FINITE ELEMENT ANALYSIS OF REINFORCED CONCRETE BEAM USING ANSYS

Pradeep singh[1], Abhishek Mishra[2], Arpit Kulshreshtha[3]
[1,2,3]PG Scholar, Dept. of Civil Engg., IPS College of Technology & Management, Gwalior –R.G.T.U, Bhopal
Email:pradeepkumar.imliya@gmail.com[1],abhimishra.mishra918@gmail.com[2], arpit@kulshreshtha.in[3]

ABSTRACT

Present paper here deals with simulation of concrete reinforced beams using ANSYS. Effect of different Fibre Reinforced Polymer will also be studied. The Fibre Reinforced Polymer (FRP) as an external reinforcement is used extensively to deal with the strength requirements related to flexure and shear in structural systems. Review of the published work has been conducted in the present paper. First the simple concrete beam will be modelled in ANSYS then the FRP material will be laminated over it. Effect of tension and various loading condition will be studied in the present paper.

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.

Failure criteria for FRP laminate

- Hashin Criteria for 2D developed in 1980
- Criteria for matrix failure under transverse compression
- Criteria for fibre failure under tension
- Criteria for fibre failure under compression
- Criterion for matrix damage in biaxial compression

Banu D. et al [1] studied the numerical modelling of two-way reinforced concrete slabs strengthen with carbon fibres reinforced polymer strips. They applied FRP as an external layer to the RC (Reinforced Concrete) beams. They have used ANSYS software to analysis the effect of FRP material as an external layer to see the effect of it on load carrying capacity. They have used SOLI65 element to model the 3D concrete beams while SOLID45 has been used to design the thick shells. They have conducted their results for load-deflection and ultimate carrying capacity.
Scordel is A.C. et al[2] studies finite element study of reinforced concrete beams with diagonal tension cracks. The most punctual production on the use of the limited component system to the investigation of RC structures was exhibited. In their study, basic shafts were examined with a model in which concrete and fortifying steel were spoken to by consistent strain triangular components, and an extraordinary bond join component was used to associate the steel to the solid and portray the bond slip impact. A direct flexible investigation was performed on shafts with predefined split examples to decide essential hassles in solid, stresses in steel fortification and bon stresses.

Parandaman P. and Jayaram M.[3] studied the Finite element analysis of reinforced concrete beam retrofitted with different fibre composites.

- They have use Pro-E software for modelling and ANSYS for analysis the modelled geometry.
- The used carbon fibre reinforced polymer (CFRP) sheet for first layer of RC beam, glass fibre reinforcedpolymer (GFRP) sheet for second layer and Kevlar fibre reinforced polymer (KFRP) sheet for third layer.
- SOLID65 element for concrete beam and SOLID45 element for FRP has been used by them.
- They found that deflection has been minimized around 75% compared to the conventional RC beam when CFRP used.
- Deflection minimized around 65% when GFRP used and 60% when KFRP used.
- Load carrying capacity increases by using FRP laminates.
- Strength increases after using FRP laminates.

TaranuN. and Bejan L. [4] studied Mechanical modellingof composite ARMIDE cu fibre.From the assortment of strands used to make FRP materials the carbon filaments have been observed to be more suitable in understanding the composite strips utilized for the basic restoration of strengthened solid twisted components. The carbon filaments have high quality toweight what's more, solidness to-weight proportions, low warm dilatation coefficient, high weaknessresistance, substance inactivity, strength at high temperatures, high removal resistance, great warm conductivity, low thickness, and high strain quality. A few hindrances of this sort of fibre are low effect quality, high electric conductivity and high costs.

Musmar M. A. et al [5] nonlinear finite element analysis of shallow reinforcedconcrete beams using solid65 element. They targeted their study towards the study of shallow reinforced concrete beam for transverse loading. SOLID65 eight node isotropic elements have been used to model the concrete beam. The analysis has been conducted using ANSYS. They concluded

- Cracking initially occurs in the vertical flexural from in the model.
- The cracking increases with increment in the load.
- The relationship between the load and deflection has been found to be linear elastic up to cracking moment strength then it inclines in horizontal plane.

