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Static Finite Element Analysis of Gfrc Simply Supported Beam

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ABSTRACT

Concrete is most utilized construction materials, it is having many advantages, some are : low cost, long service life (when properly mixed, placed and cured), ease of construction and high compressive strength. In present time the civilization depends upon the available ranges of concrete or reinforced concrete (RC) structures, ranging from domestic structures to heavy structures. However, numerous concrete structures suffer important degradations 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. The research includes static analysis of beam under glass fiber composite plate with PCC and RCC to optimize material and cost of beam with designed strength.

In present research work the response of plain concrete beam, reinforced concrete beam and reinforced concrete beam with GFRP plate is analysed with finite element analysis sotware. ABAQUS software is used to perform analysis of beam. The results and outcomes of analysis concluded that the reinforced concrete beam with GFRP plate gives better results than any other case taken under consideration.

Key words: Composite beam, Fiber Plate, Static Analysis, Abaqus, Finite element Analysis, Stress, Strain, Deflection.

1. INTRODUCTION

Finite Element Analysis

The Strengthened behaviour of the beams has been performed with Finite element analysis. The FEM package ABAQUS has been used for the analysis. The analysis is performed for the different cases. The cases are;

1. Plain cement concrete beam. (PCC).
2. Plain cement concrete beam internally bonded with FRP.
3. Reinforced concrete beam. (RCC).
4. Reinforced concrete beam internally bonded with FRP.

2. Problem Formulation and Objective

Finite element analysis has been performed to model the linear behaviour of the beams. The FEM package ABAQUS has been used for the analysis. The dimension of the beam is taken as b= 150mm, h= 150mm, and l= 700mm. The analysis is done for the various conditions. The conditions are;

1. Plain cement concrete beam
2. Plain cement concrete beam with Glass fiber plates.
3. Reinforced concrete beam
4. Reinforced concrete beam with Glass Fiber Plates.

Objective of the Research

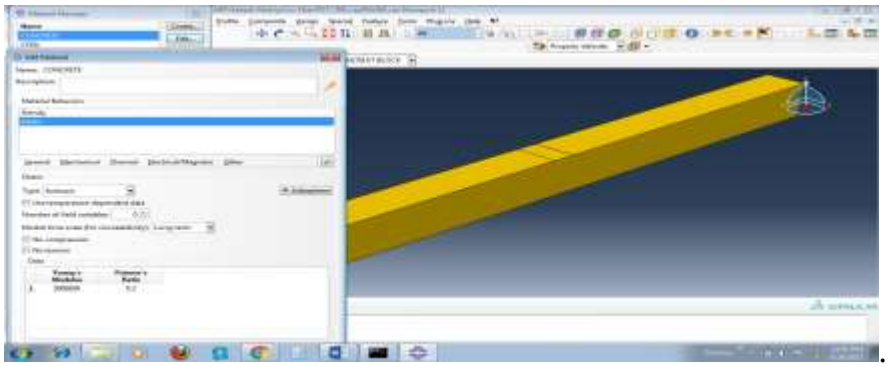
To find theABAQUS analysis result outcomes for PCC, PCC with Glass fibre plate, RCC and RCC with Glass fibre plate: at load 10000N, 5000N, 3000N, 2000N, 1000N, and 500N respectively and to compare the Stress,

Deflection and Strain result outcomes at various loads for PCC and RCC with and without Glass fiber plate at top and bottom face.

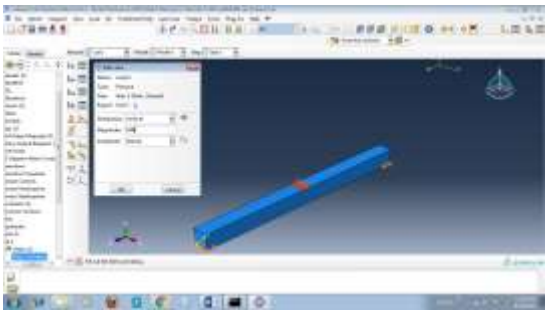
	Density Kg/m^3	Young's Modulus N/m^2	Poission Ratio
PCC	2400	30e11	0.2
RCC	7850	2E11	0.3
GFRC	1.8e-6	26e11	0.28

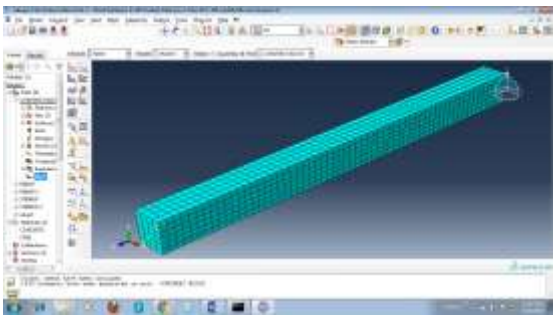
Modelling of Beam

First basic part with outer boundary dimensions is to be created and second command is to assign material property such as Young's modulus, Poisson's and density of the part. Section is also to be assign using section manager, here section is solid, homogeneous.



