Performance of Steel Fibers in Polymer Concrete

Aditya Nayak, S. Vinay Babu, N. Venkata Ramana

Abstract: ***This article presents the effect of fibers in the polymer concrete. The concrete was designed with M25 grade concrete and 10% of Bisfenol –A was added to produce polymer concrete. Few mixes are planned with incorporation of steel fibers in the proportion of 1 and 2% by volume. In all the mixes manufacture sand was used instead of river sand. The tests are conducted to estimate compressive, split and flexural strengths. From the results it is noticed that, the strengths are increasing with incorporation of polymer and steel fibers.***

Key words: Bisfenol-A, Crimped steel fibers, M-Sand, Strength tests

I. INTRODUCTION

Cement combined with appropriate aggregates and mixed with water formed a product with higher mechanical strength. The characteristics of this product were noticed and this lead to revolution in the construction industry. In spite of the fact that cement has advantageous properties, it also has certain limitations, one such limitation is the rigidity upon curing. The best example for this is the cracks developed on the surface course of the rigid pavement. The past studies suggested that upon addition of polymers in cement based materials improved the disadvantages. In this experimental program it has been focused to studied the compressive, split tensile, flexural strengths of the concrete by addition polymer (Bisfenol-A) and steel fibers.

II. LITERATURE REVIEW

Recent studies are discussing herein to know the status of the present work. C. Vipulanandan et.al.[1] studied the temperature effects, void content, tension, content of resin and the flexural performance of polymer concrete. From their work it is observed that strength, modulus of elasticity are increased at normal temperature. But the strengths are decreasing by increasing the temperature. Polymer concrete possessed good strength than the concrete without polymers. D. W. Fowler [2] provided the information regarding the polymer concrete. Polymer concrete for repair works, laying of overlays have been successful. The future scope suggested by him was concrete polymer concrete has good growth in 3D printing polymer concrete which includes cladding and architectural materials. L. Czarneckiet et al.[3] are provided the information on polymer concrete as review and also they have mentioned many application in order to enhance the strengths and also gave the information as this material is good for retrofitting of existing structures. Sykes et al. [4] provided the behavior of different polymers when added to concrete to enhance the life period of the materials for the application in the flooring of commercial, industrial, as well as residential building were studied when subjected to UV exposure, temperature tests, impacts tests, vehicle loads. Their study concluded that by adding polymers to concrete improves the strength when compared with normal concrete. M. Barbuta et al. [5] Studied the effects of solid waste, silica fumes, the fillers used were fly ash into polymer concrete to analyze compressive strength, flexural strength, split tensile strength. The outcomes of their work showed that, utilization of fly ash, silica fume increased the strength properties of polymers concrete in comparison to polymer concrete without fillers. They also specified as compressive strength was influenced by fly ash filler content in polymer concrete

III. MATERIALS

Cement: In this study PPC cement was used to make concrete mix. The cement showed the specific gravity as 3.12 and the initial, finial setting times as 47 and 238 minutes respectively.
Coarse Aggregates: 20mm size of coarse aggregate was used for making concrete.
M-Sand: Locally procured manufactured sand has been used in this work.
Water: Potable water was used for making the mix of concrete and also for curing
Epoxy: The type of epoxy used in this experiment is Bisfenol-A which is of medium viscosity and unmodified epoxy.
Crimped Steel Fiber: The crimped steel fibers with aspect ratio of 50 were used.

IV. EXPERIMENTAL PROGRAM

S.Vinay babu and N.Venkata Ramana[6] have done the work on polymer concrete and the results shown as 10% of Bisfenol-A is effective for the concrete mixes. Hence here 10% dosage is taken for the concrete mixes. The concrete mix was designed for M25 grade (1:2.15:3.37 with water cement ratio 0.53). To study the effect of fibers to the proposed concrete the fibers are mixed in the concrete mix in the proportion of 1 and 2% by volume. Total four mixes are proposed for the experimental work. Among mixes one mix was prepared without polymer and it is named as NC. For other mixes the polymer used along with (1 and 2%) and without fibers (0%). For each mix there samples are prepared and tested in the laboratory. The study focused to evaluate cube compressive (150x150x150mm), split tensile (150mm diameter and 300mm height) and flexural strengths (150x150x750mm).The casted specimens are undergone wet and dry curing of 7 and 21 days respectively.

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V. TEST RESULTS AND DISCUSSION

The results for the tests are tabulated in the Table 1. The discussions for these results are as follows

Compressive Strength Test (28 days)

The compressive strength increased by adding of epoxy and fibers. For 10% epoxy, compressive strength increased by 101.8%, when compared to normal concrete (NC), further with addition of steel fibers by 1% and 2% in the polymer concrete the compressive strength increased furthermore by 116.9% and 135.9% respectively. This kind of examination were studied by R. D. Maksimov et al.[7] with the use of polyester polymer in the concrete, were it achieved high compressive strength.

From the Table 1 it is clearly seen when percentage of fiber increased within polymer matrix, compressive strength increased, where as reduction in strength was seen in specimen made with normal concrete. The incorporation of steel fibers increases bond into mix. From this it is noticed that the gaining of strength is more rapid for 10% polymer mix, but with the addition of fibers, the strength gain is gradual.

Split Tensile Test (28 days)

The split tensile strength values are tabulated in Table 1. From the tabulated values it is seen that split tensile strength increase by addition of epoxy and fiber content, for 10% epoxy concrete it achieved high strength of 212.5%, when compared to normal concrete, by this it is clear that the incorporation of epoxy in to concrete increases the split tensile strength. Moreover strength also increased by incorporation of fibers at 1% and 2%, at these additions the increase in strength achieved was 262% and 305.5% respectively.

The influence of fiber in the mix is similar to that of compressive strength, increase in fiber dosage increased split tensile strength.

Flexural Strength Test (28 days)

The flexural strength results are shown in Table 1, from those it is observed that, the mix with epoxy has shown more strength when compared with reference concrete (normal concrete) mix. The strength achieved by normal concrete beam was 6.39 N/mm², whereas the 10% epoxy added beam attained the strength of 16.21 N/mm² and percentage increase in strength is 153%. This type of study was observed in the work conducted by C. Vipulanandan et al.[1], where they conducted bending test on polyester resin based PC by using natural sand as fine aggregates and the results recommended that by incorporation resin; flexural strength increased.

The strength increased further upon addition of fibers in to the polymer concrete. From the Table 1, it can be seen that the fiber addition of 1% and 2% in the polymer concrete increases the strength in the beam, the increase in strength observed at 1% and 2% were 187% and 221%. It can be clearly seen that fiber also has the influence in the strength.

Table 1: Strength Test Results

Sl.No.	Mix	Compressive stress (MPa)	Split tensile stress (MPa)	Flexural stress (MPa)
1	NC	31.37	4.00	6.39
2	0%	63.31	12.52	16.21
3	1%	68.06	14.48	18.34
4	2%	74.03	16.22	20.52

VI. CONCLUSIONS

The conclusions are

1. Compressive strength increased with the addition of polymer (Bisfenol – A) and fibers.
2. With increase in the fiber dosage for the mixes the strengths are increased.
3. For polymer mix,1% and 2% steel fiber mixes the compressive, split and flexural strengths are increased by 116.9, 135.9, 262, 305.5, 187 and 221% when compared with normal concrete.
4. The usage of M sand is viable for the polymer mixes.

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