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Study of Simply Supported Beam with Composite PLATE: A Literature Review

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ABSTRACT

Modern practice in civil and structural engineering involves strengthening concrete structures by externally bonded FRP composite materials. This type of reinforcing system has a significant number of advantages, such as lightness, noncorrosive, nonmagnetic, strong and highly versatile, FRP products being, in certain cases, the ideal materials for structural strengthening and rehabilitation. In present research work the response of plain concrete beam, reinforced concrete beam and reinforced concrete beam with GFRP plate are reviewed with finite element analysis software. ABAQUS and ANSYS software are used as a software study for analysis of beam. The results and outcomes of analysis are reviewedfor reinforced concrete beam with GFRP plate. Also results were studied for better results among all cases found in various research papers.

Keywords: Beam Analysis, Software Simulation, GFRP, Stress, Strain, Deflection, Shear force, Bending Moment.

LITERATURE SURVEY

D.L.Venkateshbabuet al., (2012) investigated behaviour of FRP beams. Author calculated banding moment, the model considers an exponential function in the stress-strain diagram of RC in both tension and compression parallel to the fiber. Author conducted four point loading test to determine load versus displacement relationship of RC beam with GFRP and CFRP sheets adhered to the tension face/bottom face. Author used finite element technics to understand best warping style for retrofitting the deficient beam sand they also study of effectiveness of CFRP/GFRP sheets in flexure strength of RC beams. From the results, author conclude that general behaviours of the finite models show good agreement with experimental results of beam test.Also form the result obtained by author that demonstrated that CFRP was more efficient than GFRP in strengthening the reinforced concrete beams for shear.

Dhanu M.Net al., (2014) carried out studied on experimental and numerical investigation of retrofitted reinforced concrete beams using Fiber Reinforced Polymer (FRP). They were used GFRP and Coir FRP for retrofitting of beam and compared performance between them. Experimental study involves the determination of flexural load by subjected three point loading. They calculated permissible load by using proper factor of safety on ultimate load. They took that permissible load for numerical study. For numerical study of RC beams retrofitted with GFRP were considered and they used ANSYS 13 software to analysis of beams structure. They applied load was in the form of uniformly distributed load and they considered the beam was supported by fixed support at its ends. From the result of Experiment and Numerical study carried out by author, they conclude that the flexural strength and ultimate load capacity with same deflection of the beam can be improved by retrofitting. Author also observed load carrying capacity of RC beam was higher when they applied GFRP.

Ramesh Kumar U More et al., (2014), investigated on flexural behaviour of Aramid fiber (Kevlar fiber) reinforced polymer (AFRP) used for strengthening reinforced concrete (RC) beams of M25 grade of concrete. Investigator took the beam size was 100 x 150 x 1200 mm and that was strengthened by Aramid fiber polymer sheets. Author studied on effect of strengthening on load carrying capacity and effect of damage degree. Author Used ANSYS software for validation of Experimental work and they found good agreement between analytical result and experimental result. They only work on flexural behaviour so beams were wrapped with AFRP sheets in single layer and double layers along the full length of beam at the bottom face. Author concluded from results that the ultimate load carrying capacity for 0% damage degree beams were increased after strengthened with single layer and double layer of 100 mm width AFRP strip was 27.59% and 49.27% respectively compared with controlled beam, ultimate load carrying capacity were increased with increased in layer of AFRP strip, with increased in degree of damage, deflection at ultimate load was found to be decreasing by applying AFRP strip and 0%, 70%, and 80% damaged degree beams showed higher performance in terms of load carrying capacity, while 90% and 100% damage degree beams did not show appreciable increased in load carrying capacity.

Sergio F. Bren and Beth M. Macri, (2004) experimentally carried out tests on eighteen small scale reinforced concrete beam strengthened by CFRP composites. Author aimed to understand behaviour of strengthened reinforced concrete beams under different configuration of CFRP. Author used three different type of configuration, in first case laminates were attached only tension face of the beam, second case laminate were attached only shear/side face of the beam and for third case laminates were attached entire specimen or U shape. They were used strain gauge in a region where crack in concrete were performed to monitor the variation of strains throughout testing. From the experiment they concluded composite pattern/configuration directly affect behaviour of load versus deflection load and deflection of the beam were affected by composite configuration. Author observed local strain didn't provided a realistic representation of the globe beam behaviour.