Santha kumar R. and Chandrasekaran E. [6] analysed retrofitted reinforced concrete shear beams using carbon fibre composites. They have studied the effect of CFRP on the concrete beam with fibre orientation of 45° and 90°. A quarter part of the beam has been studied by them. They have compared their results with the experimental results available and found in good agreement. For un-cracked and pre-cracked beam at ultimate stage they found variation in the results but not large. They concluded that the numerical results help in tracking the formation and propagation of the crack which was not obtained by the experimental results because of the CFRP laminate sheets.

Ibrahim A. M. and Mahmood M. S. [7] finite element modelling of reinforced concrete beams strengthened with FRP laminates. They analysed the model for reinforced concrete beams reinforced with fibre reinforced polymer (FRP) laminates using finite elements method (FEM) adopted by ANSYS. The models have been established utilizing a smeared cracking method for concrete and 3D-layered elements for FRPcomposites. The results obtained have been matchedwith the experimental data for six beams with different conditions from researches. The results have been compared for load-deflectioncurves and failure load at mid length which are in good agreement. But the finite elements results found to be slightly stiffer than that from the experimental results. The maximum difference is 7.8% for all cases included in ultimate loads.

Robert R. S. and Prince A. G. [8] studied finite element modelling on behaviour of reinforced concrete beam-column joints retrofitted with carbon fibre reinforced polymer. The Finite element modelling (FEM) has turned to be recreating the physical conduct of complex building frameworks. The (FEA) programs have increased normal acknowledgment among architects in industry and analysts. The examination of retrofitted with carbon fibrereinforced polymer sheets (CFRP) utilizing ANSYS have been exhibited in this paper. Three different strengthened sheet of CPRF on solid shaft were displayed utilizing ANSYS. Both the ends of the beam in investigation have been kept pivoted. Static load was connected at the free end of the cantilever bar. The analyses have been conducted for the retrofitted beam and the outcomes have been exhibited.

More R. U. and KulkarniD. B. [9] studied flexural behavioural study on RC beam with externally bonded aramid fibre reinforced polymer.They represent the flexural manner of Aramid fibre reinforced polymer (AFRP) with RC beams of M_{25} grade cement. Results have been conducted for beam (simply supported) of cross-section 100mm×150mm×1200mm with laminated by aramid fibre polymer sheets. The impacts of reinforcing on burden conveying limit and impact of harm degree are talked about in subtle element. The outcomes demonstrate that the heap conveying limit of bars was essentially expanded as the quantity of layer expanded. The acceptance of the trial results was finished by utilizing ANSYS programming. To concentrate on the flexural conduct of the pillar, the examples were just subjected to two point stacking system just. The bars were wrapped with AFRP sheets in single layer and twofold layers along the length at the base face of the bar. The present work incorporates Effect of harm level of the pillar and impact of number of layers. In this manner it is an achievable technique for fortifying and retrofitting of RC pillars.

Jayajothi P. et al [10] studied finite element analysis of FRP strengthened RC beams using ANSYS. Remotely fortified FRP sheet can be utilized to increase flexural quality of strengthened solid pillars. Strengthened solid bars remotely fortified with fibre strengthened polymer sheets utilizing limited component strategy embraced by ANSYS. The precision of the limited component model is checked with help of correlation its outcomes with the trial results. The heap redirection bends acquired from the limited component investigation holds great with the trial results

Modelling of beam

A beam with dimensions shown in table 1 has been drawn in the present case. ANSYS 14.5 has been used to model the beam and the analysis part has also been conducted in the ANSYS. A load of 5KN has been adopted to see the effect of the load on the deflection. The total deflection and directional deflection results have been plotted.

