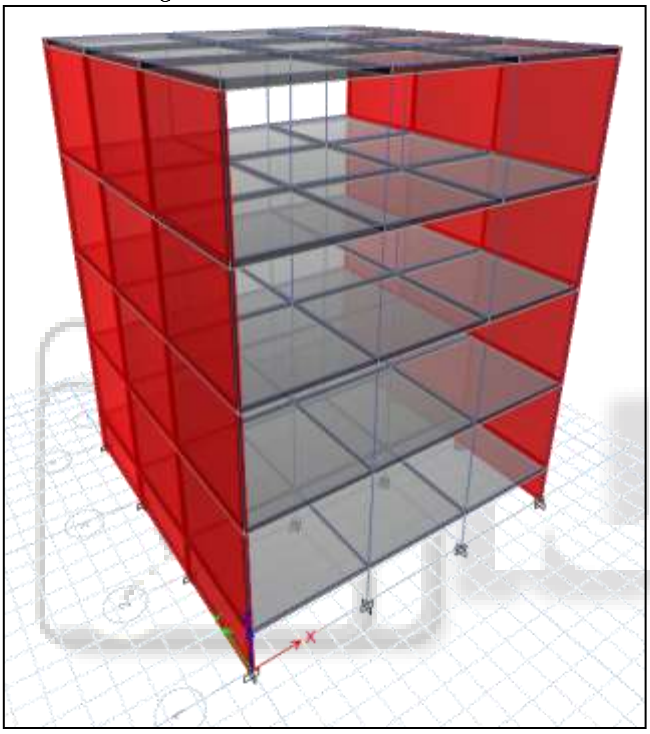


Fig. 4: 3D view of model

3) Case 3: Structure with 150 mm thick shear wall at face parallel to Blast loading face

