Behaviour of Hybrid Beams Reinforced With GFRP Rebars

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Abstract- *Glass Fiber Reinforced Polymers has high tensile strength high corrosive resistance low weight and high temperature tolerance .So it can be used as alternative material for replacement of steel reinforcement .Most of the structure fails due to explosion or seismic loads and also due corrosion of steel reinforcement .So we use GFRP bar to increase the tensile strength of beam and fibers is used to increase the compressive and tensile properties of the concrete and to reduce the crack .This paper present the experimental study of behavior hybrid beams reinforced with GFRP rebar's as the main reinforcement and test is conducted to determine the flexural strength of beam by using two point loading and compare with conventional steel reinforcement concrete beam .Two types of beam were casted normal beam and hybrid beam with GFRP Rebar's. Based on experimental investigations done on beam. The value of crack initiation loads for beam with GFRP Rebar's and normal reinforcement were 18KN and 10.2 KN respectively. The value of ultimate load carrying capacity for beams with GFRP rebar's and normal reinforcement were 28.8KN and 25.2 KN respectively.*

Keywords- gfrp rebars ,hybrid beam

I. INTRODUCTION

The gfrp rebars are, particularly with respect to reinforced concrete. In Ontario alone, it has been estimated that the replacement cost of deficient bridges and highways is 57 billion One of the biggest challenges facing engineers today is the problem of aging dollars (MTO, 2009). The major cause of deterioration among reinforced concrete structures is corrosion of the reinforcing steel. Among others, one viable option is to reinforce concrete with glass fiber-reinforced polymer (GFRP) bars, a non-corrosive material. GFRP reinforcing bars are made primarily of glass fibers. Being non-corrosive, GFRP bars can help extend the lifecycle of reinforced concrete structures substantially, as well as reduce their maintenance, repair, and replacement costs. While GFRP is becoming a viable reinforcement alternative, it presents design challenges which are different than those in the design of conventional steel reinforced concrete. One important challenge is consideration of a brittle failure mode in GFRP-reinforced members.

The difference in failure modes of steel and GFRP drastically changes the design principle for members subjected to flexure, such as beams. The CSA concrete design code (CSA A23.3-04) specifies that bottom steel reinforcement must yield before top concrete crushes, ensuring a ductile failure. GFRP rupturing is considered more brittle than concrete crushing, so beams need to be preferably designed as over-reinforced to ensure top concrete crushes before bottom reinforcement ruptures (CSA S806-02, CSA S806-12). The research presented herein aims to investigate these failure modes, specifically in the areas of predictability, post-failure behavior, and ductility.

Other than the brittle failure mode, the major shortcoming of GFRP reinforcing bars is their relatively low stiffness, when compared to steel. This reduced stiffness, combined with other factors such as different bond behavior and lower tension stiffening, results in deflections that are larger than conventional steel-reinforced beams, at any load stage. Because of these large deflections, designs may often be governed by deflection limitations. As such, it is critical that load-deflection behavior can be accurately predicted. The majority of research done to date on deflection involves modifying equations currently employed for use in steel reinforced beams, such as Branson's equation for an effective modulus of inertia (Branson, 1968).

II. GLASS FIBRE

Glass fiber–reinforced concrete is (GFRC) basically a concrete composition which is composed of material like cement, sand, water, and admixtures, in which short length discrete glass fibers are dispersed. Inclusion of these fibers in these composite results in improved tensile strength and impact strength of the material. GFRC has been used for a period of 30 years in several construction elements but at that time it was not so popular, mainly in non-structural ones, like facing panels (about 80% of the GRC production), used in piping for sanitation network systems, decorative non-recoverable formwork, and other products.
At the beginning age of the GFRC development, one of the most considerable problems was the durability of the glass fiber, which becomes more brittle with time, due to the

alkalinity of the cement mortar. After some research, significant improvement have been made, and presently, the problem is practically solved with the new types of alkali-resistant (AR resistance) glass fibers and with mortar additives that prevent the processes that lead to the embrittlement of GFRC.

III. STEEL FIBER

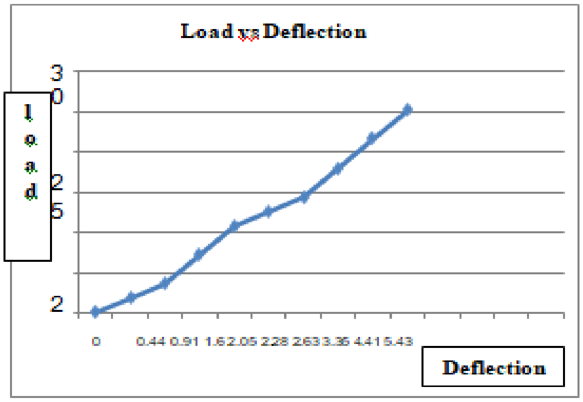
Steel fiber reinforced concrete has gradually advanced from a new, rather unproven material to one which has now attained acknowledgment in numerous engineering applications. Lately it has become more frequent to substitute steel reinforcement with steel fiber reinforced concrete. The applications of steel fiber reinforced concrete have been varied and widespread, due to which it is difficult to categorize. The most common applications are tunnel linings, slabs, and airport pavements. Many types of steel fibers are used for concrete reinforcement. Round fibers are the most common type and their diameter ranges from 0.25 to 0.75 mm. Rectangular steel fibers are usually 0.25 mm thick, although 0.3 to 0.5 mm wires have been used in India. Deformed fibers in the form of a bundle are also used. The main advantage of deformed fibers is their ability to distribute uniformly within the matrix. Fibers are comparatively expensive and this has limited their use to some extent. sfrc can, in general, be produced using conventional concrete practice, though there are obviously some important differences. the basic problem is to introduce a sufficient volume of uniformly dispersed to achieve the desired improvements in mechanical behavior, while retaining sufficient workability in the fresh mix to permit proper mixing, placing and finishing. the performance of the hardened concrete is enhanced more by fibers with a higher aspect ratio, since this improves the fibred-matrix bond. on the other hand, a high aspect ratio adversely affects the workability of the fresh mix. in general, the problems of both workability and uniform distribution increase with increasing fiber length and volume.

