EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF HYBRID TEXTILE REINFORCED CONCRETE IN FLEXURE

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ABSTRACT

Textile reinforcement was made up of non-corrosive materials and its structural application is very large based upon its properties. The paper deals with the behaviour of thin shells reinforced with textile reinforced concrete in both experimentally and analytically in flexure. The size of the specimen used was 1200mm x 250mm x 50mm tested under the four point bending load test The Thin shells was reinforced with S-glass textile reinforced concrete with fully replaced the steel reinforcement. The experimental result shows that the load and deflection varies accordingly by changing the thickness of textile layers in the shells. It was observed that failure of due to inner shear slip resistance. From the results S-glass shows more load carrying capacity and deflections was controlled. Further analytical investigation was done to validate the experimental results. In analytical investigation, S-glass textile reinforced concrete with fully replaced with steel reinforcement. It was observed that the S-glass having more flexibility.

Keywords: TRC, FEM, S-glass, ABAQUS.

1. INTRODUCTION

The improvement of meagre shells was increasing based upon the problems in structures with the application of TRC. The fabric mesh provided in the TRC replaces the steel reinforcement with more flexibility. In TRC fine grained bond concrete gives confinement to the sections.

The study focus on thin shells reinforced with S-glass textile mesh of size 1200 mm x 250 mm x 50 mm . The total four specimens are casted the three specimens are reinforced with S-glass mesh by changing the layer and another specimens is reinforced with ordinary steel. The layers that are in corporate in 3 specimens reinforced with S-glass mesh: Three layers, four layers, five layers. In control specimen, the steel is placed in orthogonal direction of spacing 175mm in longitudinal directional and 200mm in transverse direction.

2. MATERIAL

Cementitious materials used in this research are ordinary Portland cement (OPC), fine aggregate, coarse aggregate, textile reinforcement.

2.1.1 Cement

Ordinary Portland cement (OPC) of grade 53 with properties confirming with IS12269-2009 were used. The specific gravity and fineness modulus of cement is 3.14 and 6 respectively.

2.1.2 Fine aggregate

The maximum fine aggregate size used 2 mm. The various properties such as specific gravity, fineness modulus and sieve analysis are conforming to standard specification. The specific gravity and fineness modulus of fine aggregate is 2.68 and 3.01 respectively.

2.1.3 Coarse aggregate

Locally available coarse aggregate having the less than 6 mm is used in this work. The aggregate were tested as per IS383-1970.

2.1.4 Textile reinforcement

Textile reinforcement support is a material comprising of a heterogeneous structure to get a handle on the confused conduct of this material, it can to be analyzed at numerous exploratory dimensions. Fabric can be utilized to produce singular filaments of length likewise suggest to as fabric, which are described by a distance across running between 7-29 relying up on the type of material.

2.1.5 S-GLASS

Table-1. Properties of S-GLASS.

Property	value
Density g/cm^2	2.54
Tensile Strength (GPa)	3200-4100
Elastic modulus	86
Elongation at break %	5.3
Softening point	580
Poisson's ratio	0.20

3. Experimental study

3.1 Specimen details

The experiment setup consist of four number of specimen of dimension 1200 mm x 250 mm x 50 mm in which three specimen of reinforced with S-glass textile reinforcement and another one is reinforcement with conventional steel reinforcement. The instillation of S-glass is followed in this section.

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3.2 Installation of S-glass TRC

The cross section of textile reinforcement is shown in Figure-3.1 cross section of S-glass mesh placed in the concrete specimen of three, four, five layers at each layer distance 5mm from the bottom of the specimen as show in Figure-3.1, Figure-3.2, Figure-3.3, Figure-3.4.

