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FEM ANALYSIS OF AN INTZE TANK BEAM WARPED WITH FRP LAMINATES USING ANSYS 14.5

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ABSTRACT

In present research we are analyze the RCC-beam using FEM software Ansys14.5 and comparing Without FRP Beam, CFRP, GFRP and KEVLAR laminates Reinforced Beams are made strong in flexure through the utilization of Fibre reinforced polymer (FRP) composites which are attached in their tension zones. In this study finite element method is used to study the deflection of rectangular Beam reinforced by FRP laminate composites at the top surface of the beam. In this study the FRP is CFRP, GFRP and KEVLAR. Ansys software is used for finite element modelling. In this study Without FRP beam and beam laminated with CFRP, GFRP and KEVLAR are compared on the basis of deformation and stresses. The variables in the finite element modelling are type of FRP and different length of FRP laminates. In this study it is observed that KEVLAR is provided more strength to the structure as compare to the Without FRP material, CFRP and GFRP laminated beam. The analytical concrete Beam model was generated using a FEM software program Ansys14.5. In Ansys14.5 software concrete Beam this is subjected to loading through vertical loading which are 953KN. Simulation results shows that There is 42.67% reduction in deformation for length of 13000mm KEVLAR laminate as compare to Without FRP concrete as compare to Without FRP Beam and There is 41% reduction in stresses for length of 13000mm KEVLAR laminate as compare to Without FRP concrete. KEVLAR provided more strength to the structure (Beam) and effective than Without FRP Beam, GFRP and CFRP reinforced material in reduction of deformation and stresses.

Keywords- FEM, FRP, Kevlar, CFRP, GFRP, Ansys, Concrete Beam, Stress, Deformation, etc.

I. INRTODUCTION

Research on fibre reinforced concrete has been conducted since the 1960's. During the 1970s the commercial use of this material began to increase, particularly in Europe, Japan and USA. Common application areas today are concrete, pavements, industrial floors, precast elements and various kinds of repairs. The addition of randomly distributed steel fibres increases the cracking resistance of concrete, i.e. the fracture toughness, ductility, impact resistance, fragmentation and spalling resistance. However, since fibres generally are distributed through the cross section it is not possible to achieve the same area of reinforcement with fibres as with conventional bars. Hence, for normal fibre contents, the concrete exhibits a softening response. Fibres are primarily used as replacement for conventional reinforcement in non-structural applications in order to control early thermal contraction cracking and drying shrinkage cracking. However, the use of fibres for structural applications as part of the overall structural design is continuously increasing. In some types of structures with relatively low reliability levels for structural safety such as slabs on grade, foundations and walls, fibres can replace ordinary reinforcement completely. Furthermore, in load carrying structures in general, fibre reinforcement may be used in combination with conventional or prestressed reinforcement. Although economical issues has been the main limiting factor for practical use of SFR, it is presently a more interesting alternative due to lack of skilled concrete workers and need for industrialisation of the construction industry.

A potent advantage of using FRP as an alternate external confinement to steel is the high strength to weight ratio comparisons. In order to achieve an equivalent confinement, FRP plates are up to 20% less dense than steel plates and are at least twice as strong, if not more. Manufacture of modern composites is, then, possible in reduced sections and allows composite plates to be shaped on-site. The lower density allows easier placement of confinement in application. Design of external confinement to a structure should be made with conservative adjustments to the primary structures dead weight load. Changes of the stiffness of members should be considered when redesigning the structure. The improved behaviour of FRP wrapped members reduces the

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strains of internal steel reinforcement thereby delaying attainment of yielding. Much like internal steel confinement in longitudinal and lateral axes, external confinement exerts a similar pressure on the concrete as well as to the internal steel. Furthermore, FRP have high corrosive resistance equating to material longevity whilst within aggressive environments. Such durability makes for potential savings in long-term maintenance costs.

II. LITERATURE REVIEW

Murshed and Ahmed (2011) [1] carried out seismic analysis on eight soft story structures which were retrofitted with FRP wraps. It was found that seismic performance of the soft story structures can be improved by FRP wraps. Improvement in the lateral strength was negligible due to wraps but ductility improvement was quite satisfactory. It was also found that hinge formation at the performance level improved significantly. No collapse prevention hinge was found in the retrofitted structure. In most of the cases, the hinge for retrofitted structure remained within the immediate occupancy level and very few at life safety level which is very desirable scenario for structures in seismic prone areas.

