EXPERIMENTAL INVESTIGATION ON FIBRE REINFORCED CONCRETE

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ABSTRACT

Use of Fibre Reinforced Concrete (FRC) is one of the ways of overcoming the low tensile strength of concrete. Both organic and inorganic fibers can be made use in the production of FRC. On the other hand, the use of waste plastic is causing a serious environmental pollution since the plastic don't deteriorate. Such waste plastic can be reused in the form of fibres to produce waste plastic FRC. Further, flyash, microsilica and redmud are another industrial waste materials adding to environmental pollution. These waste materials are having cementatious properties and can be used along with waste plastic fibres in concrete to reduce their detrimental effect on mother earth. Therefore in this paper an attempt is made to assess the suitability of waste plastic FRC for construction purposes when different percentages of flyash, microsilica and redmud are introduced.

1. INTRODUCTION

Cement concrete is a well-known construction material in the field of civil engineering and it has a several desirable properties like high compressive strength, stiffness, durability under usual environmental Conditions. At the same time concrete is brittle and possess a very low tensile strength. It is having widespread application and it gives strength at a comparative low cost. The disadvantage of cement concrete is the emission of carbon-di-oxide gas during the production of cement clinker. Concrete has some deficiencies like low tensile strength, a low strain at facture, low post cracking capacity, brittleness and low ductility, limited fatigue life and low impact strength. From many researches it has been shown that, reinforcing concrete in tensile one or in both zones can yield a composite of good compressive and tensile strength. But in order to obtain ductility and durability the cracks should be minimize. The presence of cracks is responsible for weakness of cement concrete. This weakness can be removed by the addition of fibres in the concrete mixture and it increases its toughness or ability to resist the crack and also develops tensile strength and flexural strength. Such a concrete is called as fibre-reinforced concrete.

1.1 Fibre Reinforced Concrete

Fibre reinforced concrete is a composite material comprising of mixture of concrete mortar or cement mortar with discrete, discontinuous, uniformly dispersed appropriate fibres. The addition of fibre to the concrete makes its components tough and ductile. Already many type of fibres been used in concrete but not all the fibres can be used efficiently and economically. Each and every type of fibres has its own properties and boundaries. Addition of fibres into cement concrete not only increases the tensile and flexural strength but also minimizes the cracks. The characteristics like toughness and impact resistance can be improved by addition of fibres to the concrete have been shown by many researchers. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres. Fibres of various shapes and sizes produced from steel, plastic, glass and natural material are being used.

1.1.1 Areas of Application of FRC Materials

- Thin sheets
- Roof tiles

- Pipes
- Prefabricated shapes
- Panels
- Shotcrete
- Slabs on grade
- Composite decks
- Vaults, safes
- Impact resisting structures
- Water retaining structures
- Marine structures
- Airport runways
- Highway pavements
- Deck slab construction
- Concrete pipes

1.2 Principles of Fibre Reinforced Matrix

When a load is applied on a body which consist of a fibre embedded in a surrounding matrix, the fibre contributes to the load carrying capacity of the body when the load is transmitted through the fibre ends.The fibre reinforced matrix is essential to fulfil the following functions:

a) The load transfer generally rises as a result of different physical properties of the fibre and matrix. The incorporation of fibre into brittle cement matrix increases the fracture toughness of the compound by crack arresting process. As fibre have large value of failure strains, they give up extensibility in composite problems.

b) To bind the matrix together and to safeguard their surfaces from destruction during the handling, fabrication and service life of the composite.

c) To disperse the fibres and discrete them so as to evade any catastrophic propagation of cracks and subsequent failure by adhesion-friction, where composite is under load.

2. Literature Review

2.1 Literature Review

A brief review of literature surveys which are concerning to various parameters like mechanical properties and strength properties of Glass Fibre Reinforced Concrete are discussed in this chapter.

[1]ShrikantHarle and Prof. Ram Meghe have conducted compressive strength and tensile strength on M-30 grade of concrete for 28 days' strength using Alkali Resistant (AR) Glass Fibres of 0.03% and 0.5% by weight of concrete and have observed 15% to 20% increase in strength. Glass Fibres used here is Cem-Fill Anti Crack which are usually are usually round and straight with diameters from 0.005 mm to 0.015 mm. They can be also bonded together to produce the bundle of glass fibers with diameter up to 1.3 mm.

