ANALYSIS OF RC BEAMS STRENGTHENED WITH CEMENTITIOUS MATERIALS

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ABSTRACT: -

This paper is about the analytical study of retrofitting of beam by using finite element analysis (FEA). Reinforced concrete has become one of the most important building materials & is widely used in many types of engineering structures. In this study, is to compare the analytical results which is with & without cementitious material using ABAQUS software. The dimension of the beam is 1500mm x 200mm x 100mm of M20 grade of concrete. Finite element analysis is performed by using ABAQUS software. The different load results from the analytical study is compared.

KEY WORDS:Beam, finite element modelling, epoxy, cementitious laminates

1. INTRODUCTION

Upgrading of solid structures may be required for a wide range of reasons. The solid structures may have turned out to be fundamentally in sufficient for instance, because of material deterioration, poor configuration or development, maintenance absence, redesigning of outline burdens, for example, natural causes like earthquakes. But GFRP and solid epoxy paste can strengthen the structures. Fundamentally the method includes giving extra layers of GFRP to concrete surfaces. These plates act compositely with the solid and increase the load carrying capacity. The utilization of GFRP to steel and solid structures has turned out to be progressively alluring because of the understood great mechanical properties of these materials. These properties are good strength to density proportion, good corrosion resistance, less cost of maintenance and less installation time with routine materials.In RC buildings, portions of columns through the beams at their intersections are called beam-column joints. Beam column joint is the crucial zone in a reinforced concrete frame. It is subjected to large forces during its service life and its behaviour has a significant influence on the stability of the structure. In the design of reinforced concrete structures, much of the attention is embarked towards calculation of strength of the basic structural elements like beam, columns and slabs. Comparatively lesser emphasis has been laid on intermediate and end column beam joints. Keeping this in view, paper presents the results of numerical study of reinforced concrete end and intermediate joint by force method and displacement method. The second phase of the study includes the comparison of numerical results to the results obtained by general-purpose finite element analysis software ANSYS R16.2. Finite Element analysis method introduced by Zeinkiewicz (1) analyses the structure fairly well and near accurate. The state of stress, bending moment and shear force has been evaluated at centre of the beam.

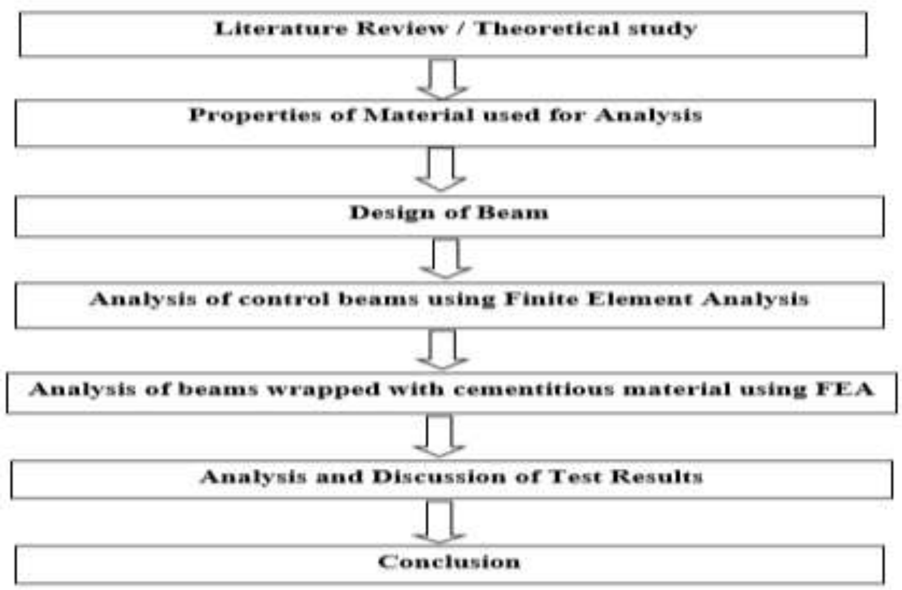
The cost of civil infrastructure constitutes a major portion of the national wealth. Its rapid deterioration has thus created an urgent need for the development of novel, long - lasting and cost - effective methods for repair and retrofit. In the present days life extension of structures through strengthening is becoming an essential activity. A host of strengthening systems has to be devised and adopted over the years. The choice of the strengthening system. Depends on the specific performance requirements. As the number of civil infrastructure systems increases worldwide, the number of deteriorated buildings and structures also increases. Complete replacement is likely to be an increasing financial burden and might certainly be waste of natural resources if upgrading or strengthening is a viable alternative. Many reinforced concrete buildings and structures need repair or strengthening to increase their load carrying capacities or enhance ductility under seismic loading. Much of our current infrastructure is constructed of concrete. As time passes, deterioration an change of use requirements facilitate the need for new structures. Demolition of existing and construction of new structures is a costly, time consuming and resource intensive operation. If existing structures could be reinforced to meet new requirements then the associated operating costs of our infrastructure would be reduced. In recent years repair and retrofitting of existing structures such as buildings, bridges, etc., have been amongst the most important challenges in Civil Engineering. The main reason for strengthening of RC structures is to upgrade the resistance of the structure to withstand underestimated loads and increase the load carrying capacity for loads such as seismic loads. The maintenance and rehabilitation of structural members, is perhaps one of the most crucial problems in civil engineering applications. Conventional methods that are already available. Slurry Infiltrated Mat (SIM) are been extensively used as external wraps for the structural strengthening and rehabilitations of buildings. In particular its application is been in the area of masonry and concrete structures. Strengthening and retrofitting activity by using synthetic fibres such as glass/carbon/aramid is becoming popular all over the world. Extensive research across the world during some years are so as led to better understanding of the properties and behaviour of SIMCON under different conditions, and more extensive use of SIMs is likely to seen in the coming years. Synthetic fibres are non-made fibres resulting from research and development in the petrochemical and textile industries. The various synthetic fibres include - acrylic, aramid, carbon, glass, etc.., but using these synthetic fibres is as costlier and chances for applicability in rural areas are remote.

