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Experimental Investigation of Reinforced Concrete Using Recron 3s

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Abstract: Concrete is the most widely used construction material across the world. Due to the persistent and continuous demands made on concrete to meet the various difficult requirements, extensive and wide spread research work is being carried out in the area of concrete technology. A normal strength concrete with very high durability and very low permeability is considered to have high performance properties. High-performance concrete always has a higher strength than normal concrete. The introduction of different types of fibers to the concrete mix helps to improve the different mechanical properties of concrete and also helps to reduce the cracks formation to a great extent. The present study deals with polyester fiber concrete and a comparison of which with conventional concrete mix. In this study,Rrecron 3s fiber is added as an additive to the concrete. This fiber is added as 1%, 2% by the weight of fine aggregate in order to improve its performance and chemical admixtures are used such as Fosroc and Glenium B-233. The Compression strength, split tensile strength and flexure strength of M25, M60 and M80 grade concrete are tested for 14, 28 and 56 days of curing and compared to find the optimum dosage of Recron 3s.
Key Words: Recron 3s, Fosroc , Glenium B-233

1. Introduction

Concrete is the most widely used construction material across the world Due to the persistent and continuous demands made on concrete to meet the various difficult requirements, extensive and wide spread research work is being carried out in the area of concrete technology. Researchers have developed variants of concrete composites like Admixture Concrete, Fibre Reinforced Concrete (FRC), Polymer Impregnated Concrete (PIC), High Performance Concrete (HPC), Self Compacting Concrete (SCC), Geopolymer Concrete etc.**(1)** But certain inherent properties like low ductility, formation of shrinkage cracks etc. cannot be rectified Formation of crack is a major problem, these cracks propagate in all direction causes corrosion of reinforcement in structures

The introduction of different types of fibres to the concrete mix helps to improve the different mechanical properties of concrete and also helps to reduce the cracks formation to a great extent. **(2)**The present study deals with polyesterfibre concrete and a comparison of which with conventional concrete mix and also find out the optimum dosage of Recron 3s fibre in the fibre reinforced concrete. In our project Recron 3s fibre is added as an additive to the concrete. Recron fibre is added for 1% & 2% by the weight of fine aggregate. The optimum percentage of the Recron 3s to be added will be found at the end of the experimental investigation.

1.1 High Performance Concrete

High-Performance concrete (HPC) exceeds the properties and constructability of normal concrete. Normal and special materials are used to make these specially designed concretes that must meet a combination of performance requirements**. (5)**

Special mixing, placing, and curing practices may be needed to produce and handle High-Performance concrete. It has also been used in shotcrete repair, poles, parking garages, and agricultural applications.

1.2 Chemical Admixtures

Chemical admixtures are used to improve the behavior of concrete under a variety of conditions. Chemical admixtures reduce the cost of construction , modify properties of hardened concrete,ensure quality of concrete during mixing / transporting/ placing/ curing, and overcome certain emergencies during concrete operations**.(3)** Chemical admixtures are used to improve the quality of concrete during mixing, transporting, placement and curing. They are namely air entrainers, water reducers, set retarders, set accelerators, super plasticizers. Superplasticizers are linear polymers containing sulfonic acid groups attached to the polymer backbone at regular intervals **(Verbeck 1968).**

1.3 Fosroc Admixtures

Fosroc SP430 (G) is used where a high degree of workability and its retention are required. Fosroc SP430 (G) is supplied as a brown liquid instantly dispersible in water. Fosroc SP430 (G) has been specially formulated to give high water reductions up to 25% without loss of workability or to produce high quality concrete of reduced permeability.

1.4 Basf Glenium B233

GLENIUM B233 is an admixture of a new generation based on modified polycarboxylic ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. GLENIUM B233 is free of chloride & low alkali. It is compatible with all types of cements. What differentiates GLENIUM B233 from the traditional superplasticizers is a new, unique mechanism of action that greatly improves the effectiveness of cement dispersion.

Traditional superplasticizers based on melamine and naphthalene sulphonates are polymers which are absorbed by the cement granules. **(6)** They wrap around the granules' surface areas at the very early stage of the concrete mixing process.The sulphonic groups of the polymer chains increase the negative charge of the cement particle surface and disperse these particles by electrical repulsion. This electrostatic mechanism causes the cement paste to disperse and has the positive consequence of requiring less mixing water to obtain a given concrete workability**.(14)**

1.5 Recron 3s

Recron 3s is a state of art reinforcing material which is used to increase strength in a variety of applications like automotive battery, paper, filtration fabrics, and an asbestos cement sheet, cement based pre-cast products and for improving quality of construction. Concrete is widely recognized as a cost-effective, versatile construction material. Recron 3s fibres are engineered Micro Fibres with a unique “Triangular” Crosssection, used in Secondary Reinforcement of Concrete.