C. C. Spyrakoset al., (2014)carried out experimental and analytical investigation of the effectiveness of FRP strengthening sheets on RC beams to increase their flexural strength and stiffness. Author conducted four point bending tests on four full scale reinforced concrete beams strengthened with externally bonded FRP. Author investigated the strength, deflection and failure mode strengthened beams in both experimentally and analytically. Form the results by the application of CFRP increased beam strength and stiffness. They were observed that different resin and anchorage system significantly influenced the resulting strength and stiffness of the specimen.

Y.C. Wang and C.H. Chen, (2003),studied on the RC tee beam with applied CFRP at tension face or bottom face of the beam and applied GFRP at side/shear face of beam. Author proposed model which was based on discrete element method. That was used to predict behaviour of load versus displacement and FRP plate bond stresses. Author concluded that model predicted of failure of strengthened beam in a more practical manner than other analytical models. Author observed model accurately predicted load displacement behaviour and they was also found excellent agreement between measured plate strain and the strain predicted by model.

Hsuan-TehHu et al, (2004) carried out numerical study by ABAQUS based on finite element method to predict the ultimate loading capacity of rectangular reinforced concrete beams strengthened by fiber reinforced plastics applied at the bottom or on side face of those beam. Author studied influences of fiber orientation, beam length and reinforcement ratio on the ultimate strength of the beam. Investigator conclude form the numerical result FRP strengthening is not effective for high reinforcement ratio as compared with low reinforcement ratio. Author observed more crack at the central region of the beam with high reinforcement ratio which was strengthened with FRP at the bottom, and found comparatively more crack at support area of the beam with low reinforcement ratio which was strengthened with FRP at the bottom. Author seen increased ultimate strength and deceased crack when FRP applied on bottom face of the beam.

J. Lundqvistet al.,(2005) carried out study on anchorage length of FRP to effective strengthening of RC beam. Author did experimental work and analytical investigation by ABAQUS that's was based in finite element analysis. Author used three different type of strengthening technique such as bonded plates, sheets and the Near Surface Mounted Reinforcement (NSMR). Investigator aim to find out critical anchorage length, for that they were took different length that was 100, 200, and 500 mm. from the experimental and analytical investigation author find out the failure load and strain in RC beam. Author conclude form the result the critical anchorage length was less the 200 mm for sheet, 200 mm for plate and anchorage length not very clearly understand in NSMR. Author also observed that increased in anchorage length added structural safety but does not increase in load carrying capacity.

F.A.Fathelbab et al., (2011) conducted analytical investigation on strengthened RC simple beam with externally bonded FRP sheets technique, that's beam was loaded in flexure, shear and a combination of flexure and shear. Author used ANSYS software to perform structure linear and non-linear analysis. Author studied main parameter control beam of different schemes of FRP sheets in flexural, shear and combination flexural and shear. Investigator compared that results and conclude that beam capacity and ductility directly proportional to CFRP sheets applied on the beam but at the same time author observed that the beam capacity didn't increased with increased in CFRP sheets but ductility did.

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Tarek H. Almusallam et al., **(2001)** study on strengthened or repaired reinforced concrete specimens. Strengthening of RC beam achieved by application of glass fiber reinforced polymer (GFRP) to the bottom face of the beam. They compared flexural capacity and mid span of the strengthened beams and control beams to evaluate effectiveness of strengthening technique. Author investigated on twelve beams and size of the beam is 150 X 200 X 2050 mm. They were applied FRP on beam three different way. In the first group author applied FRP at bottom of the beam, second group they applied FRP used u shaped sheet and in third group then applied double layer of FRP at the bottom of the beam. They used Amsler testing machine for application of load and for find out central deflection they used linear variable displacement transducer (LVTD). Author performed test on that beam and finally conclude that flexural strength increased considerably by bonding GFRP sheets to the bottom face of the reinforced concrete beams and U shaped anchorage system had considerable effected on ultimate strength and failure mode of the beam. Author also observed that to improve ductility and strength a GFRP is one of the effective solution.