Mahmood and Mahmood (2011) [2] Strengthening of concrete structures with externally bonded carbon fiber reinforced polymers (CFRPs) has been a viable technique for at least a decade and it became interesting material and applied in strengthening reinforced and prestressed concrete beams. It has been found that CFRP sheets are very suitable; not only because of its strength, but also due to its ease of application in comparison to traditional strengthening systems. Despite the fact that CFRP has been widely used in strengthening reinforced concrete members, a very limited works were found in the literature that is related to the application of CFRP in assessing the torsional strength of prestressed concrete beams. Eight medium-scale reinforced concrete beams (150mmx250mm) cross section and 2500mm long were constructed pure torsion test. All beams have four strands have no eccentricity (concentric) at neutral axis of section. There are classified into two group according uses of ordinary reinforcements. Where four beams with steel reinforcements, for representing partial prestressing beams, while other four beams have not steel reinforcements for representing full prestressing beams. The applied CFRP configurations are full wrap, Ujacked, and stirrups with spacing equal to half the depth of beam along its entire length. The test results have shown that the performance of fully wrapped prestressed beams is superior to those with other form of sheet wrapping. All the strengthened beams have shown a significant increase in the torsional strength compared with the reference beams. Also, this study included the nonlinear finite element analysis of the tested beams to predict a model for analyzing prestressed beams strengthening with CFRP sheets.

Zojaji and Kabir (2011) [3] A new computational procedure is developed to predict the full torsional response of reinforced concrete beams strengthened with Fiber Reinforced Plastics (FRPs), based on the Softened Membrane Model for Torsion (SMMT). For validating the proposed analytical model, torque-twist curves obtained from current theoretical approaches are compared with experimental ones for both solid and hollow rectangular sections. The good agreement results of this comparison show that the proposed analytical model is reliable for predicting the torsional behavior of FRP-strengthened reinforced concrete beams before and after cracking. By means of the developed approach, the power of the SMMT method, in extending to FRP-strengthened reinforced concrete beams, is demonstrated in this paper. Moreover, the contribution of FRP fabrics to the torsional response, as an external bonded reinforcement, is studied in various practical strengthening configurations. Therefore, the efficiency of each configuration is illustrated as well.

Büyükkaragöz, A. (2010) [4] various strengthening methods were frequently carried out in the world to strengthen weaker cross section beams. In this study, one beam strengthened by bonding with a prefabricated plate which has 80 mm thickness underneath and one control beam were produced. The specimens were tested in the laboratory and a single load was applied on the middle of the beam. The results of the experiments were compared with the results obtained from the beam modelled with ANSYS finite element program. When the results of the experiments were compared with the modelled computer program, it was shown that the results of computer model gave similar results to the real behaviour.

Mostofinejad and Talaeitaba (2006) [5] Use of fiber reinforced plastic (FRP) composites for strengthening of beams and columns in RC structures has attracted great attention in recent decades. However, less attention has been paid to strengthening RC connections with FRP laminates. In the current study, a finite element (FE) modelling has been proposed for the non-linear analysis of RC joints covered with FRP overlays. The model

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consists of the effects of anchorage slip and anchorage extension of the steel reinforcement in the connection zone. As for the credibility of the method, some available experimental works were modelled and non-linearly analyzed using ANSYS. The results showed that the model can predict the experimental works with good accuracy. At the end and as a case study, a base joint specimen was strengthened with FRP laminates in 7 different cases and the specimens were analyzed using the aforementioned modelling. The results showed that good ductility and strength enhancement could be achieved by employing correctly configured FRP laminates.

III. OBJECTIVE OF THE STUDY

The objective of present analysis is to evaluate the effectiveness of the use of FRP laminates as external reinforcement to reinforced concrete frames with Ring Beam section in an Intze Tank subjected to stress and Deformation. The following FRP configurations are examined:-

1. First analysis is going to be done on unreinforced sections of Intze tank ring beam which is compared to reinforced sections with FRP laminates.
2. Wrapping is done in different patterns at Intze tank ring beam.
3. After the analysis of above two researcher supposed to use different type of FRP laminates as well.
4. Researcher will validate the retrofitting method by using FRP laminates in software package ANSYS 14.5.
5. Researcher will also give the best FRP laminate properties for reduction in stress and deformation for the different loading conditions as per given objective 2 and objective 3.

In this study test specimen of an **Beam Section** from Intze Tank **Middle Section** sized **1000mm x 600mm** having overall **length 14m** of **grade M-30** and Loading condition for **Beam Section** is **953 KN/m** which is analysed in both conditions such as unreinforced means without FRP wrapping which is base model and reinforced means wrapped by FRP with different length is taken for Finite Element Method analysis for the investigation of deformation and stresses.

Warping lengths of Fibre Reinforced Polymer for both Unreinforced and Carbon Fiber Reinforced Polymer is varying which is given below in table 1.