It complements Structural Steel in enhancing Concrete’s resistance to Shrinkage Cracking and improves mechanical properties such as Flexural / Split Tensile and Transverse Strengths of Concrete along with the desired improvement in Abrasion and Impact Strengths. Yet it is also beset with a number of drawbacks that are inherent to its composition.

By generally accepted engineering standards, concrete is relatively brittle and lacks flexural strength. Intertwined with these problems is concrete’s propensity to crack in both its plastic (early-age) and hardened (long-term) state**.(7)**

Early-age cracks are microscopic fissures caused by the intrinsic stresses created when the concrete settles and shrinks over the first 24 hours after being placed. Long-term cracking is in part caused by the shrinkage that transpires over the months, perhaps years, of drying that follow. In either case, these cracks can jeopardize the overall integrity of the concrete and not allow it to maintain – or possibly ever attain – its maximum performance capability. Recron 3S Fibre Reinforcement Systems can provide a solution to most of these problems.

1.6 Fly Ash

Fly ash is a kind of ash is extracted from flue gases through Electrostatic Precipitator in dry form. This ash is fine material & possesses good pozzolanic property. Fly ash is complex material having wide range of chemical, physical and mineralogical composition. The use of fly ash in Portland cement concrete (PCC) has many benefits and improves concrete performance in both the fresh and hardened state. **(8)**

Fly ash use in concrete improves the workability of plastic concrete, and the strength and durability of hardened concrete. Fly ash use is also cost effective. When fly ash is added to concrete, the amount of Portland cement may be reduced. Generally, fly ash benefits fresh concrete by reducing the mixing water requirement and improving the paste flow behavior.

Microsilica

Silica fume, also known as Microsilica, (CAS number 69012-64-2, EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica.

Microsilica is a mineral admixture composes of very fine solid glassy spheres of silicon dioxide (SiO2). Most micro silica particles are less than 1 micron (0.00004 inch) in diameter, generally 50 to 100 times finer than average cement or fly ash particles. **(14)**

Frequently called condensed silica fume, micro silica is a byproduct of the industrial manufacture of ferrosilicon and metallic silicon in high-temperature electric arc furnaces. The ferrosilicon or silicon product is drawn off as a liquid from the bottom of the furnace. **(17)**Vapor rising from the 2000-degree-C furnace bed is oxidized, and as it cools condenses into particles which are trapped in huge cloth bags**.(19)** Processing the condensed fume to remove impurities and control particle size yields micro silica.

Micro silica, also known as Silica fume is fine amorphous silica. Added to concrete at around 30kg/m3 it changes the rheology and reacts with the cement hydration products to dramatically improve concrete strengths, durability and impermeability, allowing concrete to be used in ways never before possible **(13)**

2. Need for the Study

Today, Concrete is used in a variety of innovative designs because of its many valuable properties such as high compressive strength, stiffness, low thermal and electrical conductivity and low combustibility and toxicity.

However, concrete is also known to be brittle and weak in tension and develops cracks during curing, due to thermal expansion and contraction over a period of time.

The recent development of Recron 3s as Secondary reinforcement in Concrete in various fields has provided a strong technical base for improving these deficiencies.

2.1 Objective of the Study

1. An Experimental investigation on fibre reinforced concrete using Recron 3s for M25, M60 and M80 mix proportions are done.
2. Optimum dosage of Recron 3s is found by comparing of 0%, 1% and 12 2% addition of Recron 3s. 3. Compressive strength, split tensile strength and flexural strength of the mix proportions will be analyzed.

2.2 Mix Proportions

- Mass of cement = 552 kg /m ^{3}
- Mass of water = 149 liters
- Mass of fine aggregate = 663 kg/m ^{3}
- Mass of coarse aggregate = 1249 kg/m ^{3}

Water	:	Cement	:	F.A	:	C.A
0.27	:	1	:	1.2	:	2.1

3. Compressive Strength Test on Cubes

Concrete is a building material made from sand, water, gravel, and Portland cement. As this mixture hardens or cures, it forms a very strong and durable material. Because of its strength and resilience, concrete is widely used to construct buildings, roads, and a variety of other structures. **(16)**

To increase compressive strength, it is often necessary to change the mix ratio or add special hardeners. Compression test is conducted on cubic specimens. 54 Specimens of 150mm x150mm x 150mm concrete cubes were casted for compressive strength. The Recron 3s fibers are mixed with concrete at 0%, 1%, and 2% to cast cubes for M25, M60 and M80 grades.

