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Impact on strength of concrete properties using Polymer (Polyester fibre) with super plasticizer

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***Abstract*— Recent research aimed invention of new methods in strengthening concrete is under work for decades. Use of secondary reinforcement such as polyester, polypropylene, nylon is quite popular for various applications in construction industry in the advance countries for few decades now. Although the Polyester fibre is a waste of industrial materials, it is relatively more recent pozzolanic material that has received considerable attention in both research and application. Polyester fibre may exist both as an amorphous (transparent) and as a semi-crystalline polymer. The semi-crystalline material might appear transparent (particle size < 500 nm) or opaque and white (particle size up to a few microns) depending on its crystal structure and particle size. The present study has been undertaken to study the effect of Polyester fibres on the mechanical properties of standard concrete M 25, Polyester fibre (polymer) at dosage of 0 %, 0. 3%, 0.6%, 0.9%, 1.2% of cement added in concrete for 7 days,28 days, 90 days.**

***Keywords*: Polyester fibre s, mechanical properties**

I. INTRODUCTION

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. On the track of such invention Fibre Reinforced Composite materials plays a significant role. Polyester is a synthetic fiber derived from coal, air, water, and petroleum. Although the Polyester fibre is a waste of industrial materials. Currently, it is widely used in concrete or motar as it get early strength. It is also used in rehabilitation works, retrofitting, hollow blocks, Rcc, Pcc, pavement,plastering work.

Need of present study:-

To know the effect of Polyester fibre on the mechanical properties of standard concrete by varying the percentage of Polyester fibre added with cement (0 %, 0.3%,0.6%,0.9% ,1.2%).

The mechanical properties which shall be investigated on Cube-Compressive strength, Beam-Flexural strength and Cylinder-Split tensile strength.

The behavior of concrete with Polyester fibre as an admixture by varying the percentages of Polyester fibre and curing period of 7 days,28 days and 90 days has been observed.

II. EXPERIMENTAL PROGRAMME

In order to achieve the objectives of the present study, an experimental program was planned to investigate the effect of Polyester fibre on the mechanical properties of standard concrete, when a part of Polyester fibre is added by cement in different percentages i.e0 %, 0.3%0.,6%,0.9% ,1.2% with the use of superplasticizer. The main parameters investigated were compressive strength, split tensile strength and flexural strength.

The aim of studying properties of the materials used in concrete is to check the conformance as per codal requirements and to enable an engineer to design a concrete mix for a particular strength. The different materials used in the present study were cement, sand, coarse aggregate, Polyester fibre, superplasticizer and water. Laboratory tests were conducted on these materials and their properties have been reported.

Cement: In the present investigation, Portland Pozzolona Cement conforming to IS 1489:1991 is used. The total quantity of cement needed for the investigation is obtained in one lot from a fresh stock and without any lumps. The cement is tested Jaypee cement in accordance with the methods of test specified in IS: 1489:1991

Fine Aggregate: River sand available locally from pathankot was used as fine aggregate. A lump of clay and other foreign materials were separated out carefully. Sand was washed and dried before testing. Sieve analysis of sand was done and specific gravity,water absorption , fineness modulus 2.66, 1.45 % and 2.44 respectively.

Coarse Aggregate: The coarse aggregate used were a mixture of two locally available crushed stone of 10 mm and 20 mm size in 50 : 50 proportion. The aggregates were washed to remove dirt, dust and then dried to surface dry conditions. The specific gravity 2.78, water absorption 0.85 % and fineness modulus was found to confirm the requirements of IS: 383 – 1970.

Polyester fibre: Polyester fibre was used in cement concrete as a early reinforcement for cement to study the effect on durability characteristics of standard concrete. Polyester fibre was obtained from Reliance Industries Limited. Polyester fibre was white in colour and length of 12 mm used.

Water: The water used in the concreting work was the potable water as supplied in the structures laboratory of our college. Water used for mixing and curing was clean and free from injurious amounts of oils, acids, alkalies, salts and sugar, organic materials or other substances that may be deleterious to concrete. As per IS: 456-2000 potable water is generally considered satisfactory for mixing and curing of concrete. Accordingly potable tap water was used for the preparation of all concrete specimens.

Superplasticizer: Conplast X421IC is aqueous solution based on lignosulphonates and non-toxic with IS: 9103: 1999, To minimise permeability and increase the waterproofing properties of concrete water reducing

admixture & IS 2645- 2003 as an integral waterproofing compound.

