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Review of Glass Fibres reinforced Ordinary Portland cement Concrete

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Abstract : Concrete is good in compression but week in tension as building material. Concrete has develop cracks because of its plastic and hardened states. Resistance to cracking, shrinkage is less in concrete. These lacking can be improved by addition of glass fibers in ordinary Portland cement concrete. This research is about experimental investigation of glass fibers in different percentage 0 to 0.1%. The effect of mechanical properties of concrete tested by carrying compressive strength test, flexural strength test and splitting tensile strength test. All observations and results were tabularized. The results show enhancement in mechanical, durability properties by addition of glass fibers.

IndexTerms - Concrete, Compressive strength,Glass fibre, compressive strength, split tensile, flexural strength

I. INTRODUCTION

The concrete starts drying then suffers cracks due to plastic shrinkage, drying shrinkage and other reasons of changes in volume of concrete. The concrete without any fibers will susceptible to more cracks. Mainly micro cracks lead to measure cracks. If consider plain concrete then it is brittle and its modulus of rupture is less. This paper studies the optimized values of flexural strength and enhances the strain capacity of the plain concrete, the fibres are being used in normal concrete. The addition of fibres in the plain concrete will control the cracking due shrinkage and also reduce the bleeding of water. The addition of glass fibres in plain concrete shows higher flexural strength than plain concrete. Environmental and economic considerations played a great role in the increase in use of mineral admixtures. Cement with pozzolana like fly ash reduces the permeability of concrete and dense calcium silicate hydrate (C–S–H). A preliminary test program has been carried out to study the mechanical characteristics of glass fibre reinforced concrete with the percentage of glass fiber 0 to 0.1.

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1. REVIEW OF LITERATURE

The additional applied loads may exert internal radial pressure on concrete structures. These longitudinal cracks leads to more cracking damaging concrete .It causes public inconvenience .Dedicated research start on corrosion-induced cracking. After studying research it is found that models for cracking of cover concrete for developing longitudinal cracks. This paper explore cracks developed and their relation with enhanced increased pressure and load by calculation . Research on Different Types of Cracks in Plain and Reinforced Concrete by Snehal Abhyankar .[1]Many researchers studied in this field, showed that the orientation of fibers had a major role in increasing some properties, Balkees [2] shows that it increasing the creep resistance according to applied load, microstructure of the composite, and adhesion between the resin and the fibers. In this study, four concrete mixtures with coarse RCAs and glass fibres are manufactured according the two-staged mixing approach [9]. The target concrete strength is C40/50 and the workability of the different mixtures is slump class S4. To investigate the influence of glass fibres on the RAC properties, the CEM-FIL MinibarsTM are used in three fibre contents: 5 kg/m³, 10 kg/m³ and 15 kg/m³. These glass fibres are produced by the international company OWENS CORNING. In all concrete mixtures, the used aggregates are sand 0–2 mm (fineness modulus: 2.25), limestone 2–6.3 mm and recycled aggregates 6.3–14 mm. The latter are produced from a recycling plant in Flanders, Belgium. In table 3, the physical and mechanical properties of the used natural aggregates and RCAs are given. The physical properties including the oven-dried particle density (ρrd), the saturated surface-dried (SSD) particle density (ρssd), the apparent particle density (ρa) and the water absorption after 24h (WA24) are obtained according to the standard EN 1097-6:2013 – Tests for mechanical and physical properties of aggregates – Determination of particle density and water absorption. The mechanical properties which includes the resistance to fragmentation (LA) and wear (MDE) are performed according to the standard EN 1097-1&2:2010 – Tests for mechanical and physical properties of aggregates. [4] The basic concepts of composites material along with details of earlier works are explained by author at reference [5].The author investigated the influence of different sized glass fibers on the mechanical properties of glass fiber epoxy resin composites. The compressive experimental study to identify the effects of fiber cross sectional aspect ratio on tensile & flexural properties and failure modes of glass fiber/epoxy composites by using fibers of different cross sectional shapes was carried out by author[7].Author[8] investigated the influence of fiber orientation and fiber content of epoxy resin components on mechanical prosperities. The main aim of the

present investigation was to study the influence of fiber orientation on tensile properties and also the influence of thickness of the specimen.[11]

EXPERIMENTAL PROGRAMME

II. MATERIALS CEMENT

III. The ingredients of cement primarily consist of calcareous materials in the form of limestone, chalks and marl and argillaceous materials. The ordinary Portland cement of 43 Grade is used. The specific gravity of cement is 3.14. For ordinary Portland cement, the initial setting time is 55 minutes and the final setting time is 600 minutes.

IV. AGGREGATE

Fine aggregate is a material such as sand, crushed stones or crushed gravel passing through 4.75 mm size. Locally available sand is used as fine aggregate in the concrete mix. The specific gravity of fine aggregate is 2.75.Material which retained on 4.75 mm size is classified as coarse aggregate. For most works, 20 mm aggregate is suitable. The locally available 20 mm size of aggregate is used. The specific gravity of coarse aggregate is 2.94.

V. GLASS FIBERS

The glass fibers used in concrete suppressed the localization of micro cracks in to macro cracks hence tensile strength increase. It improves durability of concrete by increasing the strength of concrete. The Glass Fibers are of E-CR-glass (Electrical/Chemical Resistance; alumino-lime silicate with less than 1% w/w alkali oxides, with high acid resistance) with modulus of elasticity 72 GPa, Filament diameter 14 microns. Specific Gravity is 2.69, length 12 mm and having the aspect ratio of 867.1. The number of fibers per 1 kg is 215 million.

