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Comparative study of Preventive measures for Blast Loading on Existing Building components

(An Analysis Using Ansys Software)

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Abstract: Before this paper we already published one paper as "Preventive measures for blast loading on existing building components, An analysis using Ansys software " in the international journal of innovative Research in science, Engineering and Technology (IJIRSET) in the July volume 2022. Damages due to blast loading can be minimise upto some extent to save human lives using preventive measures such as fibre coating to the existing building components.
So comparative study of RCC material with and without fibre coating is presented for standoff distance 1000mm is presented in the paper published.
In this paper standoff distance is decreased, and taken as 750 mm to analyse response of beam to blast loading in a very short time duration is applied on the beam component made up of composite material as reinforced cement concrete, This response was analyse using finite element methods and software ANSYS.

Index Terms: Standoff distance, blast load, TNT, Aramid fibre, detonation point, scaling distance

INTRODUCTION

ANSYS, the finite element method software is useful to determine structural response calculations, for a short duration, blast load was applied using TNT of 50.64 kg as spherical load and detonation point at the center of beam, at standoff distance 750 mm for two cases first without coating of Aramid fibre and other with coating of Aramid fibre. It is already discussed in the paper published before it. Now for the same situation only standoff distance is minimise to study effect of standoff distance on the component.
This paper gives a idea about effect of blast load on the beam element in terms of stress, strain, deformation of the beam under blast loading as compare to the standoff distance 750mm.

ANSYS is general-purpose finite element software for numerically solving a wide variety of structural engineering problems. The ANSYS element library consists of more than 100 different types of elements. Reinforced concrete beam is modelled in CATIA V5 using top-down method. The models with and without Aramid fibres are created. Then they are imported to ANSYS for further analysis. The material properties, loads and boundary conditions are given to the model. It was inferred that explicit dynamics analysis enough to find the deflection of the structure under blast loading. Using this type of analysis, stresses, strains, and deformations of structures can be determined. The time varying displacement, stresses and strains can be easily obtained.

Example taken for analysis for blast loading is as below:

Beam specification:

1. Supports of beams: Fixed at the both the ends
2. Grade of concrete: M20
3. Grade of steel: Fe500
4. Diameter of reinforced main bars: 12 mm
5. Cross sectional dimensions of beam: 230 mm x 350mm
6. Span of the beam: 2.5 m
7. c/c spacing of stirrups: 150 mm c/c and 6 mm diameter
8. Thickness of Aramid fibre wrapped: 3 mm
9. Weight of Aramid fibre used for wrapping: 13 kg

Load specification:

1. Spherical type explosive load

Explosive specifications:

1. Explosive used: TNT
2. Detonation point: At the center of the beam.
3. Amount of TNT: 50.613 kg
4. Standoff distance: 750 mm

Environmental temperature: 22˚C

Air volume: It is taken by bounded box 390 mm x 1369.2 mm x 2500mm

Cases: a) Reinforced cement concrete beam of grade M20 and steel Fe500 without Aramid fibre and at scaled distance 750 mm.

b) Reinforced cement concrete of grade M20 and Fe500 with aramid fibre coating and at scaled distance 750 mm.