Concrete Mix Design for M 25 grade standard concrete: In the present investigation the existing method as per IS: 10262-2009 have been used for selecting the concrete mix M 25, however new information given in IS: 456-2000 have been incorporated, procedure is modified to that extent. Specific relationships, charts, graphs that are given in this method of mix design have been developed from extensive experimental investigation at the cement research institute of India as well as on the basis of data on concrete being designed and produced in the country.

Test specimens: various tests conducted on the standard concrete with Polyester fibre added varying percentage 0%,0.3%0.,6%,0.9%,1.2% of cement and replacing fine aggregate and coarse aggregate of equal quantity. For each percentage variation of Polyester fibre.3 samples were tested and average value of these three observations was taken as final result. Testing was done to investigate the mechanical properties of standard concrete by conducting following tests:

- Cubical specimens of size 150mm x 150mm x 150mm and cylindrical specimens of size 300mm x 150mm dia. were tested for the compressive strength of concrete.
- Cylindrical specimens of size 300mm x 150mm dia. were tested for split tensile strength.
- Beam specimens of size 100mm x 100mm x 500mm were tested for flexural strength of concrete.

III. TEST PROCEDURE

COMPRESSIVE STRENGTH TEST: The cubes were tested at the age of 7, 28 and 90 days. Compression strength test were carried out on 150 mm X 150mm X 150 mm cubes with compression testing machine. The specimen, after removal from curing tank was cleaned and dried According to Indian standard procedure laid down in IS: 516-1959

SPLIT TENSILE STRENGTH TEST: The test was conducted according to IS : 5816-1999 code. This test was carried out by placing a cylindrical specimen of size 300mm x 100mm dia. Laid Horizontally between the loading surfaces of a compression testing machine and the load was applied until failure of the cylinder, along vertical diameter

FLEXURAL STRENGTH TEST: The test was conducted according to IS : 516-1959 code.The dimensions of each specimen (100mm x 100mm x 500mm) were noted before testing. No preparation of the surface was required. The bearing surfaces and loading rollers are wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen was then placed in the machine in such a manner the load is applied to the uppermost surface as cast in the mould, along two lines spaced 133 mm apart. The axis of the specimen was carefully aligned with the axis of the loading device. The load was applied without shock and increasing continuously at a rate such that the extreme fibre stress increased at approximately at a rate 180 kg/min for the 100 mm specimens. The load was increased until the specimen fails, and the maximum load applied to the specimen during the test was recorded.

IV. DISCUSSION AND RESULTS

COMPRESSIVE STRENGTH TEST:

Test discussion for cube compressive strength: Polyester fibre concrete containing 0% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 23.82 N/mm^2, 33.96N/mm^2 and 41.11 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 42.56% at 28 days and increase of 72.58% is observed after 90 days.

Polyester fibre concrete containing 0.3% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 30.36 N/mm^2, 41.72 N/mm^2 and 46.95 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 37.41% at 28 days and further increase of 54.64% is observed after 90 days.

Polyester fibre concrete containing 0.6% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 30.86 N/mm^2, 44.88 N/mm^2 and 52.23 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 45.43% at 28 days and further increase of 69.24% is observed after 90 days.

Polyester fibre concrete containing 0.9% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 31.64 N/mm^2, 46.06 N/mm^2 and 53.40 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 45.57% at 28 days and increase of 68.77% is observed after 90 days.

Polyester fibre concrete containing 1.2% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 27.19 N/mm^2, 42.65 N/mm^2 and 48.70 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 56.85% at 28 days and increase of 79.10% is observed after 90 days.

SPLIT TENSILE STRENGTH TEST:

Polyester fibre concrete containing 0% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 2.44 N/mm^2, 3.56 N/mm^2 and 3.81 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 45.90% at 28 days and increase of 56.14% is observed after 90 days.

Polyester fibre concrete containing 0.3% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 2.85 N/mm^2, 3.68 N/mm^2 and 3.93 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 29.12% at 28 days and increase of 37.89% is observed after 90 days.

Polyester fibre concrete containing 0.6% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 3.05 N/mm^2, 4.08 N/mm^2 and 4.47 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 33.77% at 28 days and increase of 46.55% is observed after 90 days.

Polyester fibre concrete containing 0.9% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 2.97 N/mm^2, 3.83 N/mm^2 and 4.39 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 28.95% at 28 days and increase of 47.81% is observed after 90 days.

Polyester fibre concrete containing 1.2% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 2.80 N/mm^2, 3.63 N/mm^2 and 3.97 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 29.64% at 28 days and increase of 34.64% is observed after 90 days.