[2]Dr.P.SrinivasaRao, ChandraMouli.K and Dr.T.Seshadri have experimented on Sulphate Resistance, Rapid Chloride Permeability, Workability and Bleeding on use of Glass Fibres in Concrete. Concluding that the durability of concrete from the aspect of resistance to acid attack on concrete increases by adding AR-glass fibers in concrete. It was observed that there was no effect of sulphates on concrete. Chloride permeability of glass fibre reinforced concrete shows less permeability of chlorides into concrete when compared with ordinary concrete. The glass Fibres Bridge across the cracks causing interconnecting voids to be minimum.

[3]Kavita S Kene, Vikrant S Vairagade and SatishSathawane have concluded from their experiments of Glass Fibre Reinforced Concrete that .5% reduces cracks by addition of steel fibres under different loading conditions and the brittleness of concrete can also be improved by addition steel fibres than glass fibres. Since concrete is very weak in tension, the steel fibres are beneficial in axial-tension to increase tensile strength.

[4]R.Gowri, M.AngelineMary, have observed that higher percentages of Glass wool fibres greater than one percentage affect the workability of concrete, and may require the use of super plasticizers (workability agents) to maintain the workability. As the percentage of fibre content by total weight of the concrete increases from 0.025%-0.075% the compressive strength of the concrete also increases from 5.15% to 15.68% at 28 days. Also from the split tensile strength test it was found that, the strength at 28 days' increases by 20.41% to 29% due to the addition of glass wool fibres varying from 0.025%-0.075%. The flexural strength of glass wool fibre concrete is also found have a maximum increase of 30.26% at 0.075% of fibre content. It was observed that, the percentage increase in the strength of glass wool fibre reinforced concrete increases with the age of concrete. Also it was found from the failure pattern of the specimens, that the formation of cracks is more in the case of concrete without fibres than the glass wool fibre reinforced concrete. It shows that the presence of fibres in the concrete acts as the crack arrestors. The ductility characteristics have improved with the addition of glass wool fibres. The failure of fibre concrete is gradual as compared to that of brittle failure of plain concrete.

[5]Suresh Babu.R, Rakesh.A.J and Ramkumar.V.Rhave observed that the addition of glass fibre in concrete offers a holistic solution to the problem of permeability in concrete, increase the concrete strength and at the same time reducing the environmental impact. The permeability index value gets reduced due to addition of glass fibre, it is about 6.4% by the addition of 0.5%, 12.6% by the addition of 1% and 26.3% by the addition of 1.5% of glass fibre in M-25 concrete when compared to control concrete. Similarly, for M-50 concrete, the permeability value is about 8.7% by addition of 0.5% of glass fibre, 15% by addition of 1% of glass fibre and 30.1% by addition of glass fibre to that of control concrete. The compressive strength increased by about 16.4% by the addition of 0.5%, 24.7% by the addition of 1% and 47.3% by the addition of 1.5% of glass fibre in M-25 concrete when compared to 0% of glass fibre in concrete. Similarly, for M-50 concrete, the permeability value is about 14.3% by addition of 0.5% of glass fibre, 22.3% by addition of 1% of glass fibre and 43.5% by addition of glass fibre to that of 0% glass fibre in concrete. The addition of glass fibre in concrete will have better effect on high grade of concrete for permeability and lower grade of concrete for compression test due to quantity of cement content, water-cement ratio and the ratio of fine aggregate to coarse aggregate.

3. Design/Experimentation

Cement, m-sand and coarse aggregates are weighed and batched according to the mix proportions of M30 grade concrete proportioned as per the guidelines in IS-10262-2009. The varying percentages of glass fibres by 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of cement were casted and test done for 7 and 28 days.

Initially weighed cement, m-sand and coarse aggregate are mixed properly in dry condition. To the same mix, add varying percentages 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres by the weight of cement and mix properly to get the mix with uniformly dispersed fibres. Add 0.5% of Super Plasticizer Conplast-SP430 by the weight of cement to the water and mix thoroughly. The mixed water is added to the dry mix and mix properly. Cube dimension 150mm x 150mm x 150mm for compressive strength, Cylinder dimension 150mm diameter x 300mm height for split tensile strength were casted, cured in water for 7 and 28 days respectively as shown in figure 4.5 and tested for 7 and 28 days respectively.