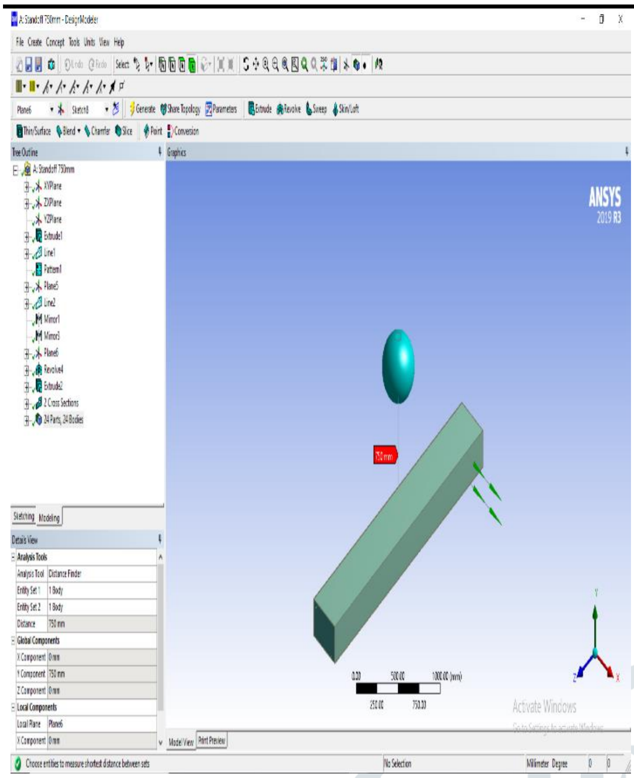

Figure 1. Beam with spherical TNT for blast load

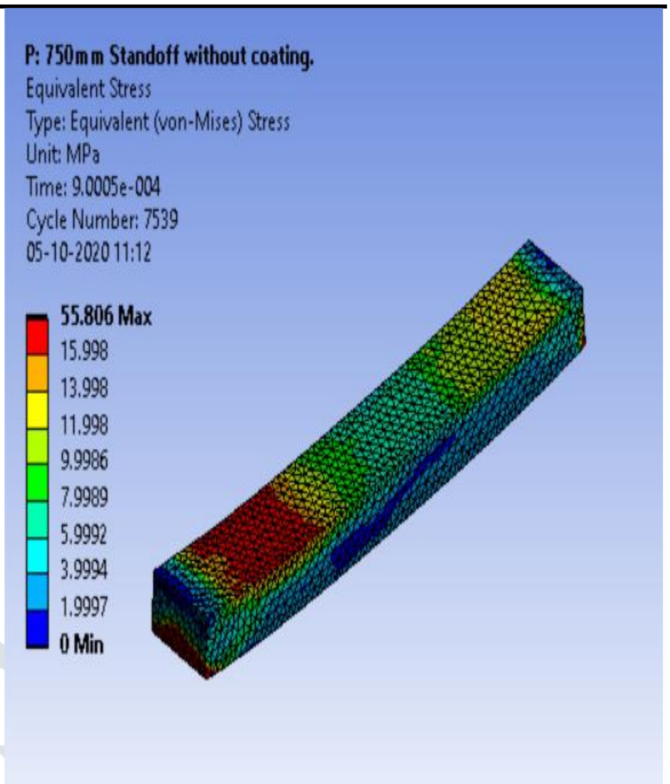

Figure 2. Stress Variation