After casting, the specimens were left in casting room for 24hours at a room temperature. Then, they were demolded and cured. The test result shows the 14, 28 and 56 days compressive strength of the concrete.

Compressive strength test				
Grade of concrete	Days of curing	Nominal	1%	2%
M 25	14	26.77	29.33	24.26
	28	28.61	32.44	29.09
	56	32.81	36.94	31.17
M60	14	58.28	61.74	59.35
	28	66.08	69.26	68.81
	56	81.63	85.37	84.77
M80	14	72.06	76.05	69.58
	28	82.64	88.15	79.65
	56	94.17	104.38	95.39

The following are the various graphs representing the M25, M60 and M80 grades of concrete for 14, 28 and 56 days of curing with 0%, 1% and 2% addition of Recron 3s

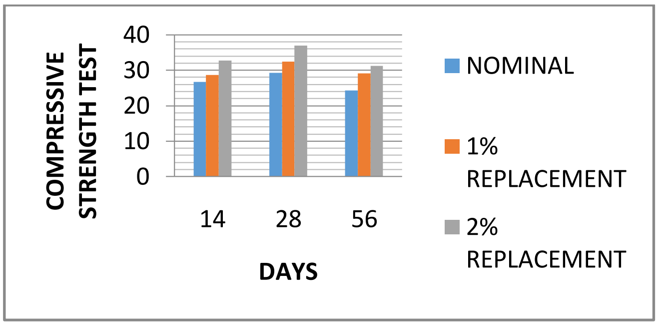

Figure.3.1 Bar graph representing the Compressive Strength variation of M25 grade concrete with increasing curing period

From the above graph it is seen that, there is a gradual increase in strength with increase in curing days. 1% addition of fiber gives higher strength as compared to nominal mix. But there is slight decrease in Compressive Strength when fiber is added for 2%. This shows that the optimum dosage is 1%.

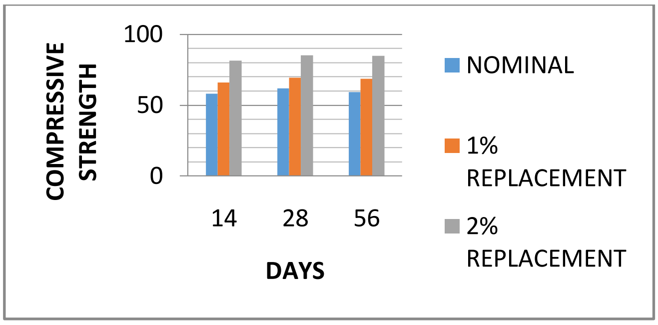

Figure.3.2 Bar graph representing the Compressive Strength variation of M60 grade concrete with increasing curing period 56

From Figure.3.2 it is observed that, Higher Compressive strength is achieved at 1% addition of Recron 3s for various curing days. This is because M60 grade concrete achieves lesser strength at nominal mix and also at 2% addition of fiber.

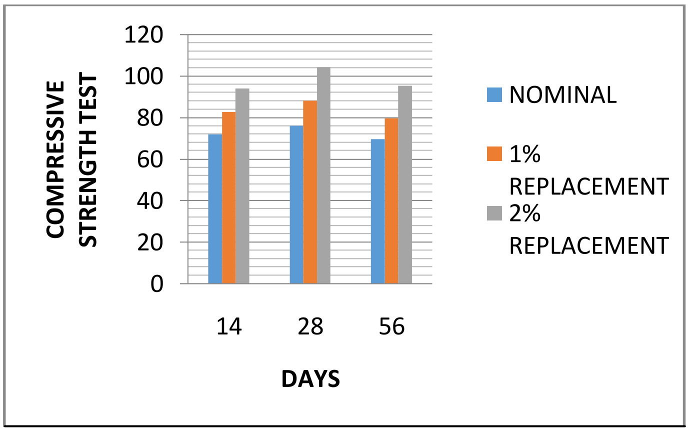

Figure.3.3 Bar graph representing the Compressive strength variation of M80 grade concrete with increasing curing period

From the above Bar graph it is seen that, Compressive Strength of concrete at 56 days of curing for 1% addition of fiber is greater than 100 N/mm^2 . So this is considered to be a maximum strength as compared to other mixes.