Retrofitting of flexural concrete elements are traditionally accomplished by externally bonding steel plates to concrete. Although this technique has proved to be effective in increasing strength and stiffness of reinforced concrete elements, it has the disadvantages of being susceptible to corrosion and difficult to install. In the last decade, the. development of strong epoxy glue has led to a technique which has great potential in the field of upgrading. Structures. Basically, the technique involves gluing steel plates or fibre reinforced polymer (FRP) plates to the surface of the concrete. The plates then act compositely with the concrete and help to carry the loads. Also, recent development in the field of composite materials, together with their inherent properties, which include high specific tensile strength good fatigue and corrosion resistance and ease of use, make them an attractive alternative to any other retrofitting technique in the field of repair and strengthening of concrete elements. FRP can be convenient compared to steel for a number of reasons. These materials have higher ultimate strength and lower density than steel. The installation is easier and temporary support until the adhesive gains its strength is not required due to the low weight. They can be formed on site into complicated shapes and can also be easily cut to length on site. Carbon Fiber Composites are the most frequently used system in previous research and retrofitting field applications. This material has superior properties which include very high tensile strength accompanied with a reasonable modulus of elasticity (almost equals that of steel) On the other hand, the Glass Fiber Composites (GFC) are comparatively cheap and have high tensile strength but with relatively low modulus of elasticity (about one-third that of carbon and reinforcing steel is also another sought after retrofitting material.

2. SCOPE AND OBJECTIVE

- Analytical study of beam.
- Retrofitting of RC beam using Finite Element Analysis (Abaqus).
- Effect of strengthening RC beam externally by wrapping FRP with pattern
- Effect of precracked beam after wrapping.
- Deformation behaviour.
- Comparing the two analytical results

3. METHODOLOGY FLOW CHART:



Flow chart of Methodology

4. CEMENTITIOS MATERIALS: -

4.1 Cement

The cement used in this study is a product from Cement Industries of Libya, with a brand name blue lion. This type-I cement complies strictly with BS 12: 1991 where it is widely used in general construction, for example buildings, bridges and other precast concrete products. It is available in 50 kg bag.