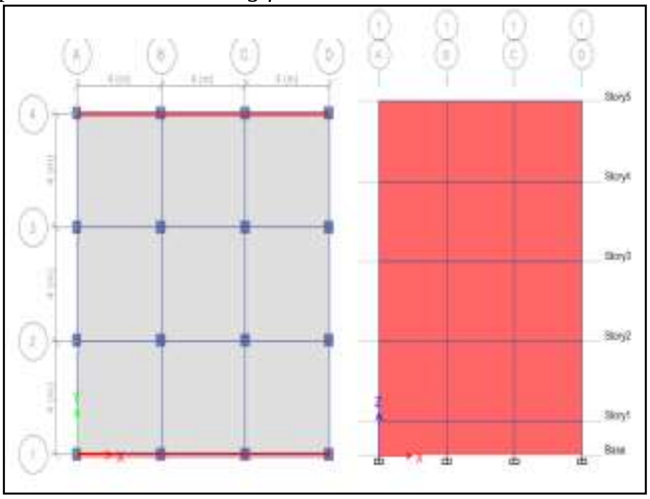


Fig. 5: Plan and elevation of model

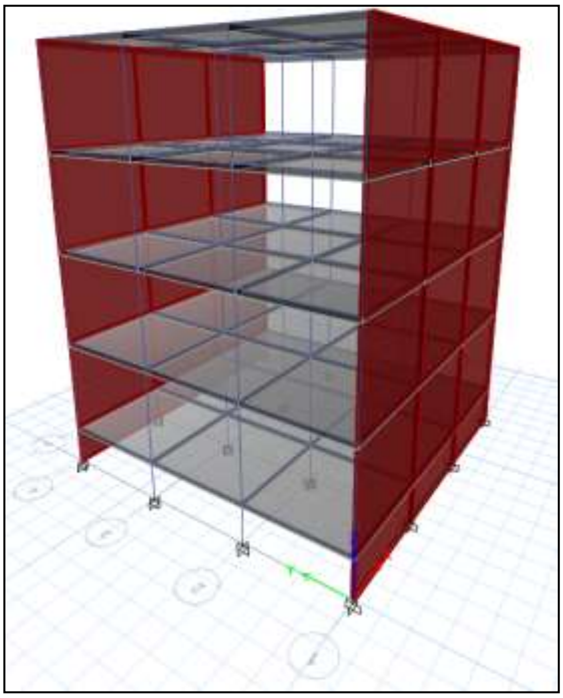


Fig. 6: 3D view of model

4) Case 4: Structure with 150 mm thick shear wall at all four faces

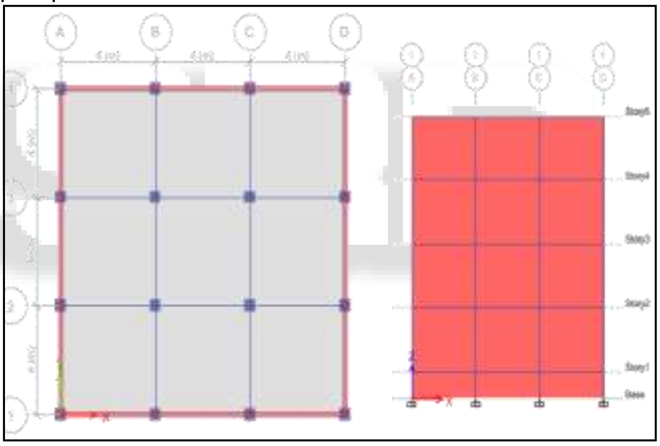


Fig. 7: Plan and elevation of model

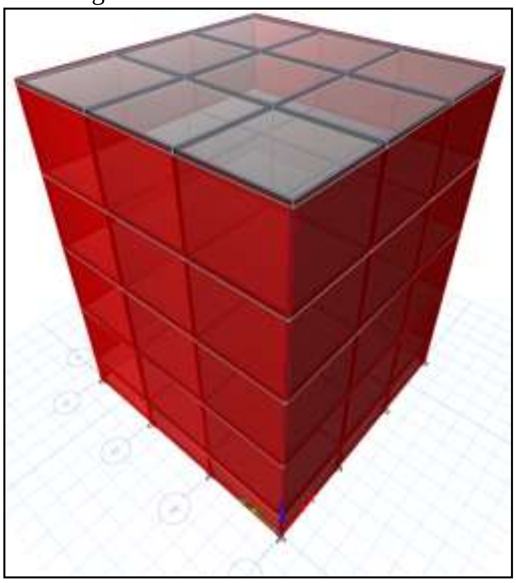


Fig. 8: 3D view of model

III. TYPE OF LOADS APPLIED ON STRUCTURE

- Dead load (self-weight)
- Live load (3KN)
- Super imposed load (floor loads) (1KN)
- Blast loads (according to IS 4991-1968 code) (300 kg TNT at 30 m standoff distance)

1) Case 1: Without infill structure with no shear wall

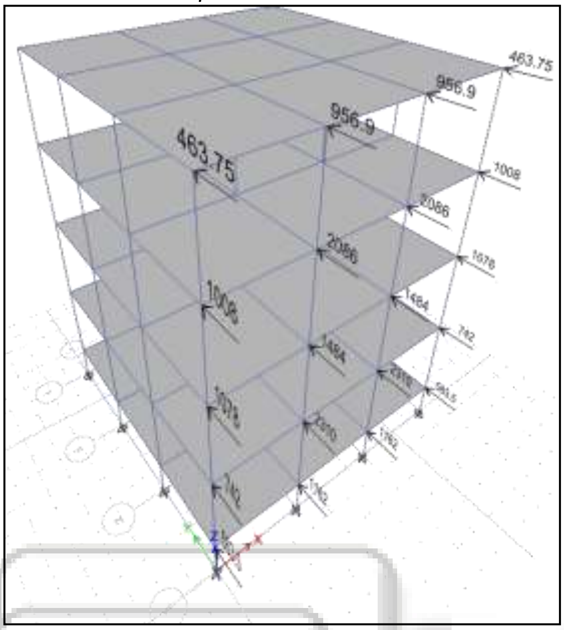


Fig. 9: Blast load applied over the structure

2) Case 2: Structure with 150 mm thick shear wall at face perpendicular to blast loading face