4. Split Tensile Strength on Cylinders

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. Split tensile test is conducted on cylindrical specimens. In this project we have used specimens of size 150mm x 300mm. Fibers were added at 0%, 58 1% and 2% to cast cylinders for M25, M60 and M80 grades. After casting, curing is done for 14, 28 and 56 days. The test result shows the split tensile strength of concrete for adopted grades

Split tensile strength test				
Grade of concrete	Days of curing	Nominal	1%	2%
M 25	14	2.85	3.2	2.78
	28	3.36	3.45	3.25
	56	3.87	4.01	3.74
M60	14	4.58	4.67	4.45
	28	5.13	5.29	5.01
	56	6.25	6.54	6.12
M80	14	5.42	5.65	5.02
	28	5.95	6.19	5.72
	56	7.54	7.94	7.25

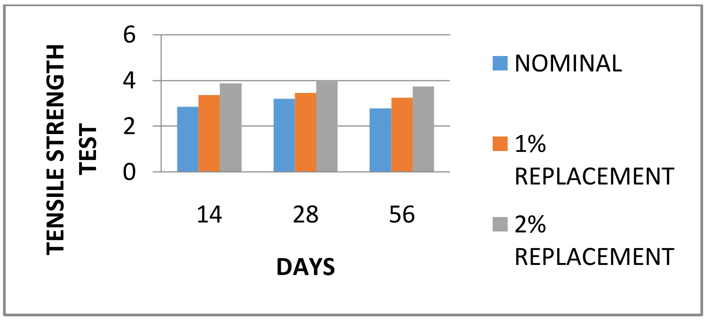

Figure.4.1 Bar graph representing the Split tensile Strength variation of M25 grade concrete with increasing curing period The above graph describes the variation of Split tensile Strength of M25 grade concrete with 0%, 1% and 2% addition of fibre for 14, 28 and 56 days of curing. It shows that 1% of fiber gives greater strength for all curing days.

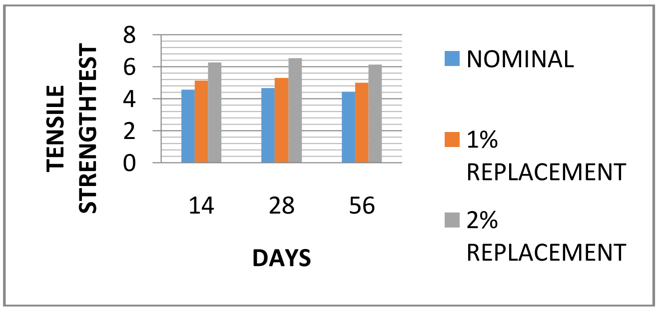

Figure.4.2 Bar graph representing the Split tensile Strength variation of M60 grade concrete with increasing curing period 60 The above graph results shows that Split tensile Strength of concrete increases with increase in curing days. Maximum Strength is attained at 1% addition of Recron 3s.

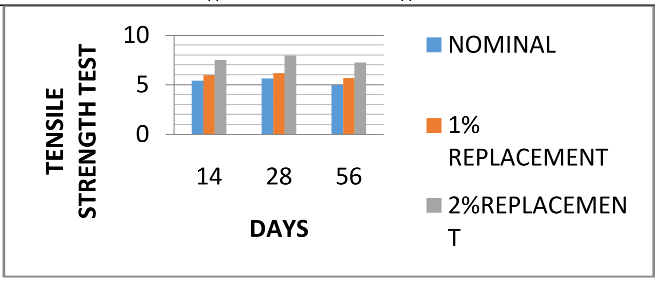

Figure.4.3 Bar graph representing the Split tensile Strength variation of M80 grade concrete with increasing curing period Split tensile strength of M80 Grade Concrete at 1% addition of Recron 3s shows maximum strength compared to all other mixes