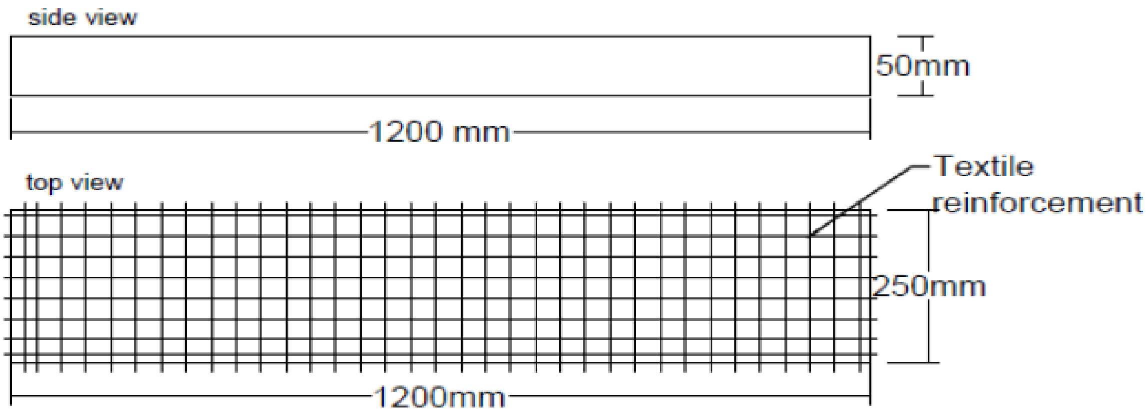

Figure-3.1. Cross section of textile reinforcement.

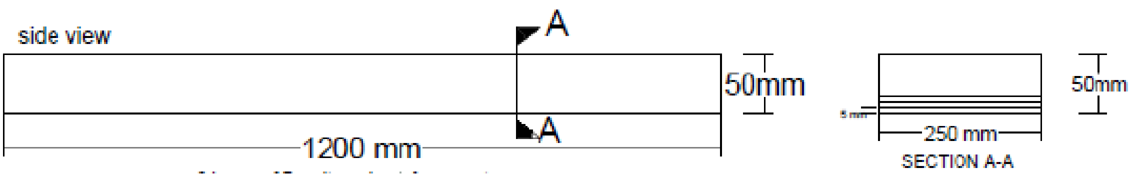

Figure-3.2. Cross section of three layers of S-glass TRC.

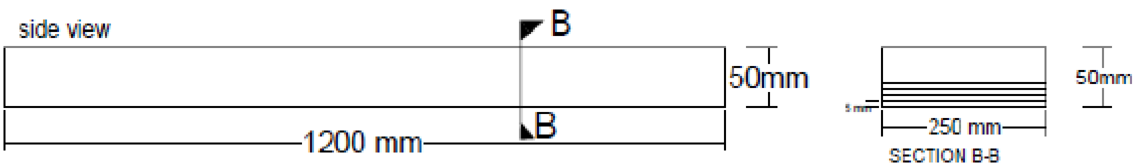

Figure-3.3. Cross section of four layers of S-glass TRC.

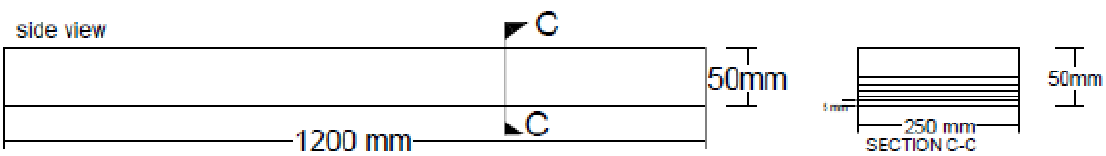

Figure-3.4. Cross section of five layers of S-glass TRC.

3.3 Installation of steel reinforcement

The cross section of control specimen (conventional steel) where the steel reinforcement is placed at a distance of 20mm from the bottom of the specimen in the tension zone as shown in Figure-3.5.

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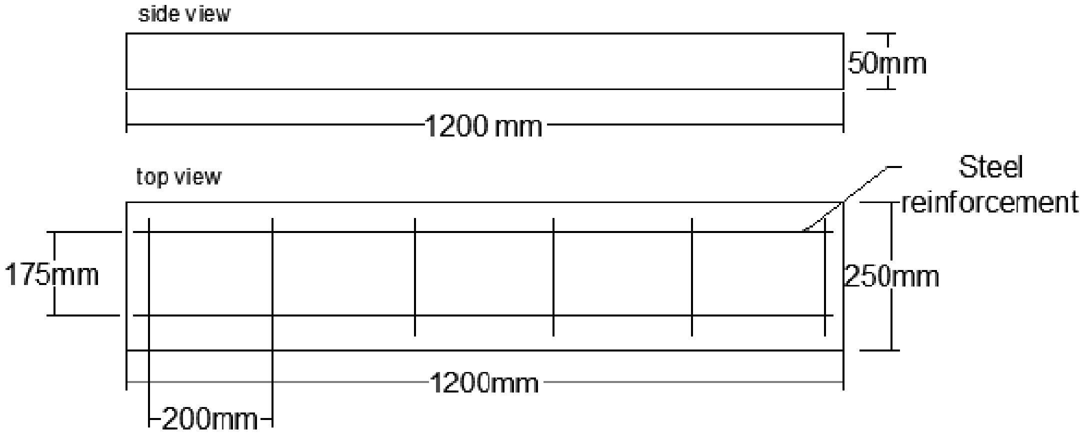