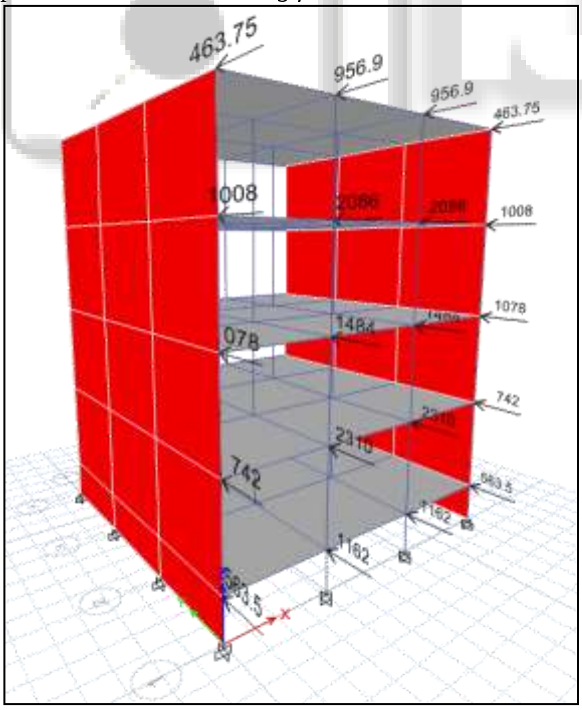


Fig. 10: Blast load applied over the structure

3) Case 3: Structure with 150 mm thick shear wall at face parallel to Blast loading face