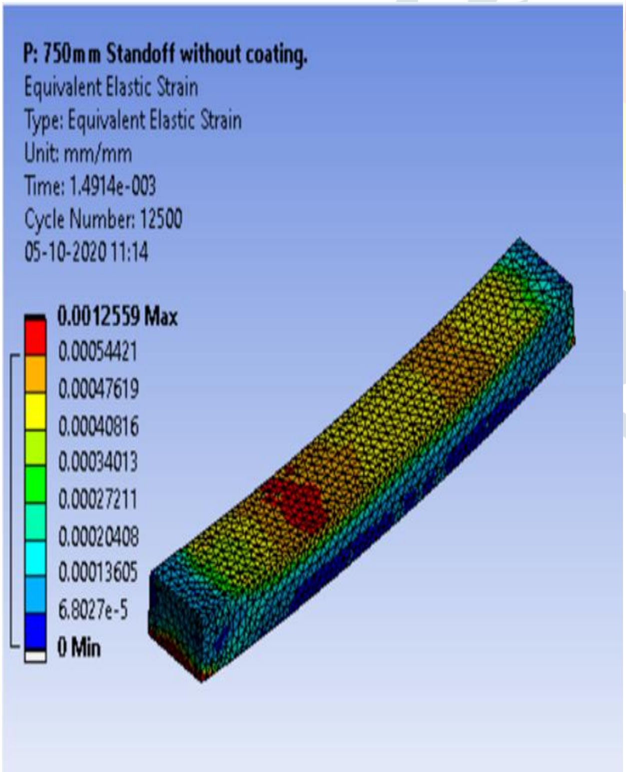

Figure 3. Strain variation

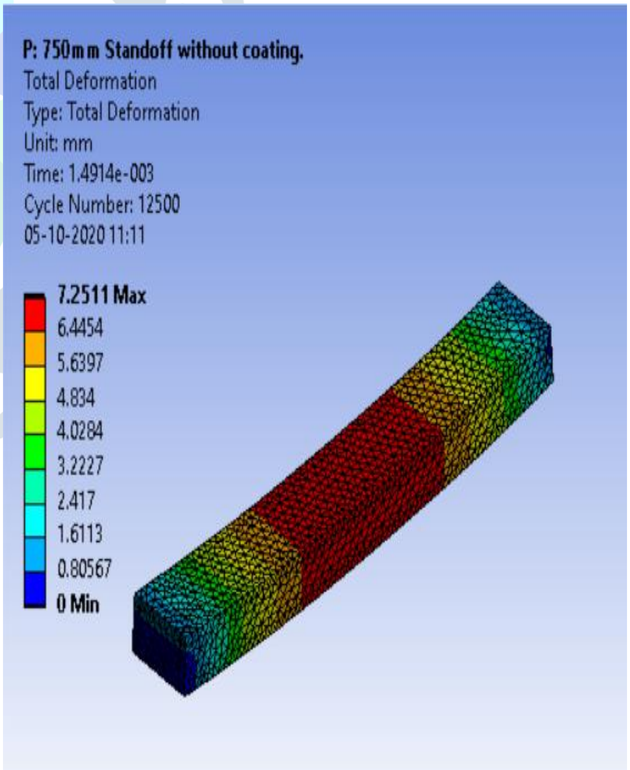

Figure 4. Deformation in concrete

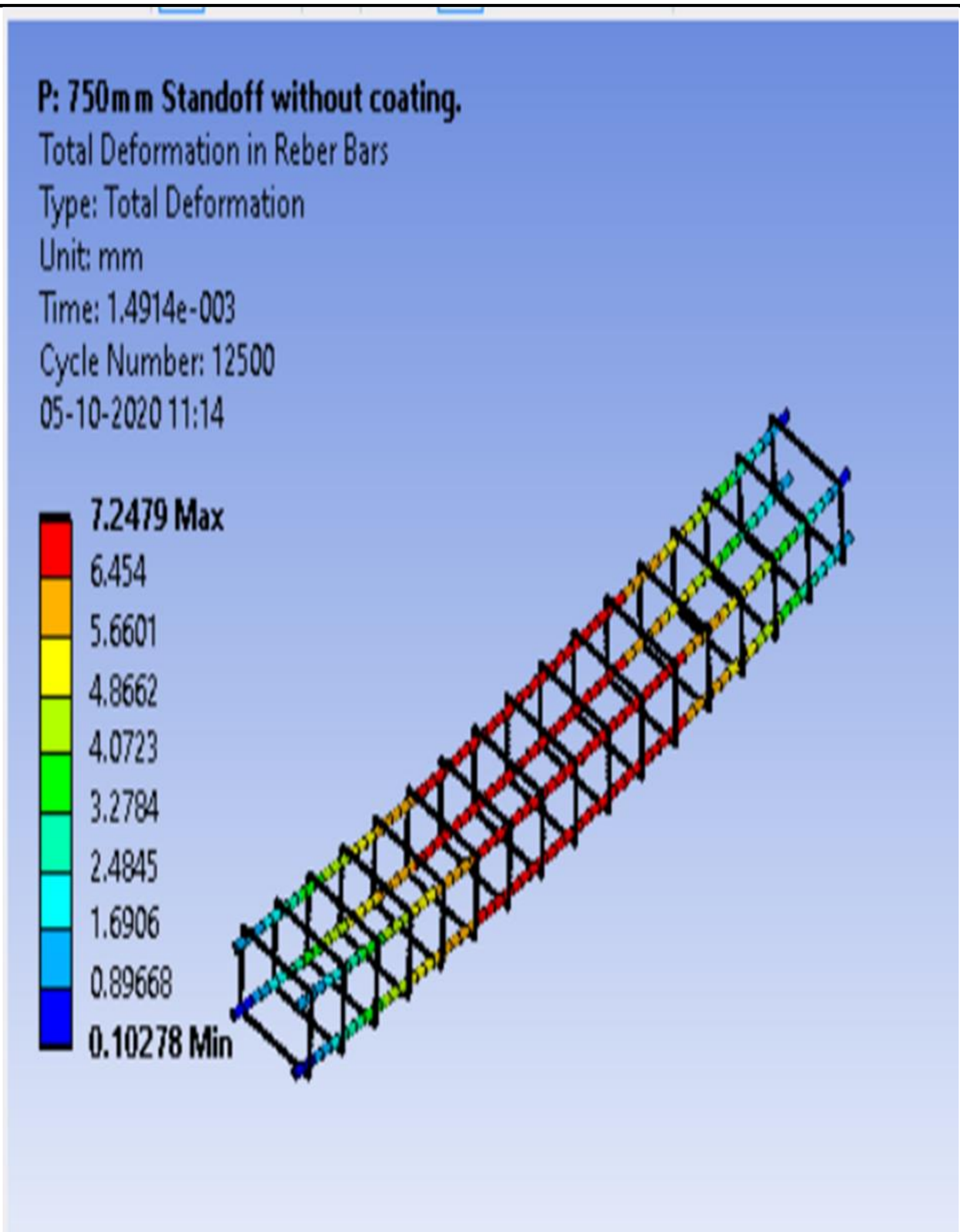