5. Flexure Strength

The determination of Flexural tensile strength is essential to estimate the load at which the concrete member may crack. As it is difficult to decrease the tensile strength of concrete by conducting a direct tension test, it is computed by flexure testing. The Flexure tensile strength at failure or the modulus of rupture is thus determined and used when necessary. Its knowledge is useful in the design of pavement slabs and airfield runway as flexure tension is critical in these cases. The modulus of rupture is determined by testing standard test specimens of 150mm x 150mm x 700mm. over a span of 600mm or 100mm x 100mm x 500mm over a span of 400mm, under symmetrical two points loading. The modulus of rupture is determined from the moment at failures as fr = M/Z, thus the computation of fr assumes a linear behavior of the material up to failure which is only a rough estimation. The results are affected by the size of specimens; casting ,curing and moisture conditions; manner of loading (third point or central point loading);rate of loading etc. The flexure strength of concrete is reinforced with shot, discontinuous Recron fibers, randomly oriented and uniformly dispersed in a cement based matrix. The theory is based on a dual criterion of crack control and composite mechanics. In this project, specimens of 150mm x 150mm x 700 mm concrete cubes were casted for compressive strength. The recron 3s fibers are mixed with concrete at 0, 1, and 2% to cast beams. Reinforcement of size 12mm and stirrups of size 8mm were used. These reinforcements were placed in 62 the mould with clear cover of 25mm. After casting, the specimens were left in the casting room for 24 hours at a room temperature. Then, they were demolded and cured. The test results show the 14, 28 and 56 days flexural strength of the concrete.

Flexural strength test				
Grade of concrete	Days of curing	Nominal	1%	2%
M 25	14	3.38	3.75	3.49
	28	3.25	3.95	3.92
	56	4.54	4.75	4.45
M60	14	4.98	5.12	5.02
	28	5.78	6.02	5.85
	56	6.35	6.78	6.45
M80	14	5.65	6.02	5.29
	28	6.75	7.12	6.45
	56	8.12	8.26	802

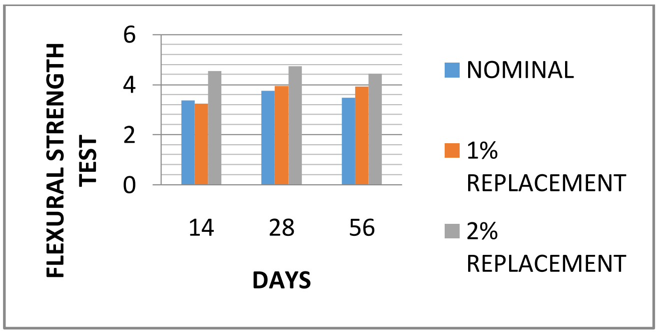

Figure.5.1 Bar graph representing the Flexural Strength variation of M25 grade concrete

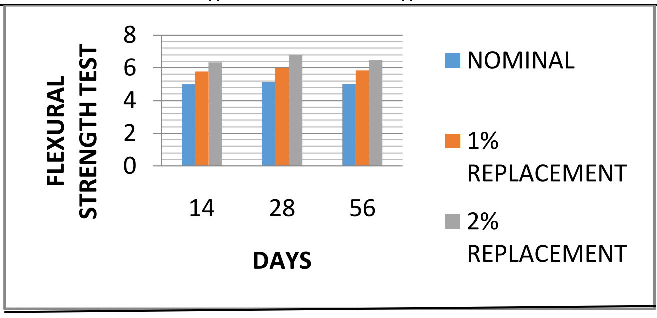

Figure.5.2 Bar graph representing the Flexural Strength variation of M60 grade concrete

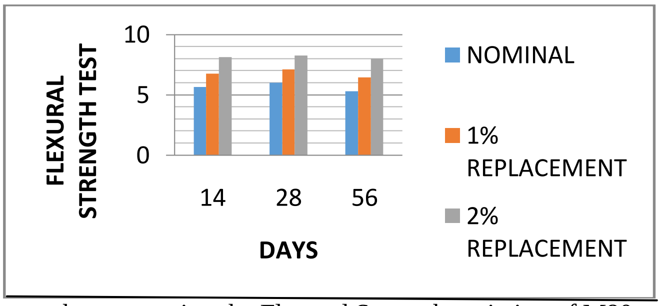

Figure.5.3 Bar graph representing the Flexural Strength variation of M80 grade concrete

Conclusions

Based on the findings of this study, the following conclusions are made:

- On a comparative basis, results indicated that Compressive Strength, Flexural Strength and Split Tensile Strength of Recron fiber concrete specimens were higher than those of plain cement concrete at all ages.
- Strength of concrete increases with increase in curing days, this shows that Recron fiber concrete gives maximum strength at 56 days of curing.
- 2% addition of Recron fiber with concrete did not provide as high improvement levels as those provided by 1% fiber.
- Addition of Recron 3s fiber reduces the segregation as there is an anchorage between the aggregate and cement.
- Recron 3s fiber reduces the maintenance cost by preventing the micro cracks and Permeability and hence resulting in increasing in durability

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