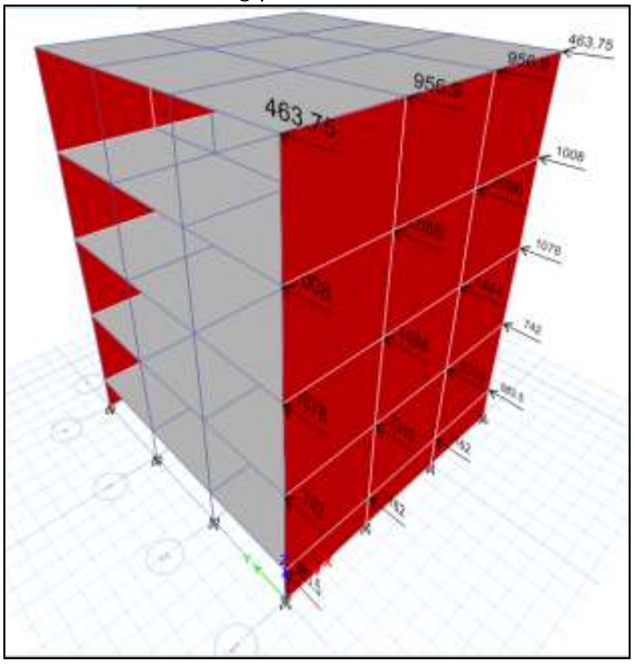


Fig. 11: Blast load applied over the structure

4) Case 4: Structure with 150 mm thick shear wall at all four faces

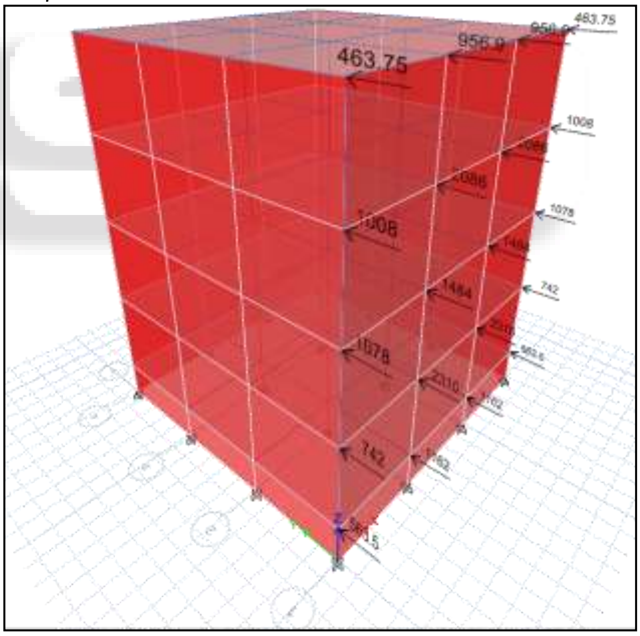
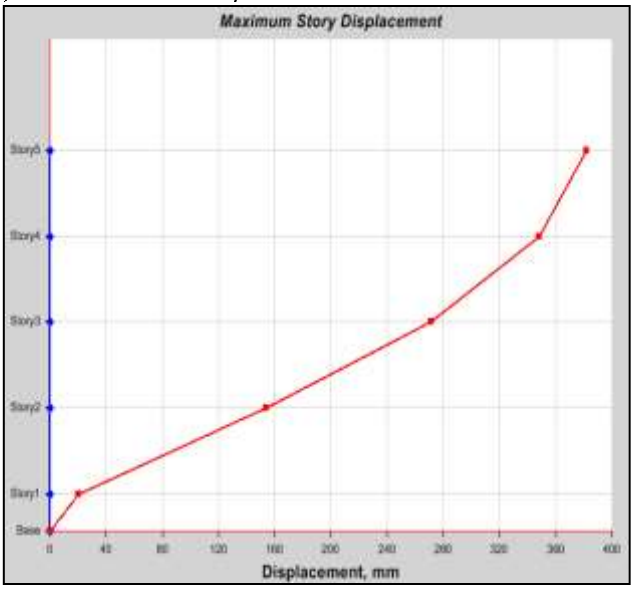


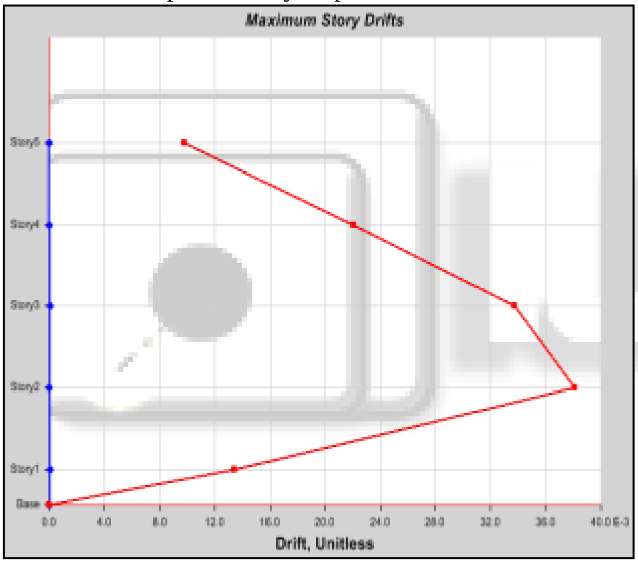
Fig. 12: Blast load applied over the structure