IV. COMPARISION OF GFRP REBARS &STEEL BARS

Properties	GFRP REBARS	STEEL BARS
Tensile strength	1100 Mpa - 1250 Mpa	400-500 Mpa
Modulus of elasticity	55000Mpa	200000Mpa
Density	21.7 KN/M3	78.5KN/M^3
Corrosion stability	Non Corrode	Corrode
Cot per kg	Rs150-200	Rs 50 to 55

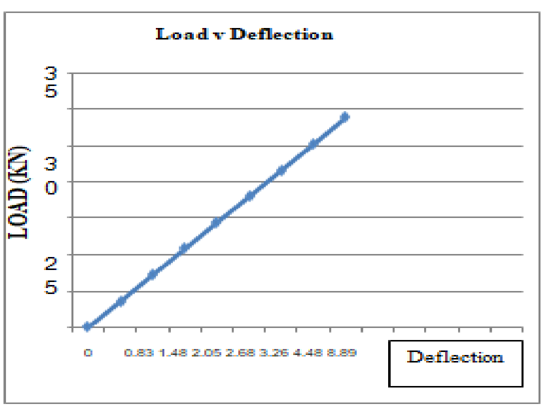
V. LOAD CARRYING CAPACITY OF NORMAL BEAM

S.NO	PROVING RING READING on 50 T CAPACITY	LOAD APPLIED (KN)	DIAL GUAGE READING	DEFELECTION (MM)
1	2	1.8	44	0.44
2	4	3.6	91	0.91
3	8	7.2	160	1.60
4	12	10.8(initial crack)	205	2.05
5	14	12.6	228	2.28
6	16	14.4	263	2.63
7	20	18	335	3.35
8	24	21.6	410	4.10
9	28	25.2 Ultimate load	543	5.43



VI. LOAD CARRYING CAPACITY OF GFRP REBARS BEAM

S.NO	PROVING RING READING	LOAD APPLIED (KN)	DIAL GUAGE	DEFLECTION (MM)
1	2	1.8	66	0.6
2	4	3.6	83	0.83
3	8	7.2	148	1.48
4	12	10.8	205	2.05
5	16	14.4	268	2.68
6	20	18 first crack	326	3.26
7	24	21.6	458	4.58
8	28	25.2	548	5.48
9	32	28.8(ultimate load)	588	5.88



VII. CONCRETE MIX PROPORTION

Mix proportion of M35 grade concrete was designed as per IS 10262-2019 and IS 456-2000. The proportion and w/c ratio for M35 is 1:1.4:3.08:0.45

VIII. REINFORCEMENT DETAILS:

The experimental investigation includes casting and testing of 3 type beams of dimension (1000 mm length, 150 mm width and 250 mm depth). Beams were simply supported at their ends with the effective span of 800 mm. A view of longitudinal section and cross section of a typical beam specimen. 1 were casted with hybrid beam with GFRP rebar as longitudinal reinforcement. Spacemen 2 were casted with fiber concrete with steel rebar hybrid beam with steel and glass fibers were used. Specimens 3 were casted with normal steel with conventional concrete . for specimen 1 GFRP 2nos of rebar of 10 mm diameter was used as reinforcement at top and bottom for shear 8mm diameter 2 legged vertical stirrups were used at 100mm c/c. Steel 2nos of 10mm diameter main bar and 8 mm stirrups were used for specimens 2 and 3. Bottom and top side concrete clear cover of 20 mm was maintained for all beams

IX. TEST PROGRAMME

The test setup involves a two point loading system by using a spread beam and two rollers. 50 ton capacity proving ring was used to load the beam .at the ends of the beam bearing support of 100mm were provided on the either sides of the beam .Dial guage was used under the beam to note the deflection the beam .the load act at the distance of L/3 to the beam length. jack is used to load the proving ring .the proving ring is used to note the amount of loads applied to the beam . The test setup is shown in below figure

X. COMPARISON OF NORMAL BEAM AND GFRP REBARS BEAM

Generally GFRP rebar's deflection is 1.5 times more than steel bars .the tensile strength of GFRP rebar's is 2 times more than steel bars .however using fibers in GFRP rebar's will gradually reduced the deflection in beam

XI. CONCLUSION

The value of crack initiation loads for beam with GFRP rebars and normal reinforcement were 18KN and 10.2 KN respectively. The value of ultimate load carrying capacity for beams with GFRP rebars and normal reinforcement were 28.8KN and 25.2 KN respectively

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