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Preventive measures for Blast loading effects on Existing Building (An Analysis Using Ansys Software)

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ABSTRACT: Dynamic loading such as blast loading in a very short time duration can effect catastrophic damages to structures and also to human lives. Structures made up of composite material as reinforced cement concrete response can be analysed using finite element methods and related softwares such as ANSYS, damages due to blast loading can be minimised up to some extent to save human lives using preventive measures such as fiber coating to the existing building components. So comparative study of RCC material with and without Aramid fiber coating is presented in this paper.

KEYWORDS: Standoff distance, blast load, TNT, Aramid fiber, detonation point, Ansys software

I. INTRODUCTION

A bomb explosion in air within or nearby a building can cause catastrophic damage on the building's external as well as internal structural frames, collapsing of walls, blowing out of large windows, blowing of debris of concrete, glass panels and affect life-safety systems. This disaster will loss of life and make injuries to occupants can occur due to many causes, including direct blast of human bodies, structural collapse, debris impact, fire and smoke, and economical loss due to fire. The indirect effects that due to structural damages evacuation of people is needed, thereby contributing to additional casualties. Gas-chemical explosions result in large dynamic loads, greater than the original ultimate loads of many structures. Such extreme loading conditions, it becomes need to develop methods of structural analysis and design to resist blast loads. Studies were conducted on the behaviour of reinforced concrete subjected to blast loads. The response of simple RC beam subjected to blast loads is studied in this paper.

The behaviour of structural elements subjected to blast loading has been the subject of study and research in recent few years.

The design and construction of public buildings are receiving renewed attention of structural engineers. Difficulties that arise with the complexity of the problem, which involves time dependent finite deformations, high strain rates, and non-linear inelastic material behaviour, have motivated various assumptions and approximations to simplify the models. These models span the full range of sophistication from single degree of freedom systems to general purpose finite element programs ANSYS

ANSYS, the finite element method software is useful to determine structural response, for the response calculations in a short duration,



II. RELATED WORK

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 modeled in CATIA V5 using top down method. The models of beam with and without Aramid fibers are created. Then they are imported to ANSYS for further analysis. Then assigning all the material properties to the beam and aramid fibre ,explosive load and standoff distances, 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 components of structures is determined.

Blast load is applied using TNT of 50.613 kg as spherical load and detonation point at the center of beam, at standoff distance 1000mm for two cases first without coating of Aramide fiber and with coating of Aramide fiber. The dynamic load analysis and design of structures to resist blast loads require a detailed study of blast phenomena and the dynamic response of structural elements.

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.

Example taken for experimental work 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: 12mm, 4 numbers 2 at bottom and 2 at top of beam
5. Cross sectional dimensions of beam :230 mmx350mm
- 6.Span of the beam:2.5 m
- 7.c/c spacing of stirrups :150 mm/c and 6mm diameter

Load specification:

- 1.Spherical type explosive load

Explosive specifications :

Explosive used: TNT

- 1.Detonation point:At the center of the beam.
- 2.Amount of TNT: 50.613 kg
- 3.Standoff distance: 1000 mm

Aramid fiber:

Aramaid fiber is polyimide of highly heat and flame resistant at high temperature and very strong synthetic fibers. It used in the aerospace applications.It have much better mechanical properties than steel.

1. Thickness of Aramid fiber wrapped on beam : 3 mm
- 2.Weight of armid fiber used for wrapping of beam = 13 kg

EnvirnomentaI temperature: 22 degree Celsius

Air volume: It is taken by bounded box 390 mm x1369.2 mm x2500mm

Cases: A) Reinforced cement concrete beam of grade M20 and steel Fe500 without aramid fiber

and at standoff distance 1000 mm

- B) Reinforced cement concrete of grade M20 and Fe500 with aramid fiber coating
and at standoff distance1000mm

A) Reinforced cement concrete beam of grade M20 and steel Fe500 without aramid fiber and at standoff distance 1000 mm