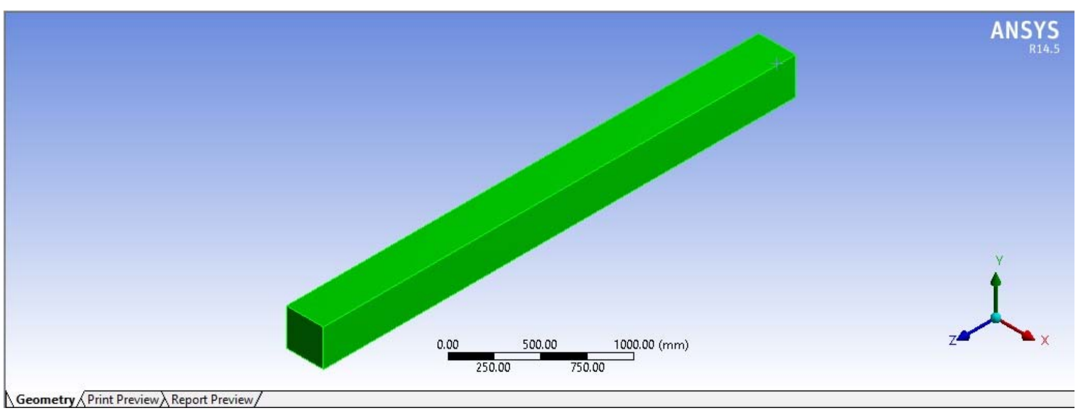

Figure 1 ANSYS modelling of a concrete beam

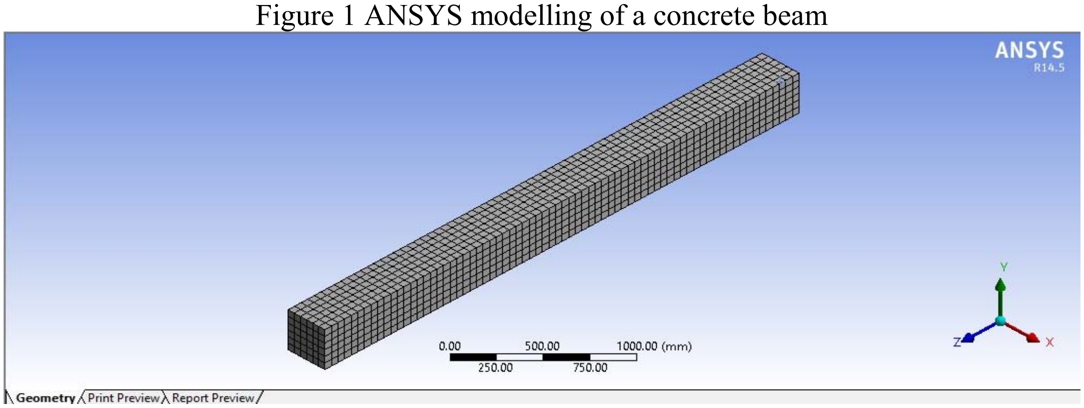

Figure 2 Meshing of the concrete beam in ANSYS

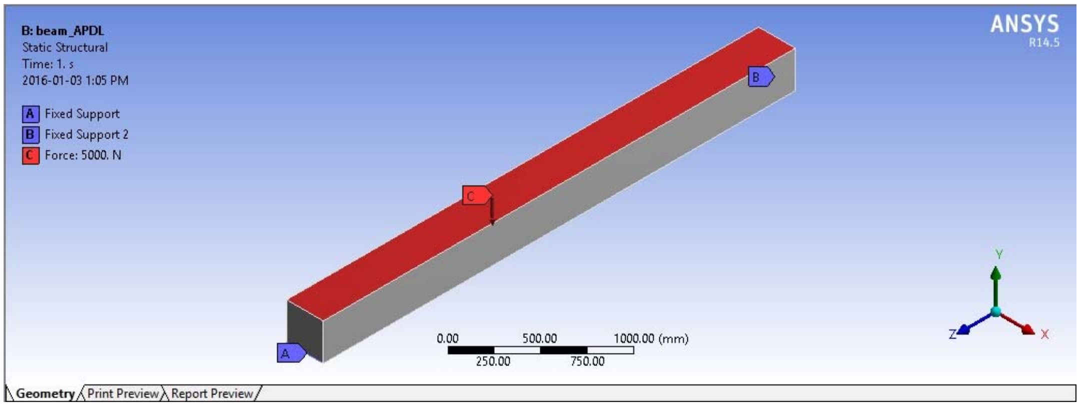

Figure 3 Loads applied fixed support at the ends and a load

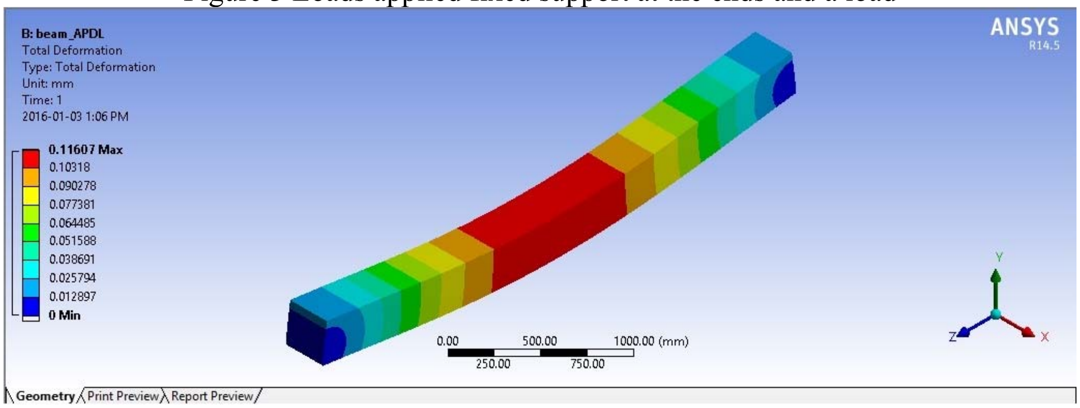

Figure 4 Total deflection of the beam

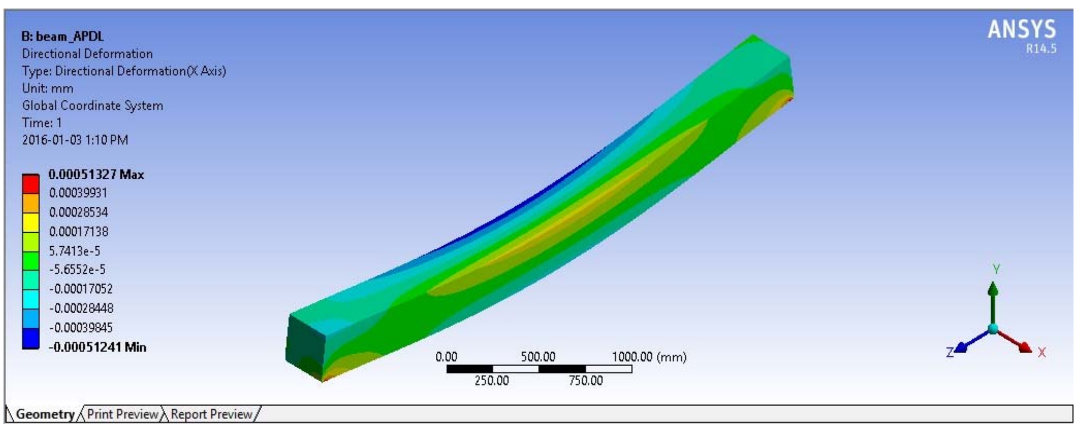

Figure 5 Directional deflection of the beam

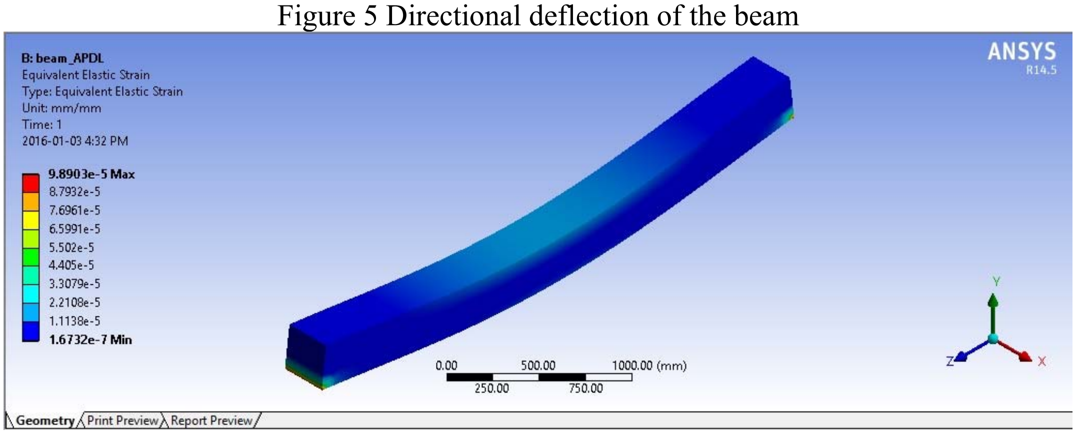

Figure 6 Equivalent elastic strain

Conclusion

1. A concrete beam has been solved in the present problem
2. FEM software help in solving the beam problem
3. Total deflection and directional deflection results have been plotted.
4. Equivalent elastic strain results have been plotted

References

1. Banu D., Barros R. C. D. and Taranu N., Numerical Modelling of Two-Way Reinforced Concrete Slabs Strengthened With Carbon Fibber Reinforced Polymers Strips, *International Conference on Experimental Mechanics*, 22-27. 2012.