4.2 Fine and Coarse Aggregates

Aggregate is important because it occupies about threequarters of the volume of concrete. Usually, there are two types of aggregate used in concrete, which are fine and coarse aggregates. Many parameters needed to be considered in selection of aggregate, for instance, types of aggregate, size and shape of the particle, and the strength of the aggregate. All aggregate must be free from dust as the dust may affect the bonding between the aggregate and cement particles. The fine aggregate used in this investigation is sea sand. Lastly, coarse aggregate used in this study is crashed stone with a maximum size of 20 mm. In addition, aggregates should be cleaned before mixing to wash away the fine particles that stick on the surface of the aggregate.

4.3 Superplasticizer

The superplasticizer used in this study is Liboment – 163. It is a new superplasticizer, which not only suitable for prestressed concrete, but also for other types of concrete. One of its benefits is that it can improve both early and final strength. In addition, slump retention and workability of concrete also enhanced by using Liboment.

4.4 River sand-

Generally composed of rounded particles, and may or may not contain clay or other impurities. It is obtained from the banks and beds of rivers.

4.5 Silica fume

It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is as pozzolanic material for high performance concrete.

4.6 Fly ash

As produced in small dark flecks by the burning of powdered coal or other materials and carried into the air.

4.7 Steel fibre

Reinforced shotcrete (SFRS) is shotcrete (spray concrete) with steel fibres added. It has higher tensile strength than unreinforced shotcrete and is quicker to apply than weldmesh reinforcement. It has often been used for tunnels.

5. PROPERTIES OF CEMENTITOUS MATERIAL

Poisons ratio	0.2
Youngs modulus	37,800 Mpa
Density	18 Kg/m3

5.1 PROPERTIES OF EPOXY MATERIAL

Epoxy density	1258 Kg/m3
Young Modulus	1257 x 106 Mpa
Poisson’s ratios	0.48

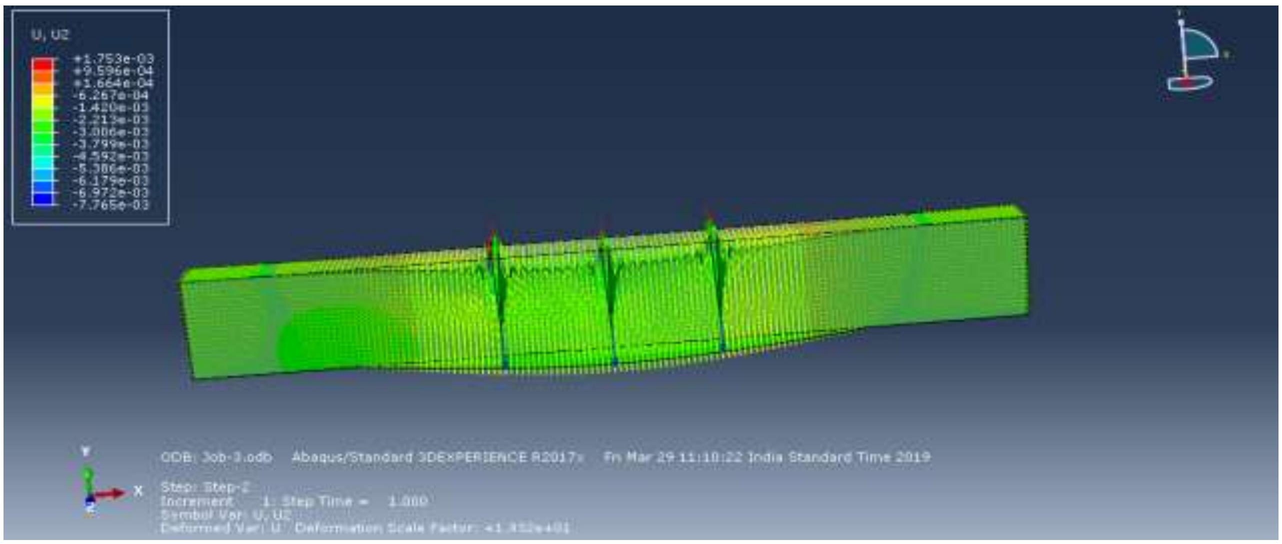
5.2 PROPORTIONS OF CEMENTITIOUS MATERIALS