Cubes and Cylinders were casted to find compression strength and split tensile strength of varying percentages 0%, 0.5%, 1%, 1.5%, 2% and 2.5% of glass fibres. The graph of compressive strength versus percentage of glass fibres added was plotted, the percentage of glass fibre achieving greater compressive strength is found for 7 and 28 days respectively. The graph of split tensile strength versus percentage of glass fibres added was plotted, the percentage of glass fibre achieving greater split tensile strength is found for 7 and 28 days respectively.

Figure 3.1 Mixing of coarse aggregate and fine aggregate

Figure 3.2 Mixing of glass fibres, Cement, coarse & fine aggregate

Figure 3.3 : Solution of Super Plasticizer and Water

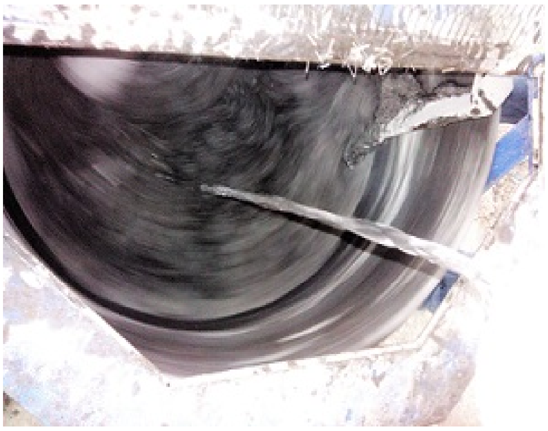

Figure 3.4 Mixing of Solution to aggregates and glass fibres

3.1Materials Used

In this present work to cast the specimens the following materials are used

1) Potable water for mixing and curing of concrete.
2) Ordinary Portland Cement 53 grade confirming to IS: 12269-1987
3) Manufacturer sand, confirming to IS: 383-1970
4) Coarse aggregate, confirming to IS: 383-1970
5) Glass fibres of effective length 12mm and equivalent diameter 14µm having the aspect ratio of 857:1.
6) Chemical Admixture: Super Plasticizer Conplast-SP430.

3.2 Design Procedure

Design of M30 grade concrete mix for the experimental work is given in detail in this chapter.

The workability of concrete mix is found out by trial and error method. Once the workability is achieved the next step is to design concrete mix. Mainly it is based on the work done in laboratories. The design of concrete is set by the procedure of The Bureau of Indian Standards commends. In IS 10262-2009 the mix design procedure is covered. The methods given by the Bureau of Indian Standards can be applied for medium strength concrete and high strength concrete both.

3.2.1 Design Specification

The design of concrete procedure is carried out to attain desired compressive strength and workability of concrete, using continuously graded aggregates. The following basic data required to be specified for the design of a concrete mix.

Step 1: Design Stipulations for Proportioning

1) Grade designation : M30
2) Type of cement used : OPC 53 grade
3) Water / cement ratio : 0.40
4) Workability : 100mm (slump)
5) Type of admixture : Super Plasticizer Conplast-SP430
6) Maximum size of aggregates: 20mm
7) Type of aggregate : Crushed angular aggregate
8) Minimum cement content : 320 kg/m^3
9) Exposure condition : Moderate

Method of concrete placing : Pumping

5.1 Conclusion

Based on the present experimental investigation conducted and the analysis of test results, the following conclusions can be drawn:

1) Glass fibre helps concrete to increase compressive strength until indicated limit. It also has a good resistance for tension.
2) The compressive strength of Glass Fibre Reinforced concrete increases in the amount of glass fibre quantity up to 1.5% and further decreases beyond.
    a) The compressive strength of Glass Fibre Reinforced Concrete was increased by 13.27% of normal concrete for 7 days.
    b) The compressive strength of Glass Fibre Reinforced Concrete was increased by 21.06% of normal concrete for 28 days.

c) From the test results it is observed that the Glass Fibre of 1.5% gained better compressive strength when compared to other percentages.

3) The split tensile strength of Glass Fibre Reinforced concrete increases in the amount of glass fibre quantity up to 1.5% and further decreases beyond.
    a) The split tensile strength of Glass Fibre Reinforced Concrete was increased by 0.53% of normal concrete for 7 days
    b) The split tensile strength of Glass Fibre Reinforced Concrete was increased by 0.87% of normal concrete for 28 days

c) From the test results it is observed that the Glass Fibre of 1.5% gained better split tensile strength when compared to other percentages.

4) . At higher percentage greater than 1.5%, there is a degradation of compressive strength and split tensile strength because the increase in weight of glass fibres results in loss of cohesiveness between the particles of the concrete.

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