FLEXURAL STRENGTH TEST: Polyester fibre concrete containing 0% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 3.21 N/mm^2, 3.93 N/mm^2 and 4.06 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 22.42% at 28 days and increase of 26.48% is observed after 90 days.

Polyester fibre concrete containing 0.3% fibre after 7 days, 28 days and 90days was found to be having compressive strength 3.29 N/mm^2, 3.97 N/mm^2 and 4.18 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 20.66% at 28 days and increase of 27.05% is observed after 90 days.

Polyester fibre concrete containing 0.6% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 3.43 N/mm^2, 4.32 N/mm^2 and 4.36 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 25.94% at 28 days and increase of 27.11% is observed after 90 days.

Polyester fibre concrete containing 0.9% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 3.74 N/mm^2, 4.21 N/mm^2 and 4.29 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 12.56% at 28 days and further increase of 14.70% is observed after 90 days.

Polyester fibre concrete containing 1.2% fibre after 7 days, 28 days and 90 days was found to be having compressive strength 3.77 N/mm^2, 4.18 N/mm^2 and 4.22 N/mm^2 respectively. A gain in strength with age is observed. The increase in strength is 10.87% at 28 days and increase of 11.93% is observed after 90 days.

PERCENTAGE OF FIBRE	No of Days		
	7	28	90
0	23.82	33.96	41.11
0.3	30.36	41.72	46.95
0.6	30.86	44.88	52.23
0.9	31.64	46.06	53.40
1.2	27.19	42.65	48.70

TABLE 1: RESULT OF CUBE COMPRESSIVE STRENGTH OF POLYESTER FIBRE CONCRETE WITH AGE

PERCENTAGE OF FIBRE	% Increase w.r.t standard concrete		
	DAYS		
	7	28	90
0.3	27.45	22.85	14.20
0.6	29.55	32.15	27.04
0.9	32.82	35.63	29.89
1.2	14.14	25.59	18.46

TABLE 2: INCREASE % OF CUBE COMPRESSIVE STRENGTH OF POLYESTER FIBRE CONCRETE WITH AGE

PERCENTAGE OF FIBRE	No of Days		
	7	28	90
0	2.44	3.56	3.81
0.3	2.85	3.68	3.93
0.6	3.05	4.08	4.47
0.9	2.97	3.83	4.39
1.2	2.80	3.63	3.97

TABLE 3: RESULT OF SPLIT TENSILE STRENGTH OF POLYESTER FIBRE CONCRETE WITH AGE

PERCENTAGE OF FIBRE	% Increase w.r.t standard concrete		
	DAYS		
	7	28	90
0.3	16.80	3.37	3.14
0.6	25	14.60	17.32
0.9	21.72	7.58	15.22
1.2	14.75	1.96	4.19

TABLE 4: INCREASE % SPLIT TENSILE STRENGTH OF POLYESTER FIBRE CONCRETE WITH AGE

PERCENTAGE OF FIBRE	No of Days		
	7	28	90
0	3.21	3.93	4.06
0.3	3.29	3.97	4.18
0.6	3.43	4.32	4.36
0.9	3.74	4.21	4.29
1.2	3.77	4.18	4.22

TABLE 5: RESULT OF FLEXURAL STRENGTH OF POLYESTER FIBRE CONCRETE WITH AGE

PERCENTAGE OF FIBRE	% Increase w.r.t standard concrete		
	DAYS		
	7	28	90
0.3	2.49	1.02	2.95
0.6	6.85	9.92	7.39
0.9	16.51	7.1	5.67
1.2	17.44	6.36	3.94

TABLE 6: INCREASE % FLEXURAL STRENGTH OF POLYESTER FIBRE CONCRETE WITH AGE

V. CONCLUSION

On the basis of the results and discussions on this investigation the following conclusions are drawn:

- Early strength is observed in concrete containing Polyester fibre after 7 days of curing.
- The compressive strength of Polyester fibre concrete increased with increase in percentage added of Polyester fibre with cement for 0.9% and then gradually decreased with 1.2% addition with standard concrete.
- The flexural strength and split tensile strength of Polyester fibre concrete increased at 0.6% of cement with standard concrete.
- Reduction in workability is obtained when we increase the limit of 1.2 %.
- The Polyester fibre concrete having 0.9% having increase in compressive strength and in 28 days. But 0.6% having increase in flexure strength and split ensile strength.

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