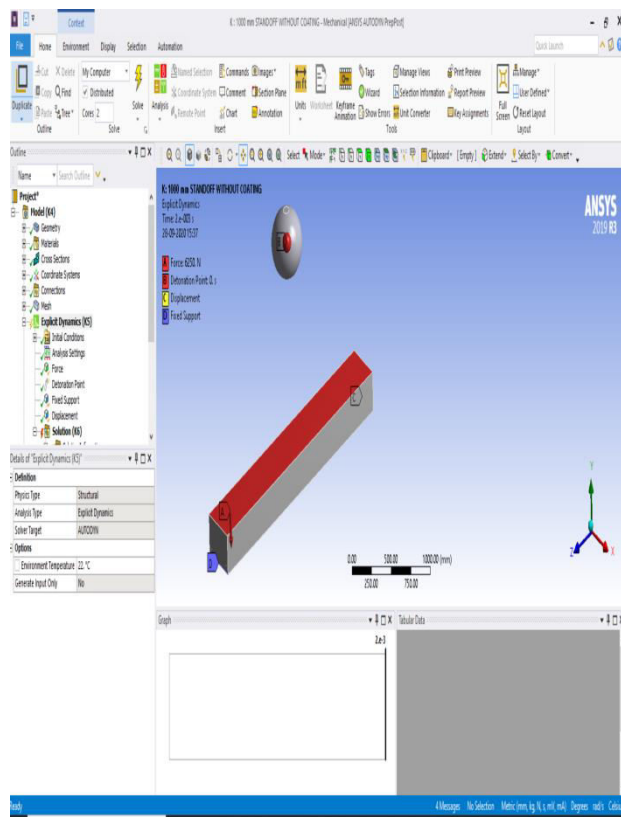


Figure 1 beam with spherical TNT for blast load

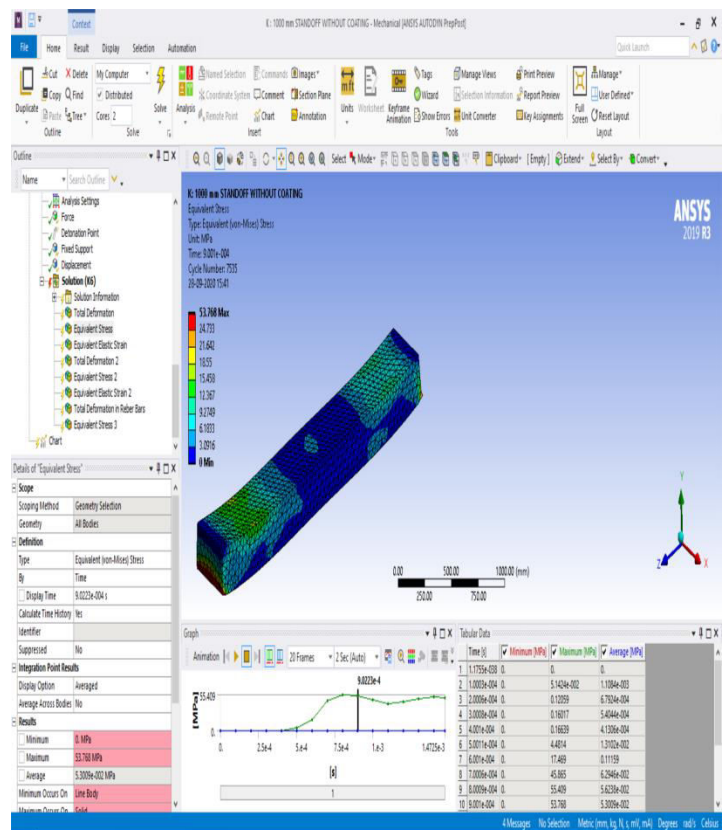


Figure2. Stress distribution