P.Parandamanet al., **(2014)** worked on RC structure which is damaged during earthquake and they tried to retrofitting of that reinforced structure with fiber reinforce composite. They presented paper on finite element analysis of beam retrofitted with different fiber reinforced polymer composite sheets carried out using ANSYS software. They applied GFRP, CFRP and KFRP on same size of beam and then author did modelling and analysis by ANSYS. Investigator's objective is to compare performance of above three retrofitted beams with controlled beam. Author finally concluded from the ANSYS results, deflection of the retrofitted beam with CFRP is minimized about 73% compared to controlled beam, deflection of the retrofitted beam with GFRP is minimized about 65% compared to controlled beam, deflection of the retrofitted beam with KFRP is minimized about 60% compared to controlled beam and load carrying capacity of retrofitted beam is higher than the controlled RC beam specimen.

(Rizkalla&Nanni, (2003) Concrete is one of the most utilized construction materials, as a result of its many advantages that it has, such as low cost, long service life (when properly mixed, placed and cured), ease of construction and high compressive strength. Thus, modern civilization relies upon the continuing performance of a wide variety of concrete or reinforced concrete (RC) structures, ranging from apartment buildings to bridges. However, numerous concrete structures suffer important gradations and damages due to environmental exposure or extraordinary overload or have insufficient strength because of defective construction, increased service load requirements, or updated codes, fiber reinforced polymer (FRP) composites strengthening becoming nowadays a commonly accepted and widespread technique.

Proposed Problem Definition

Finite element analysis is to be performed to model the linear behaviour of the beams. The FEM package ABAQUS are used for the analysis. The dimension of the beam is taken as b= 200mm, h= 300mm, and l= 3000mm. The plate thickness varies 2mm, 4mm, 6mm and 8mm

The analysis is done for the various conditions. The conditions are;

1. Plain cement concrete beam

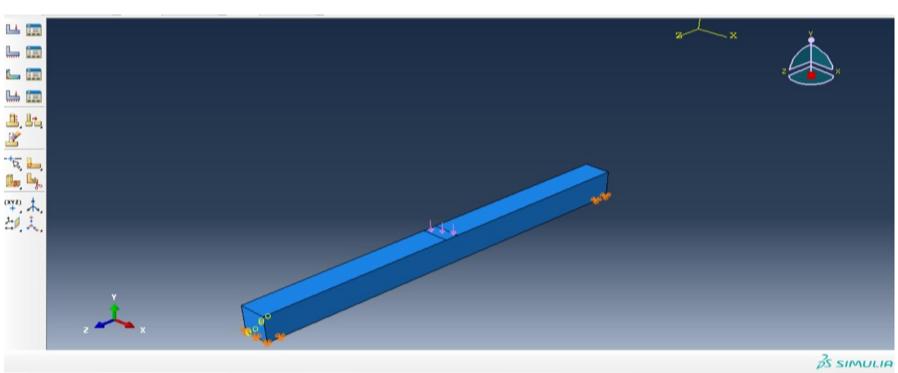

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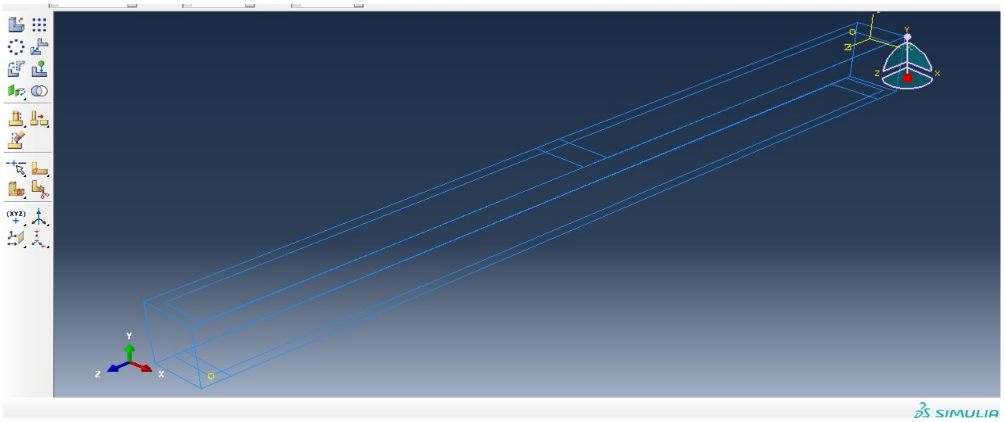
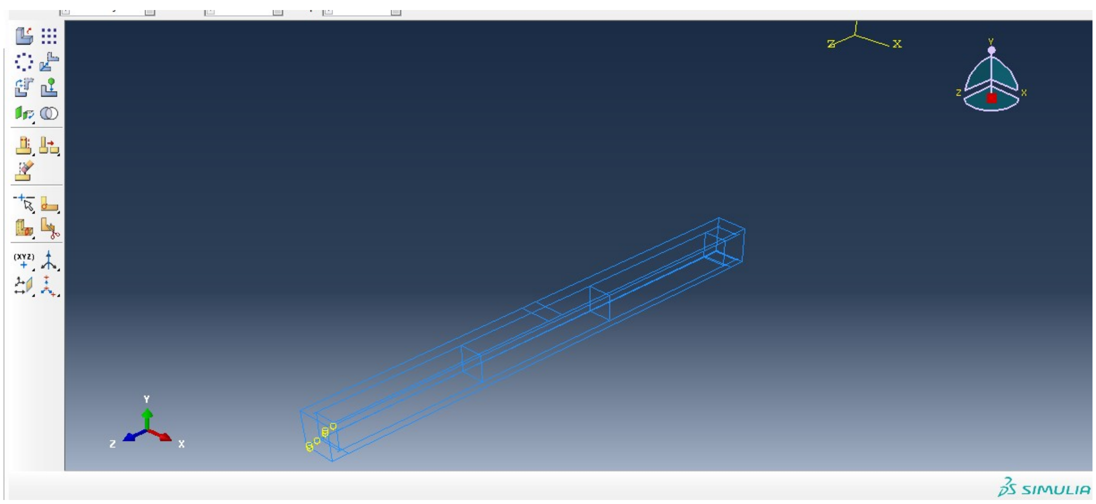
Fig: PCC Load Definition