Third stage is to run assembly command either there are multiple parts or single part. Next step is to assign boundary conditions, figure below is for defining load using load manager. Here present research load is defined and vey next stage is to mesh model by defining number of elements, type of mesh and element type.





Finally job is submitted to run the programme for ABAQUS as part is prepared, defined, and modelled for its load and boundary conditions as per research objective and experimental setup.

3. Analysis of Beam

This section of research is presenting ABAQUS analysis outcomes one by one for load value 10000N, 5000N, 3000N, 2000N, 1000N, and 500N respectively. First outcomes for PCC are presented for each load, and further it is followed by outcomes for RCC model. Load is applied at the centre span of 50 mm as an case taken for research propose.

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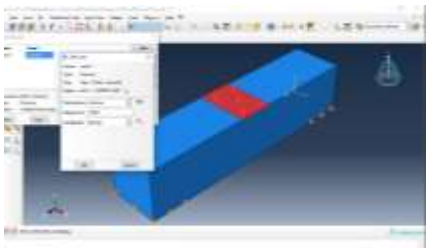
At each load outcome is achieved as a value for maximum stress (S), maximum deflection (U) and maximum strain (E).

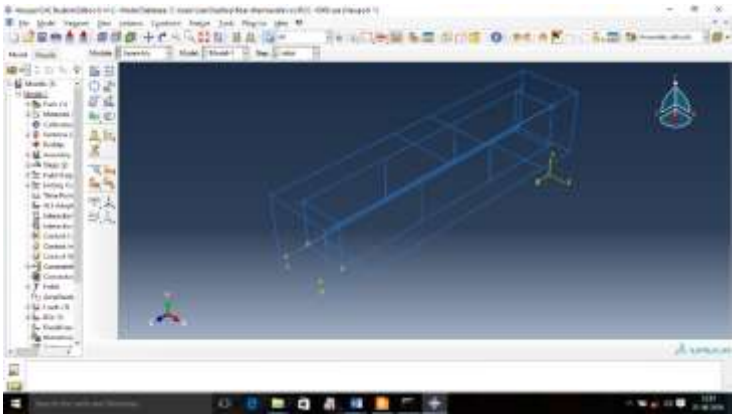
The dimension of the beam is taken as b= 150mm, h= 150mm, and l= 700mm. The analysis is done for the various conditions.

1. Plain cement concrete beam

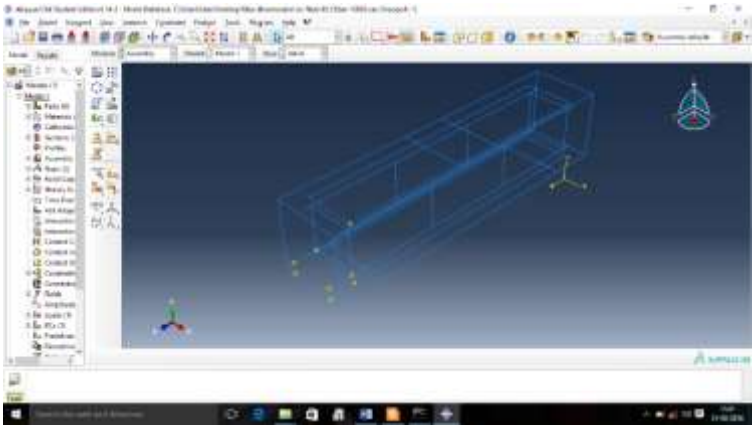


2. Plain cement concrete beam with Glass fiber plates.
   Glass fiber plate is modelled with dimensions width = 110mm, l = 600mm and thickness 12mm. Two plate each at position 20mm inside from top and bottom face are taken to insert Glass fiber into PCC.

3. Reinforced concrete beam
   Reinforcement is modelled using round steel bar of 8mm for longitudinal member which are four in number. Also four rings are considered with same material and same size at the distance of 150mm from each other.



4. Reinforced concrete beam with Glass Fiber Plates.



4. Result and Discussion

Individual stress, deflection and strain results at various loads applied for analysis of PCC, RCC beam's both with and without GFRC.