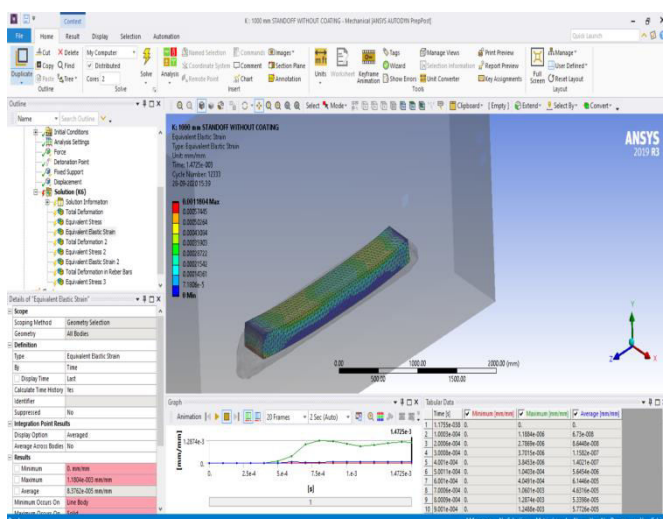


Figure3. Strain distribution

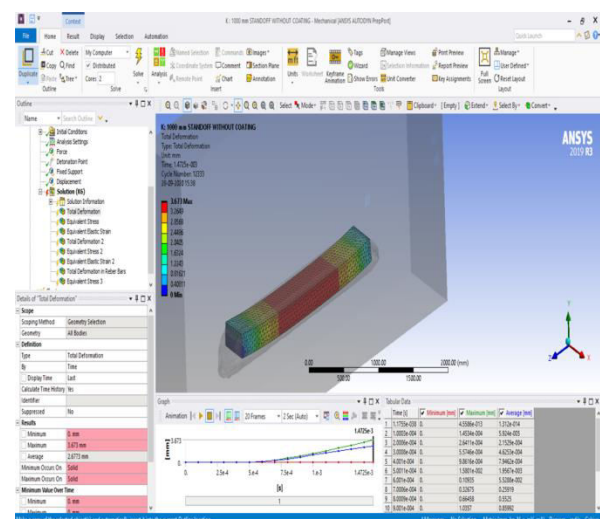
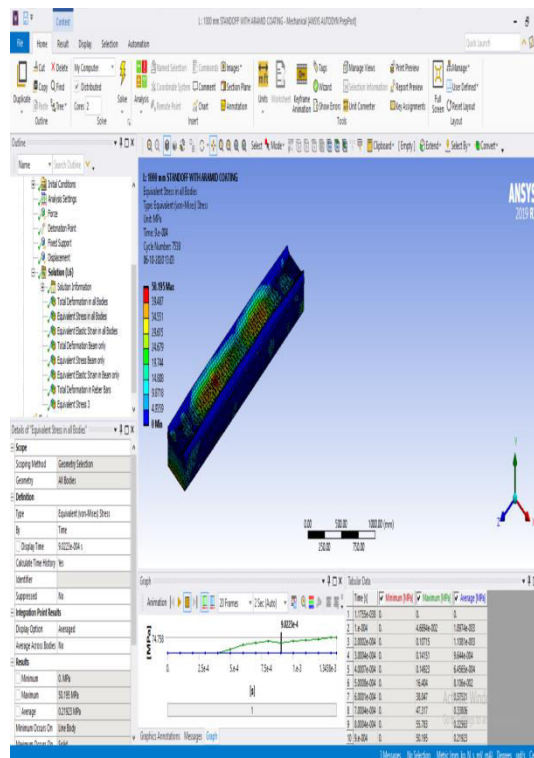
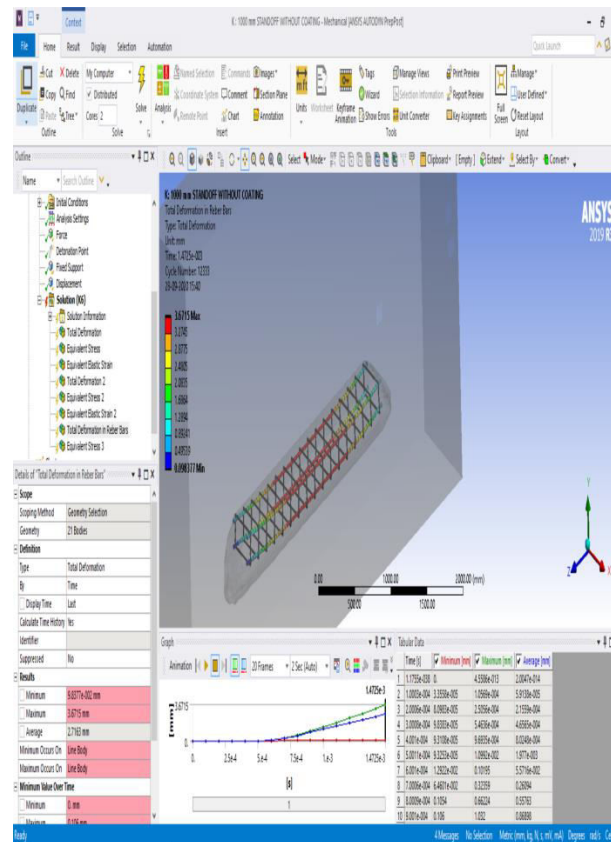