Table 1 warping lengths of FRP laminates

Test Name	**FRP**			**Warping Length L (m)**
B1	**Without FRP**	**Without FRP**	**Without FRP**	**NIL**
B2	**Kevlar**	**CFRP**	**GFRP**	**1**
B3	**Kevlar**	**CFRP**	**GFRP**	**5**
B4	**Kevlar**	**CFRP**	**GFRP**	**9**
B5	**Kevlar**	**CFRP**	**GFRP**	**13**

IV. RESULTS

Table 2 Comparison of FRP Result (Deformations)

Load (KN/m)	**Results**	**Beam Section Type Rectangular**					**% Variations**
	Deformation (mm)	**Unreinforced**	**Reinforced With Different warping length L(mm)**				
			L=1000	**L=5000**	**L=9000**	**L=13000**	
953	Unreinforced	36.2	-	-	-	-	
	KEVLAR		29.014	26.348	23.528	20.754	42.6%
	CFRP		32.454	28.521	26.281	24.245	33%
	GFRP		33.954	31.648	27.428	26.854	25.8%

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Table 3 Comparison of FRP Result (Stress)

Load (KN/m)	Results	Beam Section Type Rectangular					% Variations
	Stress (mm)	Unreinforced	Reinforced With Different warping length L(mm)				
			L=1000	L=5000	L=9000	L=13000	
953	Unreinforced	562.36	-	-	-	-	
	KEVLAR		392.55	375.39	354.14	332.12	41%
	CFRP		424.35	375.45	356.85	340.84	39.39%
	GFRP		433.55	408.39	391.14	354.33	37%

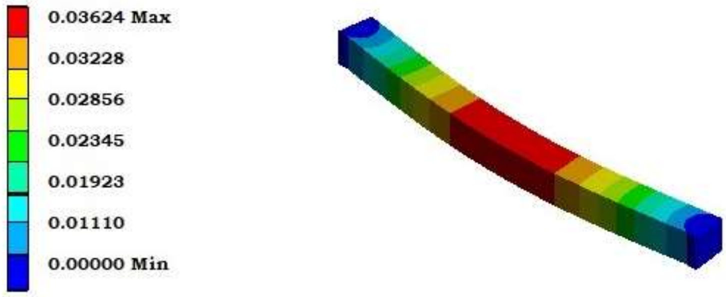

Figure 1. Deformation of Base Model Beam Section

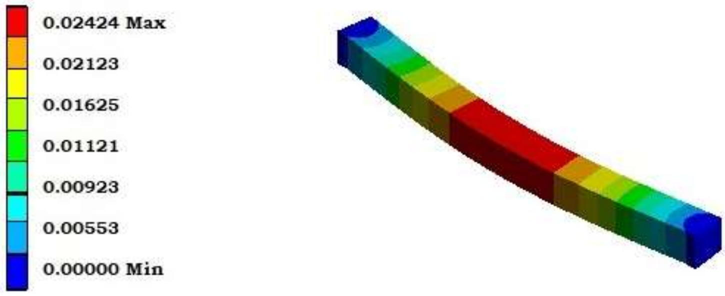

Figure 2. Deformation of CFRP L=13000

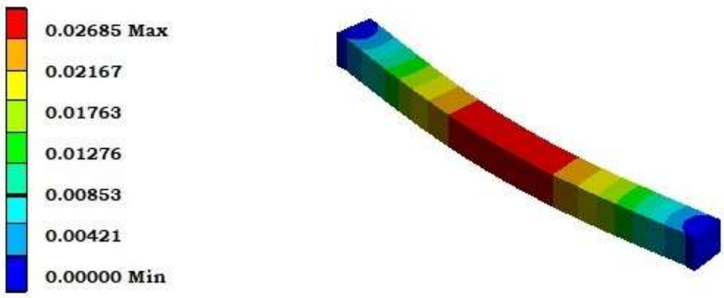

Figure 3. Deformation of GFRP L=13000

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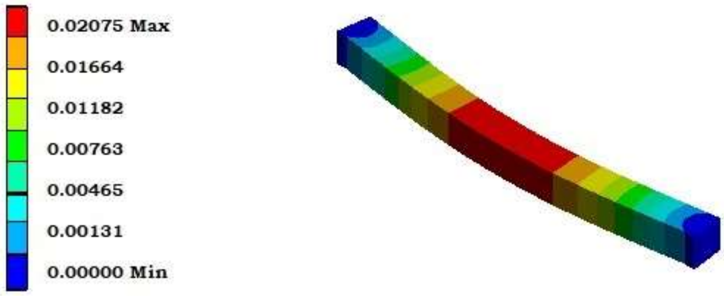

Figure 4. Deformation of KEVLAR L=13000

V. CONCLUSIONS

1. There is 33% reduction in deformation for length of 13000mm CFRP laminate as compare to Without FRP concrete.
2. There is 39.39% reduction in stresses for length of 13000mm CFRP laminate as compare to Without FRP concrete.
3. There is 25.8% reduction in deformation for length of 13000mm GFRP laminate as compare to Without FRP concrete.
4. There is 37% reduction in stresses for length of 13000mm GFRP laminate as compare to Without FRP concrete.
5. There is 42.67% reduction in deformation for length of 13000mm KEVLAR laminate as compare to Without FRP concrete.
6. There is 41% reduction in stresses for length of 13000mm KEVLAR laminate as compare to Without FRP concrete.
7. KEVLAR provided more strength to the structure Beam and effective than CFRP and GFRP reinforced and Without FRP concrete material in reduction of deformation and stresses

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