Figure 5. Deformation in rebars

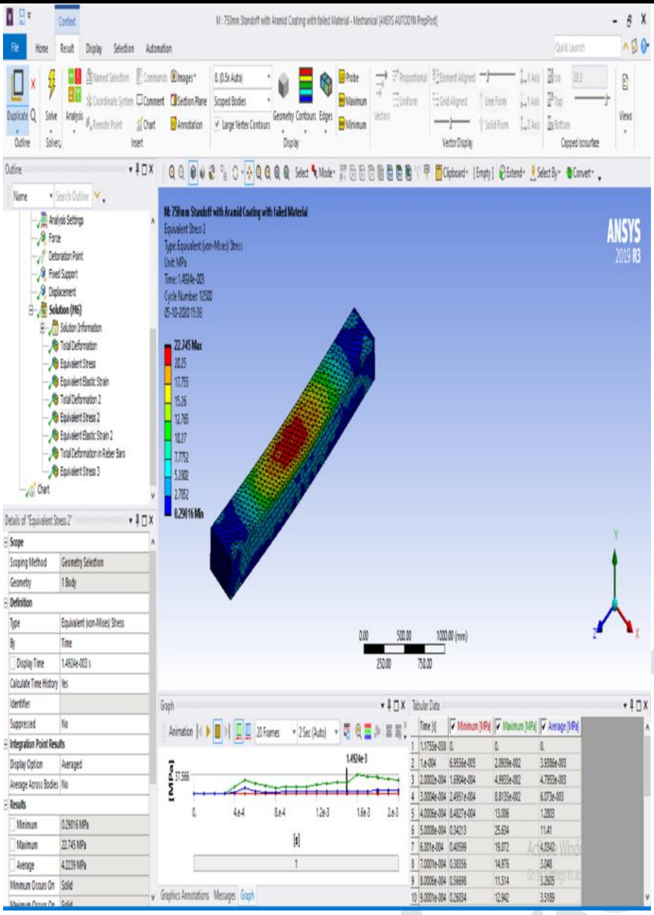

Figure. 6 Stress distribution with Aramid fibre coating