Figure-3.5. Typical cross section of steel reinforcement.

3.4 RESULT AND DISCUSSIONS

The test results shows that load vs. deflection was taken that by load was applying at constant rate of 2kN. The initial crack was observed at 6kN. At displacement of 4 mm in the tension zone and multiple cracks are obtained after the initial crack was observed. The deflection was increased gradually with respective of applying load. As the load increased, the cracks are starts opening its width. The ultimate load was taken by control specimen is 30 kN.

Table-2. Ultimate load and deflection.

S.No	Specimen	Ultimate load	Deflection	% of Increase load carrying capacity
1	cc	30	28	-
2	3 layer	32	26	6.67
3	4 layer	36	25	20
4	5 layer	38	24	26.67

Figure-3.6. Failure specimen of control specimen.

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The experimental results of 3 layers of S-glass TRC shows that the formation of initial crack was observed at 4kn at displacement of 4.81 mm by applying constant load of 2kn. The multiples cracks were developed after the formation of initial crack. As the load start increasing, the width of crack opening also increased. The ultimate load for 3 layers of S-glass TRC in specimen is 32kN.The failure specimen shown in Figure-3.7.

Figure-3.7. Failure specimen of 3 layer S-glass TRC.

The four layers of S-glass TRC show that the formation of initial crack was observed at 6kN at displacement of 5.89 mm by applying constant load of 2kN. The multiples cracks were developed after the formation of initial crack. The ultimate load for 4 layers of S-glass TRC in specimen is 36kN. At the ultimate load, the sound that created by the fibres. The specimen takes more loads when compared to 3 layers of S-glass. The failure specimen shown in Figure-3.8

Figure-3.8. Failure specimen of 4 layer S-glass TRC.

five layers of S-glass TRC exhibits the same type of failure as the 4 layers of S-glass TRC where the initial crack was observed at 6kn at displacement of 4.21 mm by applying constant load of 2kn. The multiples cracks were developed after the formation of initial crack. The failure load for 5 layers of S-glass TRC in specimen is 38kN. At the ultimate load, the sound that created by the fibres. The specimen takes more loads when compared to 4 layers of S-glass TRC but displacement is more in 5 layers of TRC. The failure specimen is shown in Figure-3.9.

Figure-3.9. Failure specimen of 5 layer S-glass TRC.