Figure4. Total deformation



B) Reinforced cement concrete of grade M20 and Fe500 with aramid fiber coating and at standoff distance 1000mm

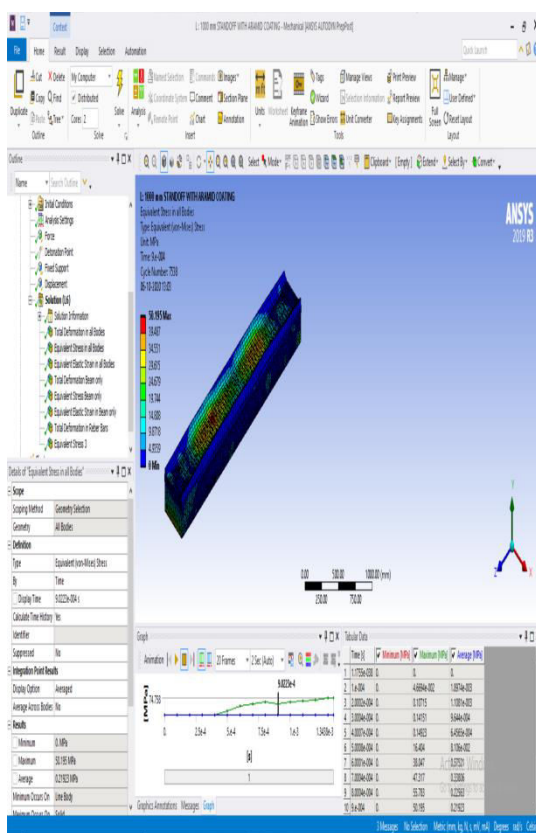


Figure6.stress distribution with aramid fiber coating

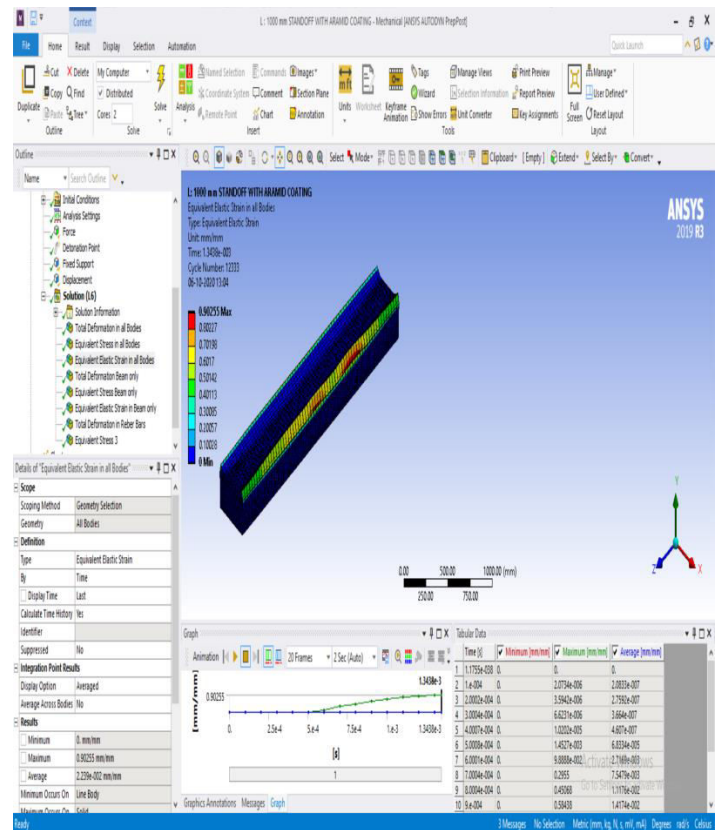


Figure7.strain distribution with aramid fiber coating

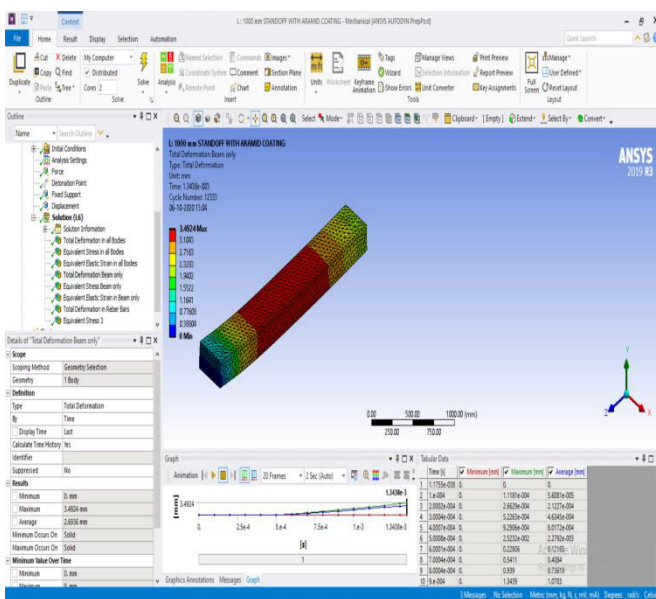


Figure8.Deflection with aramid fiber coating

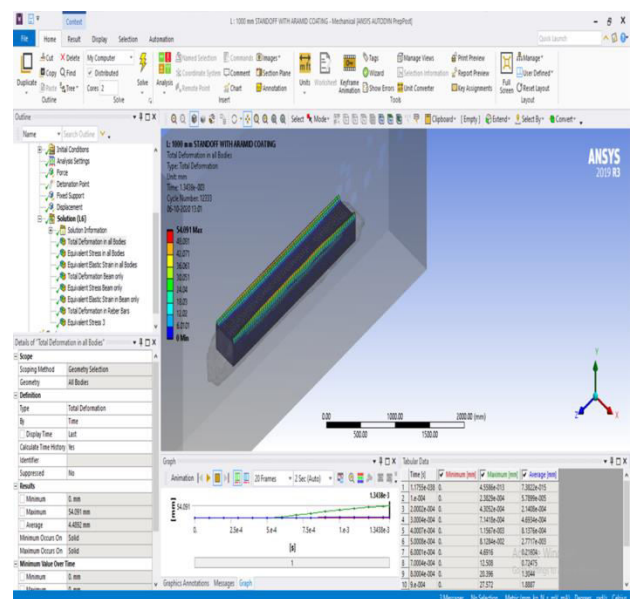


Figure9.Total deflection

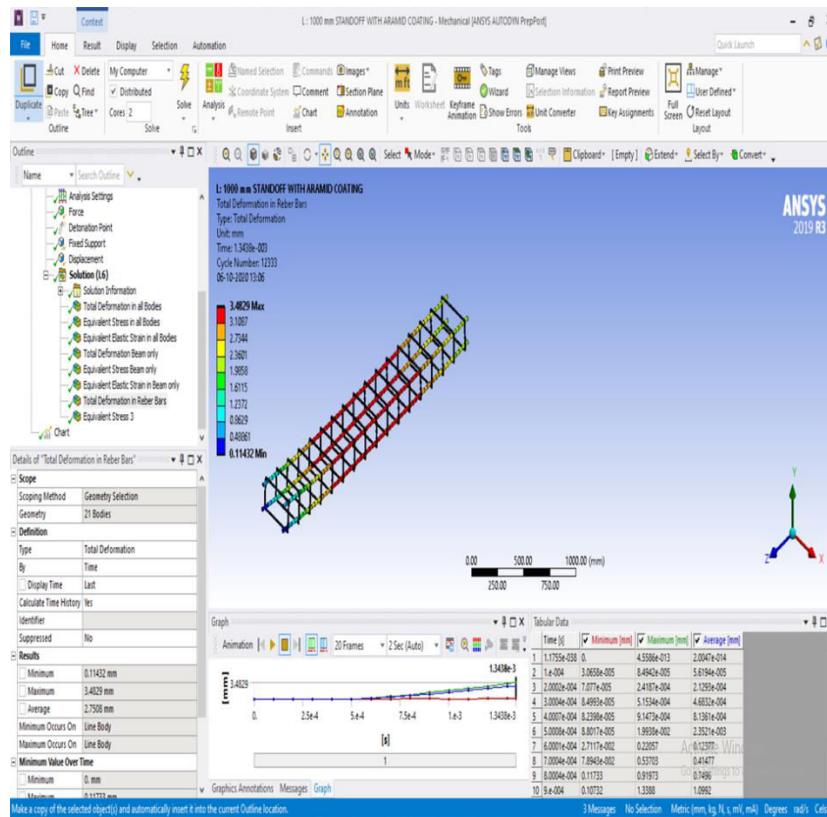


Figure :Deformation of rebars

III. 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 fact that as column fails all structure will collapse soon, although beam failure is secondary