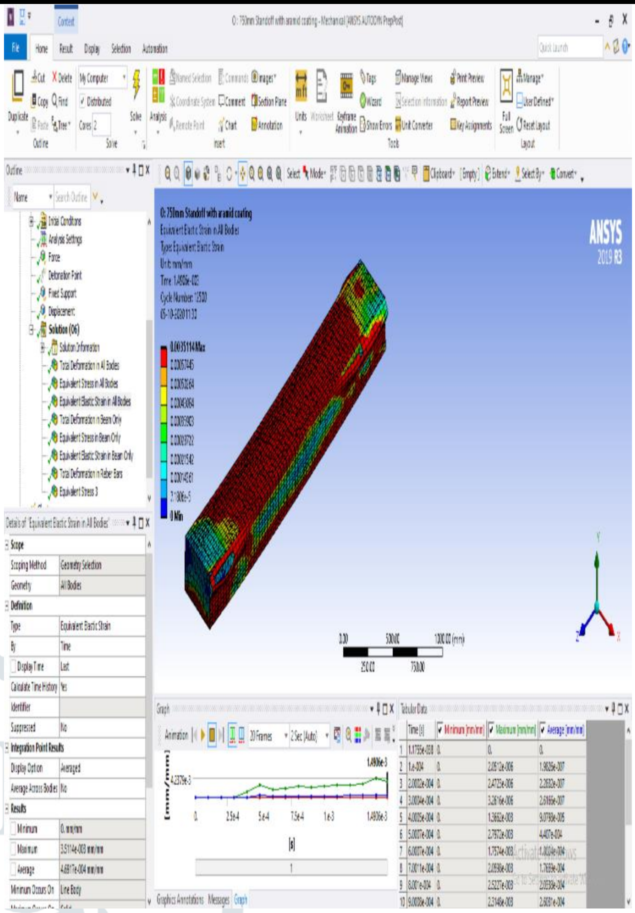

Figure 7. Strain distribution with Aramid fibre coating

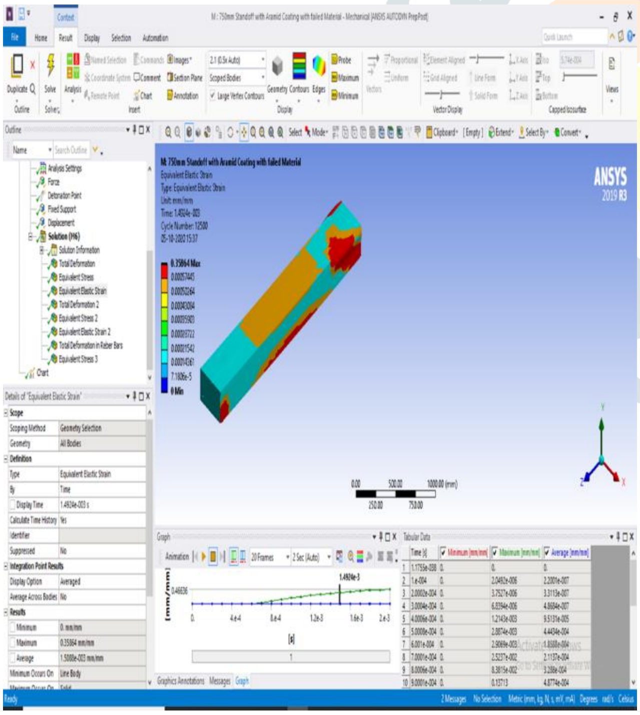

Figure 8. Deformation of concrete (debris)