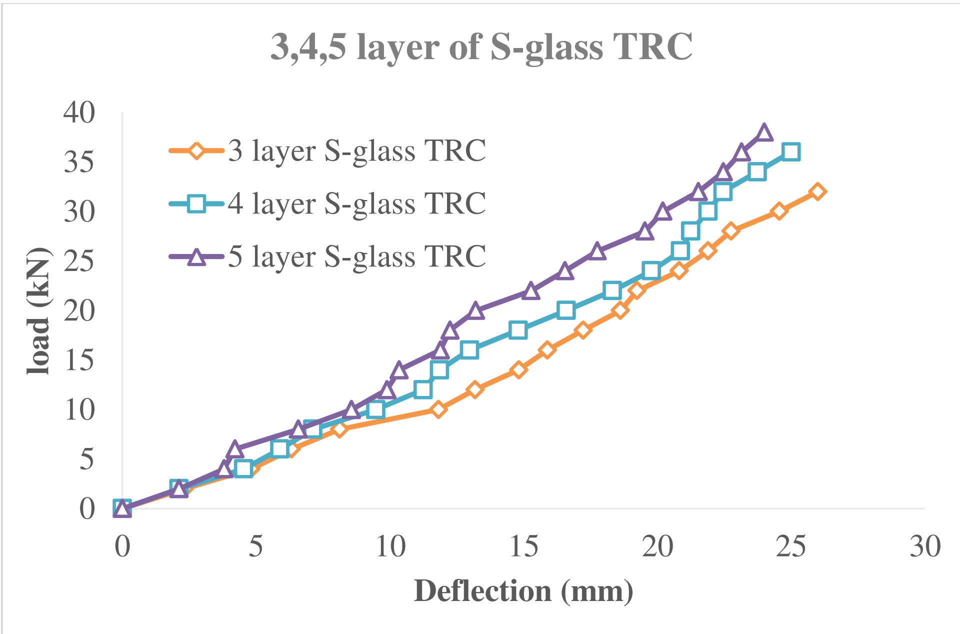

Figure-3.10. Load Vs. Deflection curve for 3, 4, 5 layer S-glass TRC.

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4. Analytical study

The paper deals with behaviour of the thin shells reinforced with TRC. It includes material models, element types, mesh, convergence and boundary conditions. To be able to verify the quality of the model, results must compare to experimental results.

4.1 ABAQUS model

Abaqus/standard, 6.10 was used for the finite element modelling in this work. This FEM package includes a large variety of material models and parts together with facilities necessary for this particular subject

Table-3. Properties of the TRC cross section.

Material	Dimensions
Concrete model	1200mm x 250mm x 50mm
Reinforcing material	1200mm x 250mm x 2 mm

Analytical part mainly consists of three stages; they are modelling, meshing and analysis. The modelling of the slab is carries out by creating the exact model of the test specimen. The project carries out under fine meshing conditions. As the mesh gets finer the time taken for analysis also increases. An exact condition where the experimental has been carried out is stimulated in FEM software. The loads, loading distances and support distances are provided exactly as experimental model

Based on the analytical results, the formation of initial crack for control specimen is 5.1kN. The S-glass TRC mesh which is placed in specimen of about 3 layers, 4 layers, 5 layers having initial crack at 3.7kN, 5.5kNn, 5.9 kN respectively and deflected shape of S-glass TRC shown in Figures 4.1,4.2,4.3

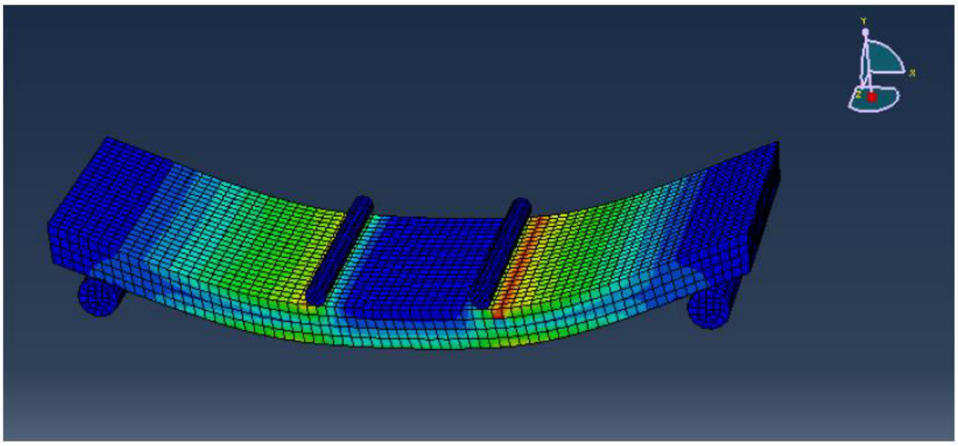

Figure-4.1. Deflected shape of S-glass TRC.