Mix Proportions

In this study, control mix A was designed as per IS 10262:2009 to achieve a target compressive strength of 25 MPa. The glass fibres of 0 %, 0.03%, 0.06% and 0.1 % by volume fraction of concrete were used.

Preparation and Details of Test Specimens

In the present experimental investigation cubes of 150mm x 150mm x 150mm of M-20 grade concrete were casted with varying percentage of addition of 0.03%, 0.06% and 0.1% of glass fibre. After casting, test specimens were demoulded after 24 hours and were kept in the curing tanks until the time of test.

Tests on Concrete

Casting and testing of cubical specimens of size 150mm×150mm×150mm for compressive strength, flexural strength test and splitting tensile strength test was done as per IS:516-2020 specification compressive strength test was performed on 150mm cubes, tested at 28 days, with their specimen in each case and cured in the water tank completely immersed at constant temperature 28˚-30˚C until the test age. All the test specimens were demodulate 24 hours after casting.

Table 1 – Compressive strength test result

Type of concrete	Cube	Crushing load KN	Compressive strength N/mm^2	Average compressive Strength N/mm^2
M-20 with 0.0% glass fiber	N1	650	27.67	23.93
	N2	525	23.88	
	N3	520	23.22	
M-20 with 0.03% glass fiber	3a	545	25	26.15
	3b	540	24.91	
	3c	690	35.31	
M-20 with 0.06% glass fiber	6a	548	25.22	26.78
	6b	545	25.21	
	6c	715	32.6	
M-20 with 0.1% glass fiber	1a	430	19.11	29.65
	1b	680	30.22	
	1c	884	39.29	

Fig. 1 Compressive strength of % of Glass Fiber

Type of concrete	Beam	Crushing load KN	Flexural strength N/mm^2	Average Flexural Strength N/mm^2
M-20 with 0.0%	N1	17.2	3.412	3.455
	N2	15.31	3.76	

glass fiber	N3	20.32	3.96	
M-20 with 0.03% glass fiber	3a	16.3	3.16	3.681
	3b	19.48	3.796	
	3c	21.03	4.236	
M-20 with 0.06% glass fiber	6a	17.48	3.396	3.654
	6b	18.55	3.745	
	6c	19.94	3.978	
M-20 with 0.1% glass fiber	1a	17.84	3.648	3.998
	1b	20.18	4.118	
	1c	22.25	4.53	

Fig. 2 Flexural strength of % of Glass Fiber

Table 3 - Splitting Tensile Strength Test Result

Type of concrete	Cylinder	Crushing load KN	Splitting Tensile strength N/mm^2	Average Splitting Tensile Strength N/mm^2
M-20 with 0.0% glass fiber	N1	75.85	3.27	3.25
	N2	72.60	3.14	
	N3	82.43	3.47	
M-20 with 0.03% glass fiber	3a	73.30	3.10	3.41
	3b	82.4	3.55	
	3c	80.9	3.49	
M-20 with 0.06% glass fiber	6a	95.90	4.12	3.73
	6b	78.9	3.35	
	6c	83.43	3.68	
M-20 with 0.1% glass fiber	1a	133.25	5.71	5.18
	1b	114.20	4.86	
	1c	81.03	3.49	

Fig. 3 Splitting Tensile strength of % of Glass Fiber

2. Results and Discussions

Compressive strength

Table 1 gives the test results of compressive strength at 28 days. Compressive strength increases with increasing percentage of glass fibers. It can be observed that 28 days compressive strength is increased by 8.81% with addition of 0.03% of glass fiber compared to normal M-20 concrete. It can be observed that 28 days compressive strength is increased by 11.25% with addition of 0.06% of glass fiber compared to normal M-20 concrete. Also it can be observed that 28 days compressive strength is increased by 23.44% with addition of 0.1percentage of glass fiber compared to normal M-20 concrete. Concern with percentage of addition of glass fibers are gives better results by addition 0.1 % (Fig. 1).

Flexural strength

Flexural strength increases with increasing percentage of glass fibers. It can be observed that 28 days flexural strength is increased by 7.27%with addition of 0.03% of glass fiber compared to normal M-20 concrete (Table 2). It can be observed that 28days flexural strength is increased by 9.25%with addition of 0.05% of glass fiber compared to normal M-20 concrete. Also it can be observed that 28 days flexural strength is increased by 19.31% with addition of 0.1% of glass fiber compared to normal M-20 concrete (Fig. 2).

Split tensile strength

Table 3 gives the test results of splitting tensile strength at 28 days. Flexural strength increases with increasing percentage of glass fibers. It can be observed that 28 days Splitting tensile strength is increased by 3.8% with addition of 0.03% of glass fiber compared to normal M-20 concrete. It can be observed that 28 days Splitting tensile strength is increased by 14.73%with addition of 0.06% of glass fiber compared to normal M-20 concrete. Also it can be observed that 28 days Splitting tensile strength is increased by 43.23%with addition of 0.1% of glass fiber compared to normal M-20 concrete. Concern with percentage of addition of glass fibers are gives better results by addition 0.1 % (Fig. 3).

3. Conclusions

The present study concluded that the addition of glass fibres at 0 %, 0.03%, 0.06% and 0.1 % by volume of cement reduces the cracks under different loading conditions.

It has been observed that the

- workability of concrete increases at 0.1% with the addition of glass fibre.
- The increase in compressive strength, flexural strength, split tensile strength for M-20 grade of 28 days are observed to be more at 0. 1%.
- The workability of concrete decreases from 1% due to the addition of fibre. The compressive strength is very high at 0.1% having for 28 days is 29.65 N /mm2.

- The tensile strength is very high at 1% having for 28 days is 2.94N /mm2. The split tensile strength is very high at 0.1% having for and for 28 days is 5.18 N /mm2 .

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