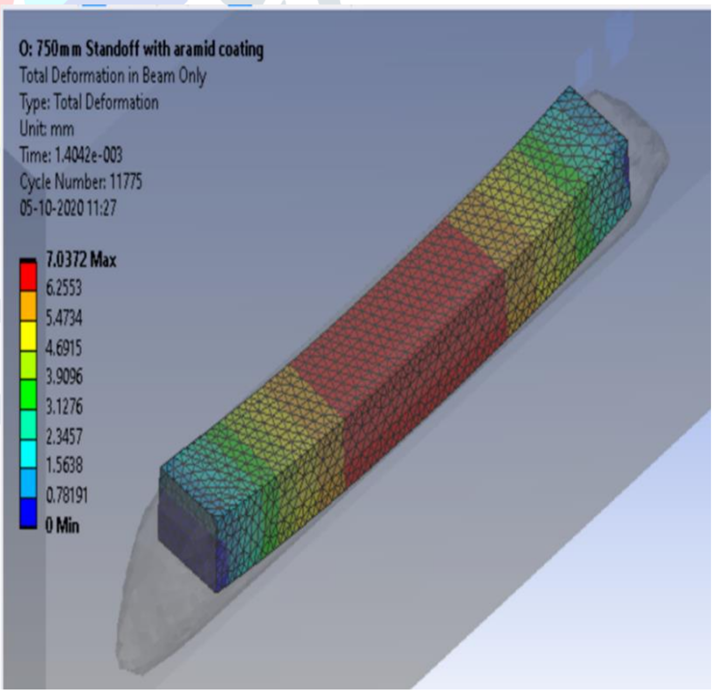

Figure 9. Deformation of beam

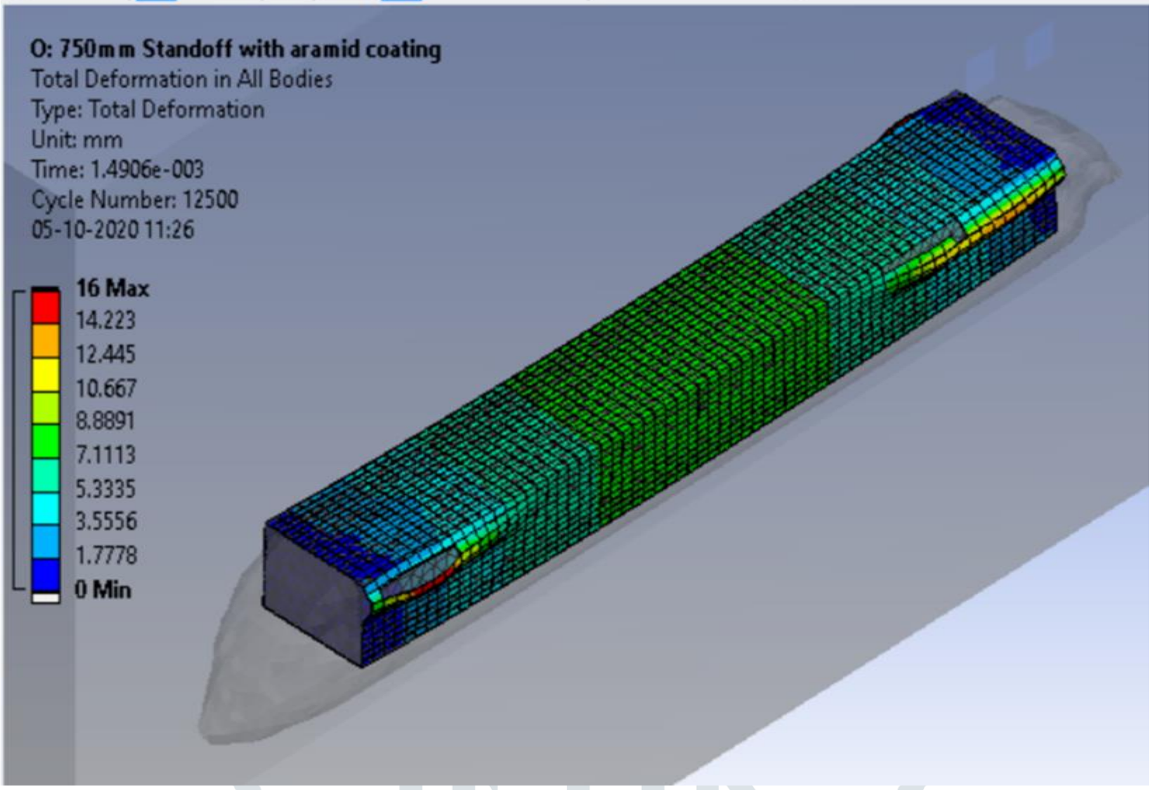

Figure 10. Total deformation of all the material

METHODOLOGY

Nitish Moon PhD Thesis on **PREDICTION OF BLAST LOADING AND ITS IMPACT ON BUILDINGS** in this thesis author done his experimental work on column, it is highly correct that as column fails structure will collapse soon although beam failure is secondary effect of column failure, as a experimental study we take beam for experimental/simulation study. In this thesis author made comparative study with grades of concrete. this concept can be used for proposed structure, but in this paper for existing structure we done here wrapping of Aramid fibre in 3 mm.

With the help of ANSYS Theory manual, version 5.6, 2000 we get idea about this software.
American Society of Civil Engineers (1997) Design of Blast Resistant Buildings in Petrochemical Facilities, Reston, VA this book shows era of blast loading scenerio. From the determination of loading, analysis methods, upgradation of existing building by shear wall etc.

T. Ngo, P. Mendis, A. Gupta & J. Ramsay, Blast Loading and Blast Effects on Structures
The University of Melbourne, Australia they concluded that ductility level of structure help to improve the building performance under blast loading.

IV. RESULTS AND DISCUSSION

Case a) Reinforced cement concrete beam of grade M20 and steel Fe500 without aramid fibre wrapping

Sr. No.	Response	Result for standoff distance 1000 mm	Result for standoff distance 750 mm
1	Maximum stress	53.76	55.806 MPa
2	Maximum strain	0.00118	0.0012559 mm
3	Maximum movement of concrete debris	3.67	7.2511 mm

Case b) Reinforced cement concrete of grade M20 and Fe500 with aramid fiber coating wrapping

Sr. No.	Response	Result for standoff distance 1000 mm	Result for standoff distance 750 mm
1	Maximum stress	50.19	22.745 MPa
2	Maximum strain	0.09025	0.00354 mm
3	Maximum movement of concrete debris	3.49	7.0372 mm

CONCLUSION

By comparison of results tabulated above for two different cases and for different standoff distances, it can be concluded that Aramid fibre wrapping can minimise the effect of blast loading on existing RCC component. And according to standoff distances effect of damages are minimise.

Aramid fibre proves as a good blast resisting material for existing building. by increasing number of layers of wrapping of aramid fibres further damage can be reduces. And safe standoff distance can be calculated for any other precaution like barrier such as blast wall.

REFERENCES

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