IV. ANALYSIS RESULTS

1) *Case 1: Without infill structure with no shear wall*

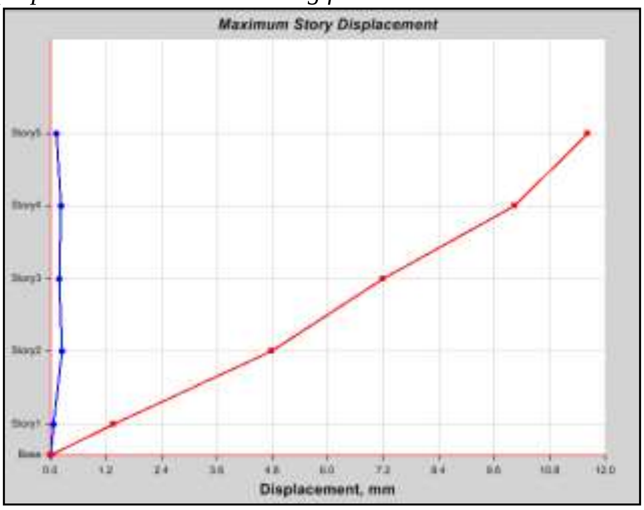


Graph 1: Storey displacement curve

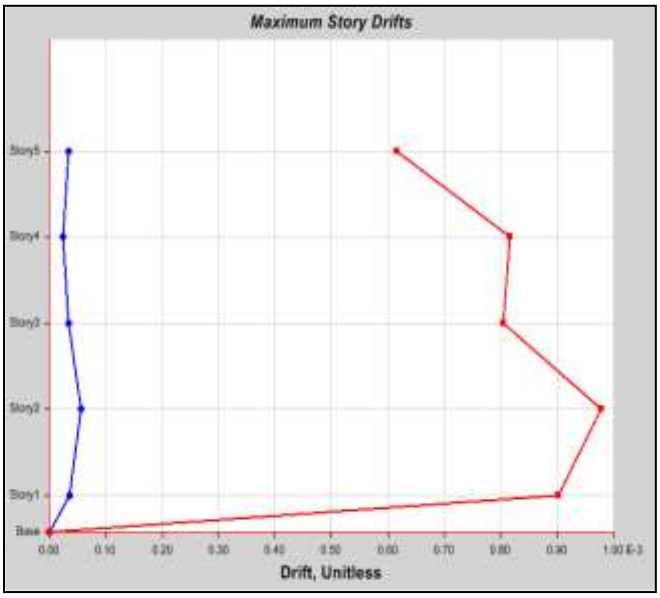


Graph 2: Storey drift curve

2) *Case 2: Structure with 150 mm thick shear wall at face perpendicular to blast loading face*

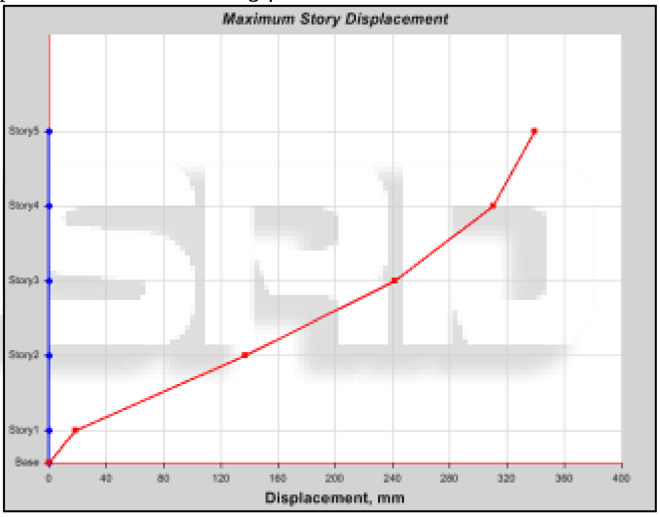


Graph 3: Storey displacement curve

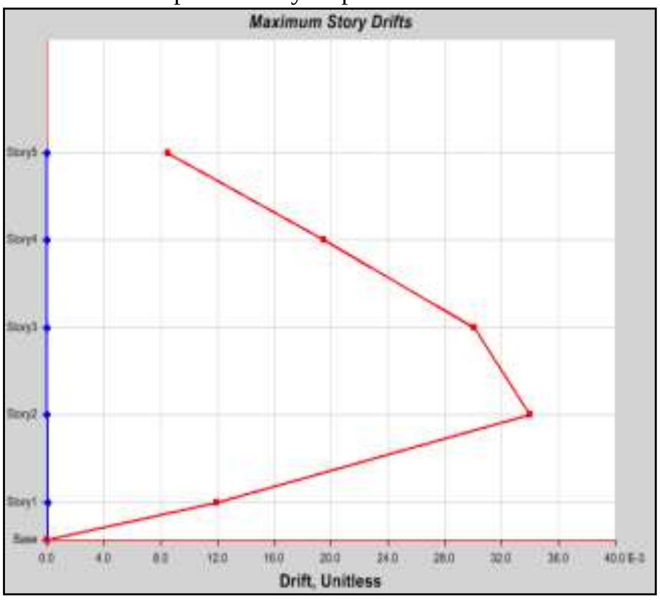


Graph 4: Storey drift curve

3) *Case 3: Structure with 150 mm thick shear wall at face parallel to Blast loading face*