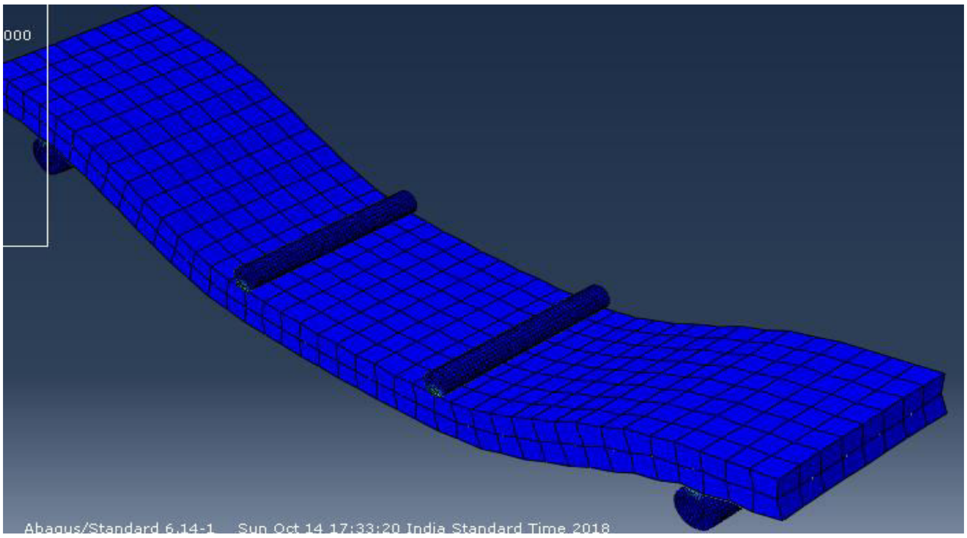

Figure-4.2. Deflected shape of S-glass 4 layer TRC.

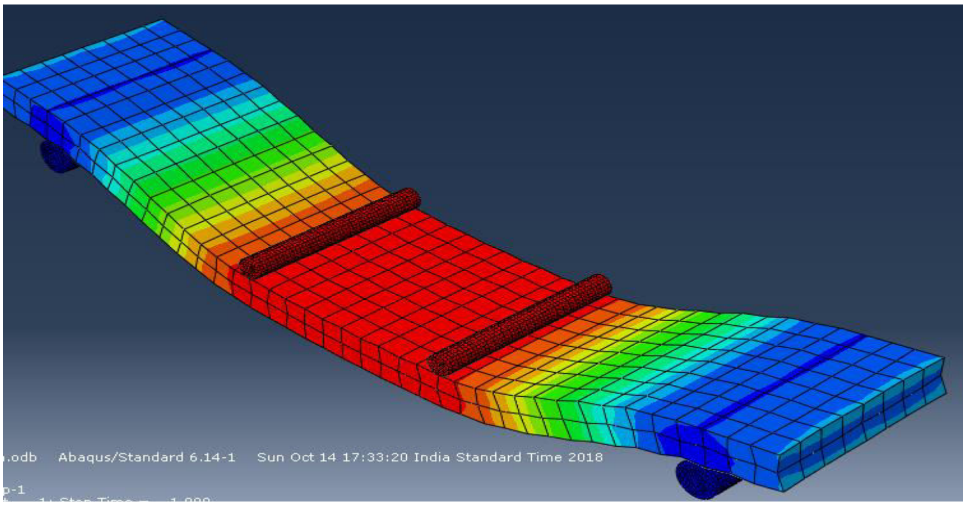

Figure-4.3. Deflected shape of S-glass 5 layer TRC.

Table-4. Load and Deflection.

Load kN	**Deflection mm**		
	3rd layer	**4th layer**	**5th layer**
0	0	0	0
5	6.45	5.5	4.6
10	12.16	10.62	9.54
15	16.35	12.68	12.12
20	20.45	17.92	13.83
25	23.04	21.32	19.91
30	27.23	23.62	22.35
35	29.35	27.13	26.81
40	31.32	29.13	28.52

5. COMPARSION BETWEEN ANALYTICAL STUDY AND EXPERIMENTAL STUDY

It was found that experimental and analytical load vs. deflection curve had difference where analytical curve shows a bit of more deflection when compared with experimental curve. When load is increased analytical curve shows higher load as compared to the experimental curve and in case of deflection, there is bit higher in the analytical curve when compared with experimental curve. The comparison load-deflection curves of control specimen shown in Figure-5.1 high in the deflection but carries more load in analytical curve. In both cases the deflection is almost equal up to certain limit and both the curves separated when the load reaches to the 14kN. However the failure specimen in both the cases is almost equal with difference of 2kN