effect, as a experimental study we take here beam for experimental/simulation study. In this thesis author made comparative study with grades of concrete for proposed structure.

With the help of ANSYS Theory manual, version 5.6, 2000 we get idea and working of this software.

American Society of Civil Engineers (1997) Design of Blast Resistant Buildings in Petrochemical Facilities, Reston, VA this book shows ira of blast loading sinerio.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. EXPERIMENTAL RESULTS

Case of beam	Span of beam	Cross sectional area of beam	Explosive charge TNT kg	Stand off distance	Max stress Mpa	Max strain mm/mm	Deformation mm
Fixed RCC beam Without aramid fiber coating	2.5 m	230x350mm	50.613	1000mm	53.76	0.00118	3.67
Fixed RCC beam with aramid fiber coating	2.5 m	230x350mm	50.613	1000mm	50.19	0.09025	3.49



V. CONCLUSION

By comparison of results tabulated above for two different cases, it can be concluded that Aramid fiber wrapping can minimise the effect of blast loading on existing RCC component. It can minimise spalling of concrete and debris hence Aramid fiber proves as a good blast resisting material for existing building.

In this analysis 3mm thickness of fibre layer can reduce deflection upto 0.18 mm and stress upto 3.57 Mpa . By increasing number of layers of fibres it is possible to further minimise effect of blast loading.

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