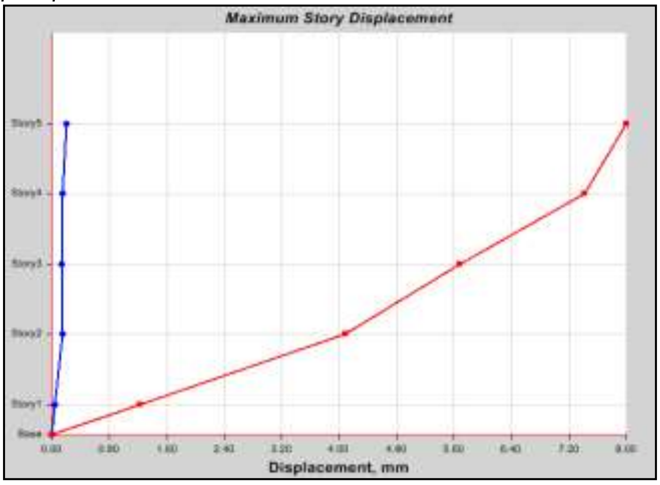


Graph 5: Storey displacement curve

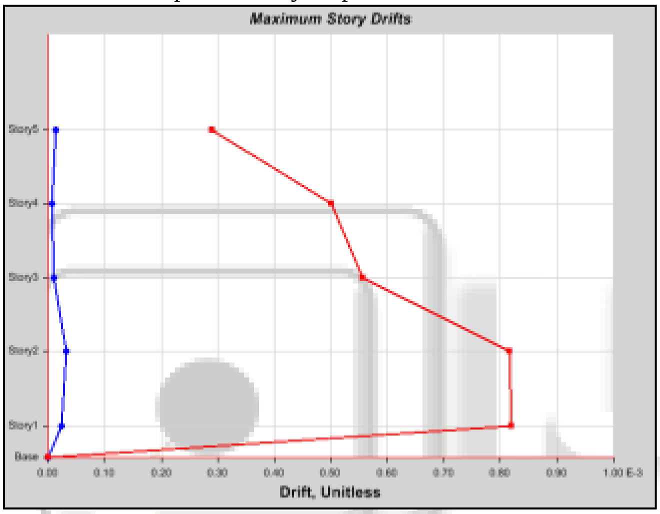


Graph 6: Storey drift curve

4) Case 4: Structure with 150 mm thick shear wall at all four faces



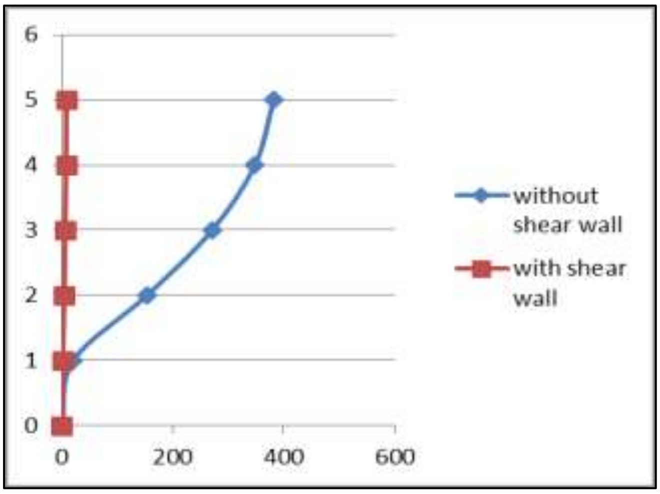
Graph 7: Storey displacement curve



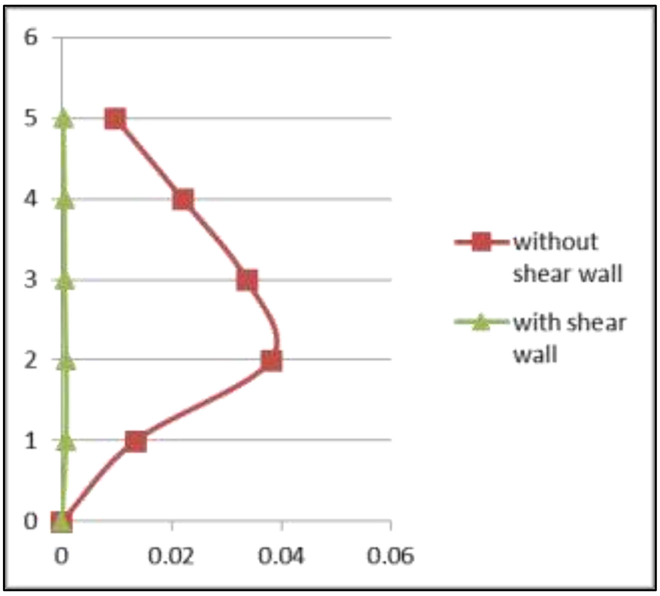
Graph 8: Storey drift curve

V. Variation in Storey Displacement and Storey Drift with or without Shear Wall and Also with Change in Position of Shear Wall with Raepect of Explosion Direction

A. Variation in storey displacement and storey drift with or without shear wall at all four faces

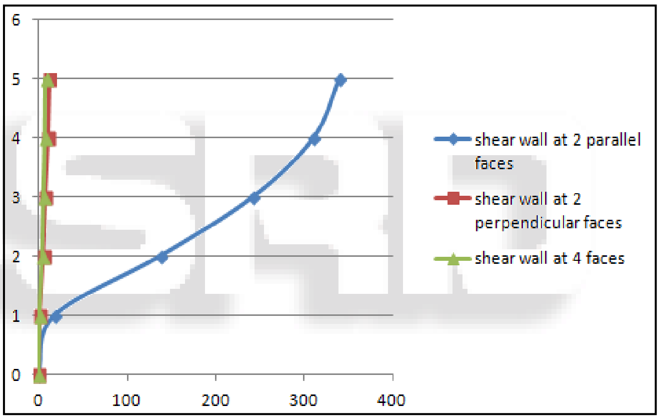


Graph 9: Variation in storey displacement

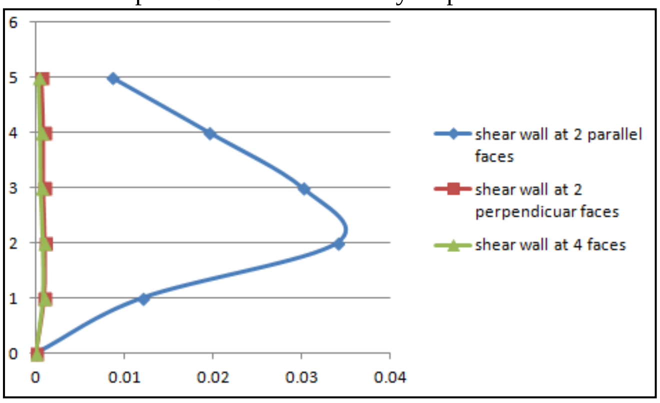


Graph 10: Variation in storey drift

B. Variation in storey displacement and storey drift when shear wall is provided at different faces with respect to blast loading face



Graph 11: Variation in storey displacement



Graph 12: Variation in storey drift

VI. Conclusion

From a thorough analysis of reinforced concrete structure exposed to blast load, it can be drawn as a conclusion that structure designed for normal loads are not safe when it exposed to an explosion. For the safety of civilians and for the valuables, the important structures should be analyzed by blast criteria given by IS 4991-1968.

Following conclusions can be made from the analysis:-

1) In without infill structure we if we provide 150 mm thick shear wall at two face perpendicular to the blast loading face without changing the yield of explosion and standoff distance maximum storey displacement are reduced drastically by around 97 %, and maximum storey drift reduced by around 96%.
2) In without infill structure we if we provide 150 mm thick shear wall at two face parallel to the blast loading face without changing the yield of explosion and standoff distance maximum storey displacement are reduced only by around 11.13 %, and maximum storey drift reduced by around 10.80 %.
3) In without infill structure we if we provide 150 mm thick shear wall at all four face without changing the yield of explosion and standoff distance maximum storey displacement are reduced by around 97.9 %, and maximum storey drift reduced by around 97.86 %.

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