2. Plain.cement concrete beam with Glass Fiber Plates. The plate thickness varies 2mm, 4mm, 6mm and 8mm.



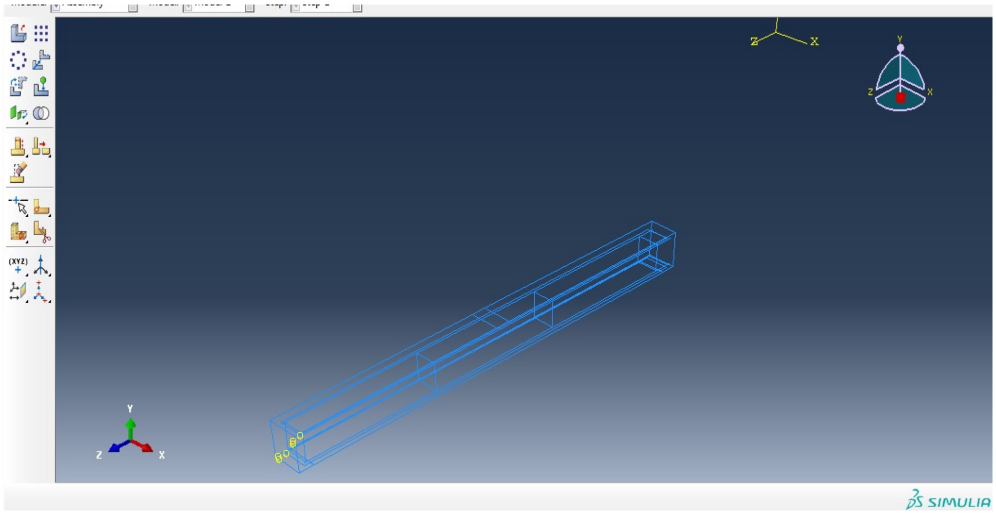
PCC Assembly with Glass Fiber Plates

Reinforced concrete beam



RCC beam Model

3. Reinforced concrete beam with Glass Fiber Plates. The plate thickness varies 2mm, 4mm, 6mm and 8mm.



RCC Beam with Glass Fiber Plates

RESEARCH FUTURE OBJECTIVE

1. To find the ABAQUS analysis result outcomes for PCC at load 1000N.

2. To find the ABAQUS analysis result outcomes for PCC with Glass fiber plate at bottom face at load 1000N

3. To find the ABAQUS analysis result outcomes for RCC at load 1000N.
   To find the ABAQUS analysis result outcomes for RCC with Glass fiber plate at bottom face at load 1000N with thickness variation 2mm, 4mm, 6mm and 8mm.

4. To compare the Stress, Deflection and Strain result outcomes at various loads for PCC and RCC with and without Glass fiber plate at bottom face.

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