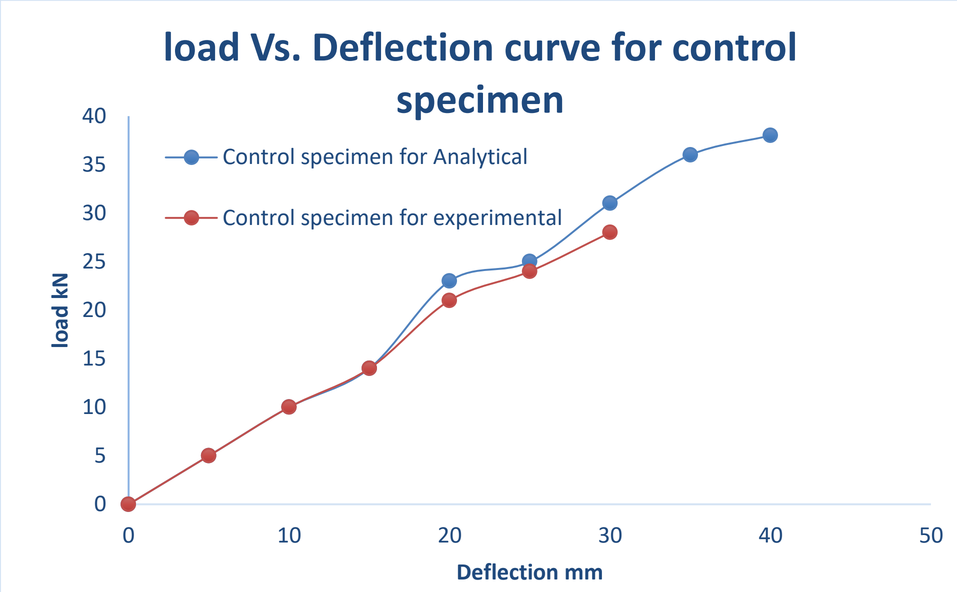

Figure-5.1. Comparison load vs. deflection curve of control specimen.

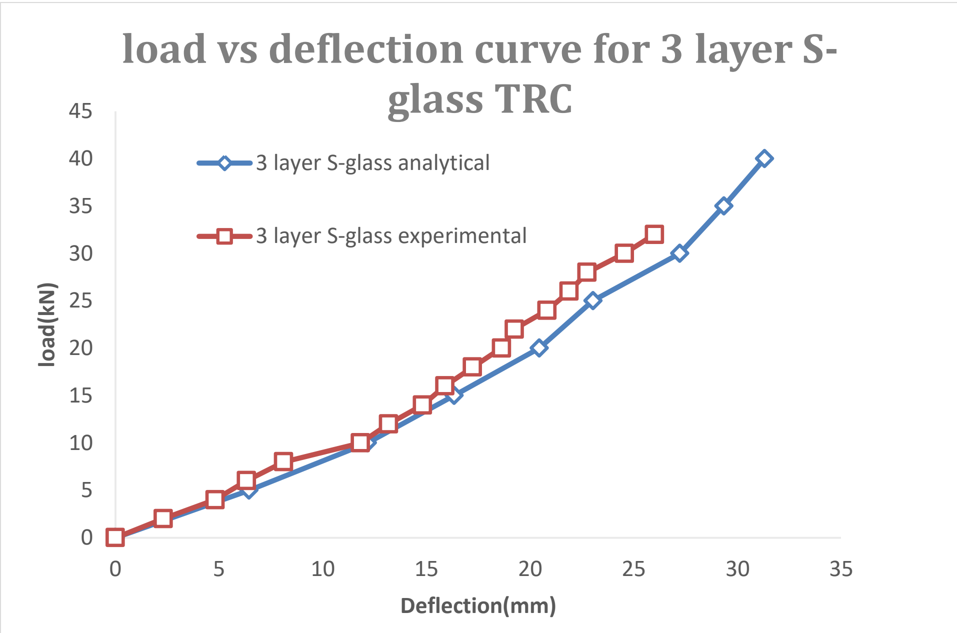

Figure-5.2. Comparison load vs. deflection curve of 3 layer S-glass TRC.