Cement	500kg/m3

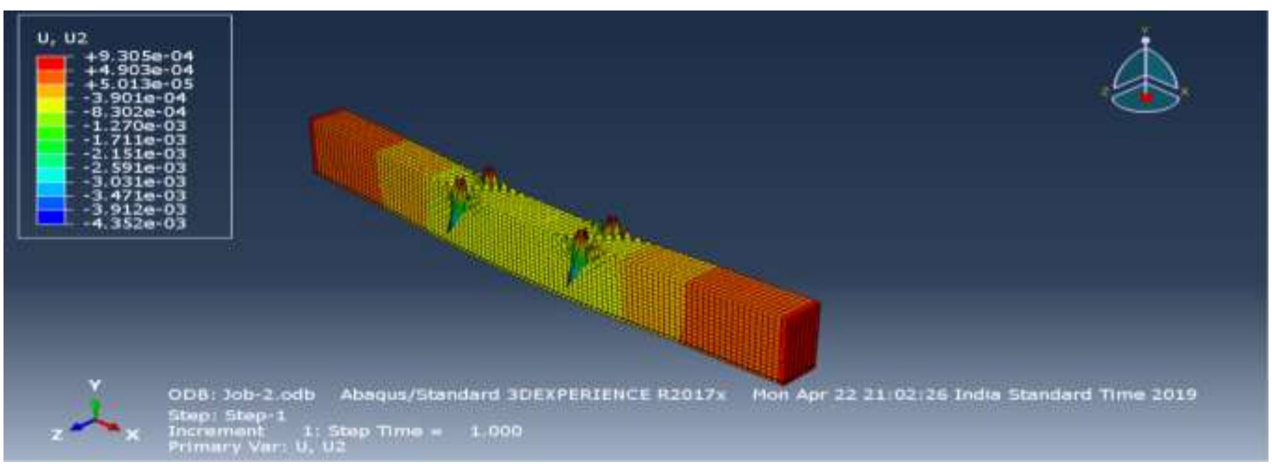
Seized sand	550 kg/m3
Silica fume	125 kg/m3
Quartz powder	200 kg/m3
Steel fiber	157 kg/m3
Super plasticizer	3.4%
Fly Ash	150 kg/m3
w/c ratio	0.28

