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Experimental Study of Glass Fiber Reinforced Concrete With Precast SIFCON Laminate

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ABSTRACT

RC structures maybe damaged or collapsed because of sustaining additional loads such as seismic load, change in live load etc. Retrofitting is one of the best solution to avoid the collapse of the structure. In this paper the beam is retrofitted by precast slurry infiltrated fibrous concrete. It is a type of high performance fiber reinforced concrete made by infiltrated Glass fiber bed with a specially designed cement based slurry. In this paper M sand is used for fine aggregate. The experimental program is to be done to access the flexural behavior of the strengthened conventional and GFRC. The flexural behavior is to be analyzed by two-point loading test.
Keywords: Precast SIFCON, GFRC Beam, Flexure, M Sand, Fiber Reinforced Concrete.

I. INTRODUCTION

Reinforced concrete structures often must face modification and improvement of their performance during their service life. The main contributing factors are change in their use, new design standards, deterioration due to corrosion in the steel caused by exposure to an aggressive environment and accident events such as earthquakes. In such circumstances there are two possible solutions: replacement or strengthening. Full structure replacement might have determinate disadvantages such as high costs for material and labor, a stronger environmental impact and inconvenience due to interruption of the function of the structure e.g. traffic problems. When possible, it is often better to repair or upgrade the structure by strengthening. While many solutions have been investigated over the past decades, there is always a demand to search for use of new technologies and materials to upgrade the deficient structures. In this context, a promising new way of resolving this problem is to selectively use advanced composites such as High Performance Fiber Reinforced Cementitious Composites (HPFRCCs). With such materials novel repair, retrofit and new construction approaches can be developed and that would lead to substantially higher strengths, seismic resistance, ductility, durability while also being faster and more cost - effective to construct than conventional methods. Thus, retrofitting and rehabilitation of structures can be concluded to be best alternative. The purpose of this project is to compare the experimental behavior study on normal reinforced concrete beam and Glass Fiber Reinforced Concrete beam(GFRC) strengthened by Slurry Infiltrated Fiber Concrete (SIFCON) laminate.

SIFCON is a high-strength, high-performance material containing a relatively high-volume percentage of glass fibres as compared to glass fibre reinforced concrete (GFRC). It is also sometimes termed as ‘high- volume fibrous concrete’. The origin of SIFCON dates to 1979, when Prof. Lankard carried out extensive experiments in his laboratory in Columbus, Ohio, USA and proved that, if the percentage of glass fibers in a cement matrix could be increased substantially, then a material of very high strength could be obtained, which he christened as SIFCON. While in conventional SFRC, the glass fibre content usually varies from 1 to 3 percent by volume, it varies from 4 to 20 percent in SIFCON depending on the geometry of the fibres and the type of application. The process of making SIFCON is also different, because of its high glass fibre content. While in GFRC, the glass fibres are mixed intimately with the wet or dry mix of concrete, prior to the mix being poured into the forms, SIFCON is made by infiltrating a low-viscosity cement slurry into a bed of glass fibres 'pre-packed' in forms / moulds. The matrix in SIFCON has no coarse aggregates, but a high cementitious content. However, it may contain additives such as fly ash, micro silica and latex emulsions. The matrix fineness must be designed so as to properly penetrate (infiltrate) the fibre network placed in the moulds, since otherwise, large pores may form leading to a substantial reduction in properties. A controlled quantity of high - range water -reducing admixture (super plasticizer) may be used for improving the flowing characteristics of SIFCON. All types of steel fibers, namely, straight, hooked, or crimped can be used.

II. METHODOLOGY

Concrete

All the testing specimens for the flexural beams are to be cast using M20 concrete having the dimensions of 100 x 100 x 500 mm. To check targeted concrete compressive strength after 28 days, three cubes will be cast and tested to ensure getting the designed compressive strength.

Table 1. M20 Mix proportion

Cement	M-Sand	Coarse aggregate	Water
382 Kg/m3	677 Kg/m3	1140 Kg/m3	191.6 Kg/m3
1	1.7	2.98	0.5

SIFCON laminate

E-glass fibers of 0.4 mm diameter and aspect ratio of 50 are used to cast SIFCON laminates. fiber volume fraction is 7% cement and sand were used for making cement slurry with the mix proportion 1:2. super plasticizer of 1.5% is used to increase the workability of the cement based slurry so as to facilitate easy infiltration of cement slurry in to the fibre matrix. wooden moulds were used to cast the laminates. Initially the fibres were placed in the mould to its full capacity and then the cement based slurry is made to infiltrate in to the mould. The laminates were demolded after 24 hours and were cured for 28 days.

STRENGTHENING PROCEDURE OF SIFCON TO BEAM

The concrete surface is made rough by wire brush and it is thoroughly cleaned to remove all dirt and debris. The epoxy resin and hardener are weighed in the ratio of 1:1 and mixed thoroughly and applied over the concrete surface. The laminate is then placed on the top of epoxy resin coating such that the warp direction of the fabric is kept along the longitudinal reinforcement of the beam. During hardening of the epoxy, a constant uniform pressure is applied to ensure good contact between the epoxy, the concrete and the laminate. Concrete beams with laminate are cured for 7 days at room temperature before testing.

TEST SETUP AND PROCEDURE

The testing procedure for the entire specimen was same. After the curing period of 28 days was over, the beam surface was cleaned and white washed for clear visibility of cracks. Before testing, the member was checked for dimensions and a detailed visual inspection was made with all information carefully recorded. The load was increased incrementally up to the calculated working load, with loads and deflections recorded at each stage. Loads will then normally be increased again in similar increments up to failure. This is necessary to avoid damage to gauges and although accuracy is reduced, the deflections at this stage will usually be large and easily measured from a distance. Similarly, cracking and manual strain observations must be suspended as failure approaches. Special safety precautions shall be taken; if it is essential to take precise deflection readings up to collapse. Cracking and failure mode was checked. The most commonly used load arrangement for testing of beams will consist of two-point loading.

III. RESULTS AND DISCUSSION

Flexural strength without laminate.

Table 2

Specimen	Ultimate load(kN)			Flexural strength(N/mm2)		
Fiber vol	conv	0.05 %	0.1 %	conv	0.05 %	0.1 %
S-1	6	7.1	7.8	2.03	2.73	3.06
S-2	6.7	7.3	8.4	2.59	2.9	3.38
S-3	5.8	7.25	8	1.98	2.84	3.23

Flexural strength with laminate.

Table 3

Specimen	Ultimate load(kN)			Flexural strength(N/mm2)		
Fiber vol	conv	0.05 %	0.1%	conv	0.05 %	0.1 %
S-1	6.8	8.9	10.98	2.7	3.58	4.16
S-2	7.25	9.15	11.35	2.9	3.66	4.54
S-3	7.15	8.8	10.8	2.85	3.5	4.08

IV. CONCLUSION

Based on the experimental investigation the following conclusions were drawn

- The compressive strength of the concrete cubes doesn't vary with fiber concentration. It gives only 4% higher value than the conventional.
- The normal flexural strength of the concrete with laminate is increased up to 7% than the conventional.
- The ultimate load for 0.05% fiber volume with laminate is increased up to 26% than the conventional.
- The ultimate load for 0.1% fiber volume with laminate is increased up to 34% than the conventional.
- By strengthening the beam, performance of the weak structure can be improved, and it will protect many lives from sudden failure.
- Additionally no minimum concrete cover is needed to prevent corrosion of the reinforcement, if laminates are provided.

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