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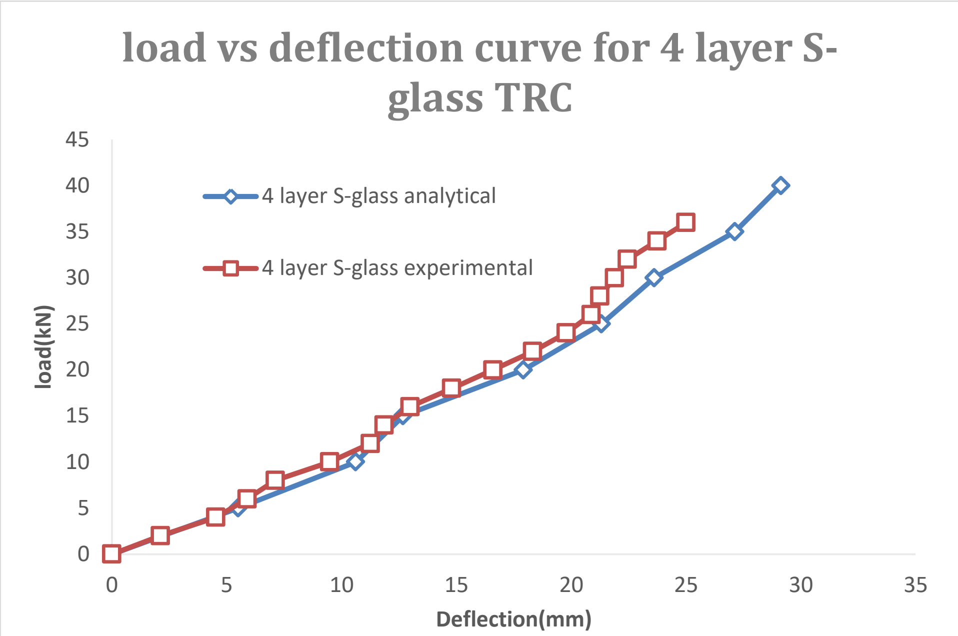

Figure-5.3. Comparison load vs. deflection curve of 4 layer S-glass TRC.

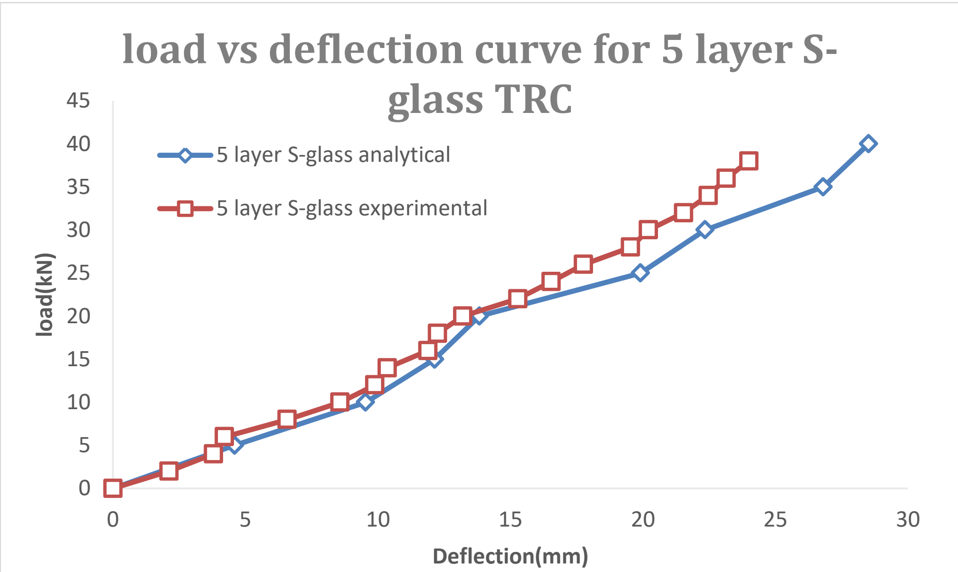

Figure-5.4. Comparison load vs. deflection curve of 5 layer S-glass TRC.

6. CONCLUSIONS

The S-glass TRC is used as replacement of conventional steel has been used in this project. The 3,4,5 layers of S-glass TRC is used as reinforcement to thin shells where placed at a distance of 5mm from the bottom of thin shells. Using of S-glass TRC lead to improvement in flexural strength:

a) By increasing the textile layers in specimens, it bears more loads when compared to the control specimen.
b) The optimum layers for thin shell reinforced with S-glass textile reinforced concrete is 4 layers in which deflection are controlled at ultimate load where specimen is are carrying more deflections at ultimate load.
c) Finally the TRC specimen behave more flexible than the control specimen
d) By using the TRC specimen, the weight of specimen is low where density of S-glass reinforcement mesh is low when compared with normal conventional specimen.
e) More strength was attained by using S-glass TRC.

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