2. Scordelis A.C., Ngo D and Franklin H.A., Finite Element Study of Reinforced Concrete Beams with Diagonal tension Cracks. *Proceedings of Symposium on Shear in Reinforced Concrete,* 42, 1972.
3. Parandaman P. and Jayaram M., Finite element analysis of reinforced concrete beam retrofitted with different fibre composites, *Middle-East Journal of Scientific Research* 22(7), 948-953, 2014.
4. Taranu N., Bejan L., Mecanicamediilor composite armate cu fibre, Editura CERMI, Iaşi, 2005.
5. Musmar M. A., RjoubM. I. and Hadi M. A.A.,Nonlinear Finite Element Analysis of Shallow Reinforced Concrete Beams Using Solid65 Element, *ARPN Journal of Engineering and Applied Sciences,* 9(2), 85-89, 2014.
6. Santhakumar R. and Chandrasekaran E.,Analysed Retrofitted Reinforced Concrete ShearBeams Using Carbon Fibre Composites, *Electronic Journal of Structural Engineering,* 4 66-74, 2004.
7. Ibrahim A. M. and Mahmood M. S., Finite Element Modelling of Reinforced Concrete Beams Strengthened With FRP Laminates, *European Journal of Scientific Research*, 30(4), 526-541, 2009.
8. Robert R. S. and Prince A. G., Finite Element Modelling on Behaviour of reinforced concrete beam-column joints retrofitted with carbon fibre reinforced polymer, *International Journal of Civil and Structural Engineering*, 1(3), 576-582, 2010.
9. More R. U. and KulkarniD. B. Flexural Behavioural Study on RC Beam with Externally Bonded Aramid Fibre Reinforced Polymer, *International Journal of Research in Engineering and Technology*, 3(7), 316-321, 2014.
10. Jayajothi P., Kumutha R. and Vijai K., Finite Element Analysis of FRP Strengthened RC Beams Using Ansys,*Asian Journal of Civil Engineering*, 14(4), .631-643, 2013.