6. ANALYTICAL INVESTIGATION

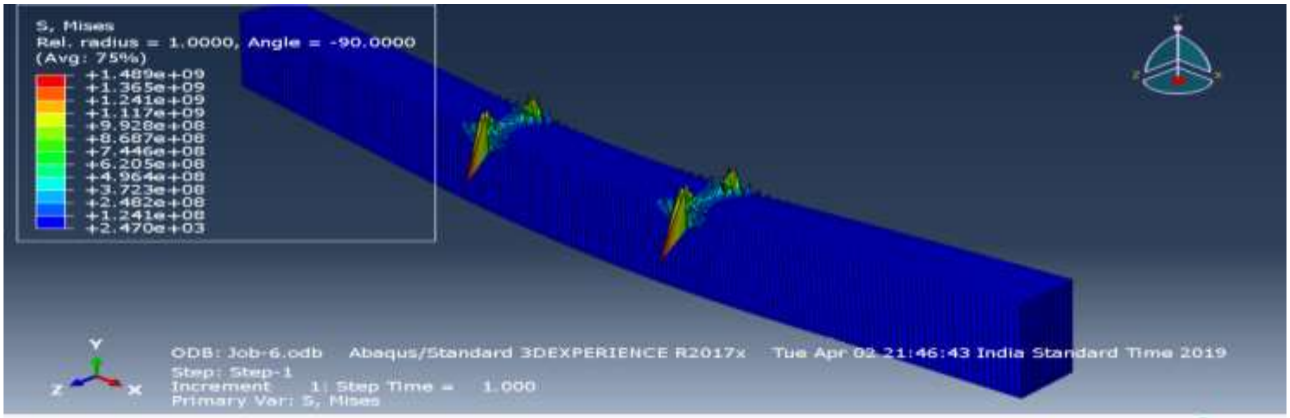
6.1 CONTROL BEAM TEST 70% LOAD



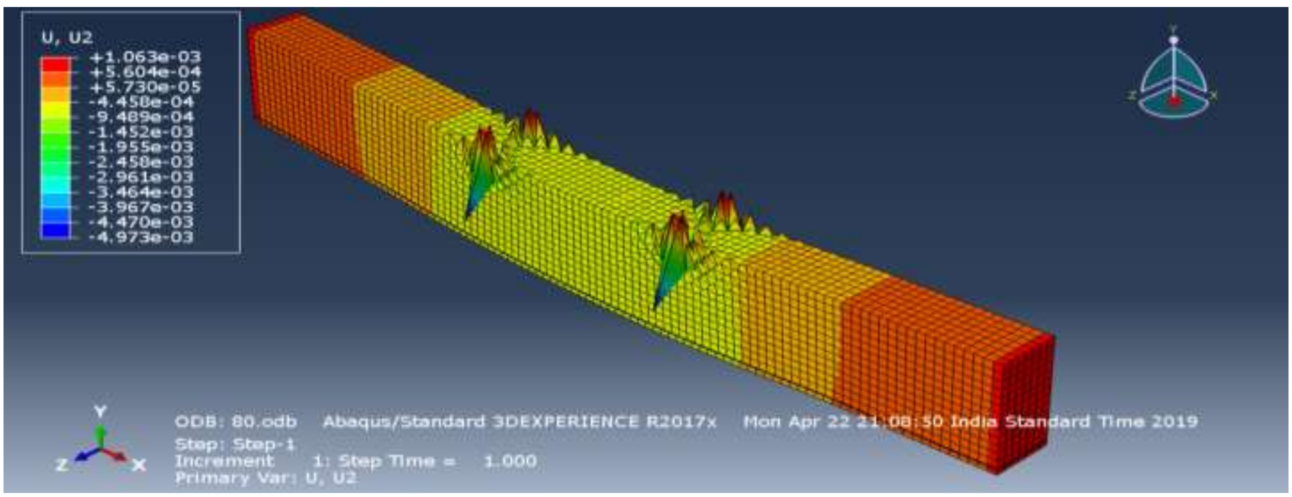
6.1.1 LOAD TEST AFTER WRAPPING WITH CEMENTITIOUS LAMINATESWITH 70% LOAD



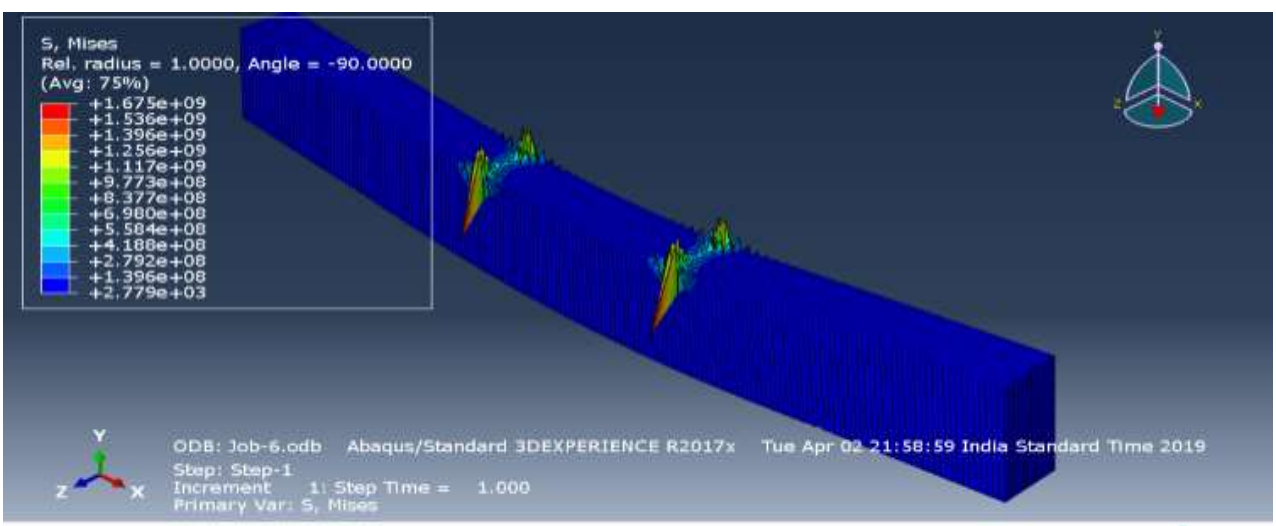
6.2 CONTROL BEAM TEST WITH 80% LOAD



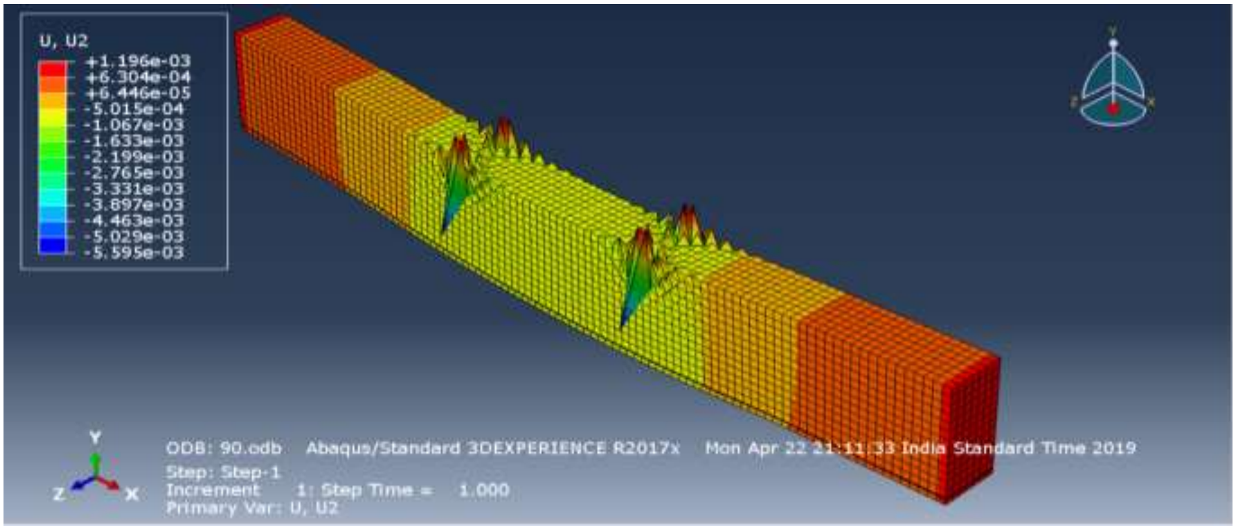
6.2.1LAMINATED BEAM WITH CEMENTITIOUS WITH 80% LOAD



6.3 CONTROL BEAM WITH 90% LOAD



6.3.1LAMINATED BEAM WITH CEMENTITIOUS 90% LOAD



7. COMPARISON OF CONTROL BEAM & CEMENTITIOUS LAMINATED BEAM

70% 80% 90%

7.1 WITHOUT CEMENTITIOUS MATERIAL:

+1.303e+09 +1.489 e+09 +1.675 e+09

+1.194e+09 +1.365 e+09 +1.536 e+09

+1.086 e+09 +1.241 e+09 +1.396e+09

7.1.2 WITH CEMENTITIOUS MATERIAL:

+1.387e+09 +1.572 e+09 +1.721 e+09

+1.218e+09 +1.427 e+09 +1.618 e+09

+1.117 e+09 +1.317 e+09 +1.467e+09

CONCLUSION

1. After working on Abaqus software we found that, that software is very much reliable about the testing on a beam, which allow us to do work & complete on a short period of time.
2. We also get to know that any kind test can perform on the Abaqus software, which can save expenses of the work of a civil engineer.
3. we found out that after retrofication beams strength increased, which further increased life of structure.

4. This technique will reduce the construction cost and increase life of the structure.

5. Cementitious materials has helped to rehabilitate the beams cementitious sheet & BASF Master Brace 2000 has helped to reduce the growth of cracks width at ultimate loads.

6. The flexural strength of the bottom wrapped beams is higher than the control beams.

7. The ductility of the strengthened beam is much higher than the control beams.

8. Beams rehabilitated using single layer cementitious sheet (10mm thickness), there is increase in ultimate load by 10.6% to 13.33% when compared to control beam.

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