	PCC					
LOAD	500.0000	1000.0000	2000.0000	3000.0000	5000.0000	10000.0000
STRESS	726.8000	1454.0000	2907.0000	4361.0000	7268.0000	14540.0000
DEFECTION	0.1269	0.2538	0.5076	0.7614	1.2690	2.5380
STRAIN	0.00015	0.000295	0.00059	0.000885	0.001475	0.00295

	RCC					
LOAD	500.0000	1000.0000	2000.0000	3000.0000	5000.0000	10000.0000
STRESS	726.3000	1453.0000	2905.0000	4358.0000	7263.0000	14530.0000
DEFECTION	0.1267	0.2535	0.5070	0.7605	1.2670	2.5350
STRAIN	0.0015	0.0030	0.0009	0.0013	0.0022	0.0044

	PCC WITH GFRC					
LOAD	500.0000	1000.0000	2000.0000	3000.0000	5000.0000	10000.0000
STRESS	724.7000	1449.0000	2899.0000	4348.0000	7247.0000	14490.0000
DEFECTION	0.1267	0.2534	0.5068	0.7602	1.2670	2.5340
STRAIN	0.0001	0.0003	0.0006	0.0009	0.0015	0.0030

	RCC WITH GFRC					
LOAD	500.0000	1000.0000	2000.0000	3000.0000	5000.0000	10000.0000
STRESS	723.3000	1447.0000	2893.0000	4340.0000	7233.0000	14470.0000
DEFECTION	0.1263	0.2527	0.5054	0.7580	1.2630	2.5270
STRAIN	0.0002	0.0004	0.0009	0.0013	0.0022	0.0043

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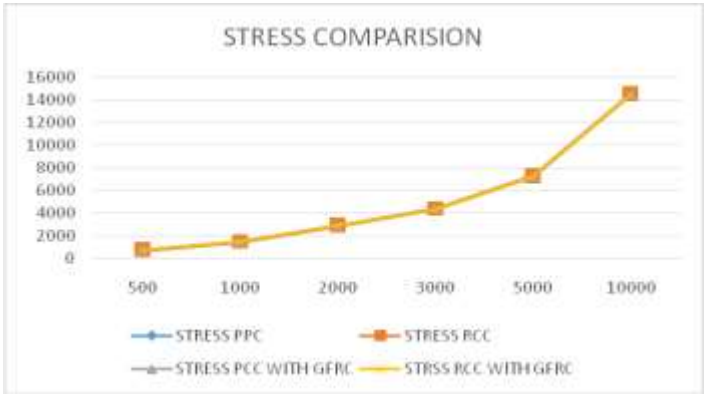
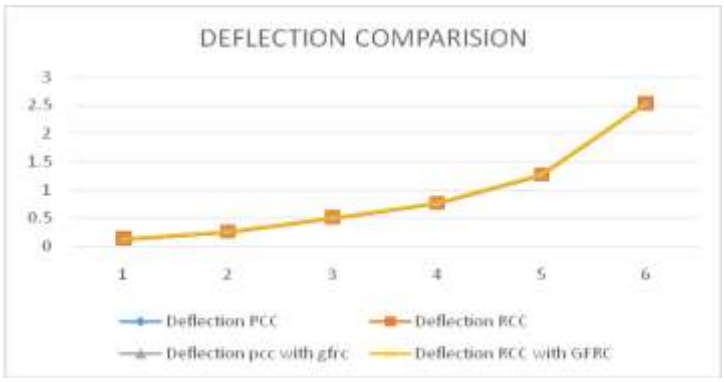
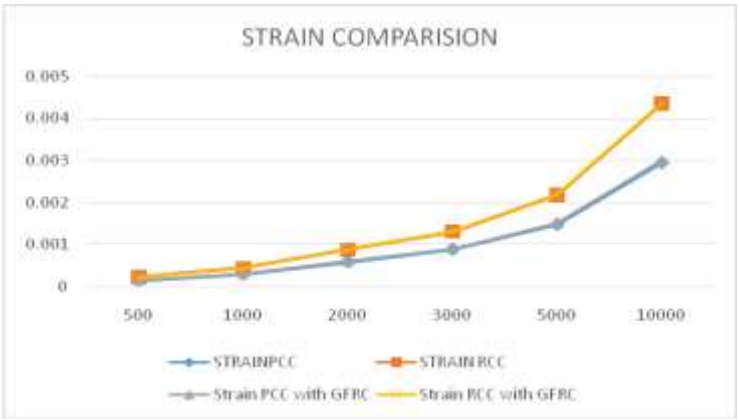
Result Comparison Graphs for Stress, Deflection and Strain







5. Conclusion

Rehabilitation by GFRC has proven itself to be a better feasible option than other methods. So the future prospects for the utilization of GFRC in Civil engineering infrastructure are good. Researchers around the world are now looking at the new and innovative ways of utilization of the same. The behaviour of concrete beams strengthened with GFRC unidirectional composite laminates have been studied. GFRC inserted beams behaves better than the PCC or RCC beam. Deflections in the beams retrofitted with GFRC are less than PCC and RCC beam. From the finite element analysis the RCC with GFRC has the higher stiffness than all other cases. For the same load the RCC beam with GFRC have the less stresses and deflection. In the comparison cases both experimental and analytical results are coinciding. Therefore the

FEA software ABAQUS can use effectively for the beam analysis.

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