EXPERIMENTAL INVESTIGATION OF POLYMER CONCRETE AND FIBER REINFORCED CONCRETE WITH CONVENTIONAL CONCRETE

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ABSTRACT

In this project is planned to compare two different high strength concrete, one is made up of polymer and another one is made up of steel fiber. In polymer concrete, unsaturated isopthalic polyester(9%,12%,15%,18%) along with a catalyst cobalt octate(1%) and a accelerator methyl ethyl ketone peroxide(1%). In fiber reinforced concrete, binding wire of 1 cm long is going to be used as steel fiber(1%,1.5%,2%,2.5%). Using the above concrete, appreciable number cube, cylinders and prisms are going to be made and they will test for compressive and tensile strength respectively. The test results are going to be compared with conventional concrete from the comparisons the effectiveness of the high strength concrete will be evaluated.

KEYWORDS: Compressive strength, Split tensile strength.

I. INTRODUCTION

In the modern building materials and construction industry the role of concrete is increasing day by day. As a construction materials, concrete is the largest production of all other material. The increase in demand for the ingredients of concrete is met by partially or fully replacement of materials by the waste materials which is obtained by means of various industries.

Fly ash is generally used as replacement of cement, as an admixture in concrete, and in manufacturing of cement. Whereas concrete containing fly ash as partial replacement of cement poses problems of delayed early strength development, concrete containing fly ash as partial replacement of fine aggregate will have no delayed early strength development, but rather will enhance its strength on long-term basis. This study explores the possibility of replacing part of fine aggregate with fly ash as a means of incorporating significant amounts of fly In the last two decades, the use of fiber-reinforced polymer FRP composites has been gaining increasing popularity in the civil engineering community, due to the favourable intrinsic properties possessed by these materials extremely high strength-to weight ratio, good corrosion behaviour, electromagnetic neutrality

Normally concrete is weaker in tension. So in this project we add the steel fiber to increase tensile strength in fiber reinforced concrete. M_{20} (1:1.5:3) concrete is converted into the high strength concrete by adding polymer and steel fiber.

V. Bhikshma.,et al[9]- Polymer as admixture can improve the properties like higher strength and lower water permeability than the conventional concrete. Rheomix 141 is styrene-butadiene co–polymer latex, specifically designed for use with cement composites. It is used in mortar and concrete as an admixture to increase resistance to water penetration, improve abrasion resistance and durability. The objective of the present investigation is to study the behaviour of polymer cement concrete in the hardened state. The variables studied include the grade of concrete and dosage of polymer. Five different grades of concrete M20 to M60 with polymer quantities starting from 5% to 10% were used in the present work. The various mechanical properties like compressive strength, splitting tensile strength, flexural strength, stress–strain characteristics, and modulus of elasticity and permeability characteristics of concrete have been studied. The results obtained thus are encouraging for partial addition of polymer with cement up to 10%.

k.Saravana raja mohan.,et al[8]- “strength and behavior of fly ash based steel fiber reinforced concrete composite**”** this experimental investigation is to study the effect of replacement of cement (by weight) with five percentage of fly ash and the effect of addition of steel fiber composite. An ideal choice would be 15%fly ash with 0.15% of fiber gives an increases of 5% to 31% increase in cube strength at the end of seven days and 12% to 55% at the end of 28 deys.

Jane Proszek Gorninskia.,et al[2]- The concentrations of polymer used were 12% of orthophtalic polyester and 13% of isophtalic polyester by weight of the dry materials. Fly ash was used as a filler and compositions with 8%, 12%, 16% and 20% of ash by weight of aggregate were studied. Increase in axial compressive strength as concentrations of fly ash increased.

II. EXPERIMENTAL PROGRAM

2.1.MATERIALS USED

2.1.1. CEMENT

The commonly used cement is the ordinary Portland cement. For the present experimental investigation ordinary Portland cement of 43 grade has been used for preparing the conventional concrete specimen throughout the work. Specific gravity of cement is 3.1.

2.1.2. FINE AGGREGATE

Locally available river sand were used as a fine aggregate. Specific gravity of fine aggregate is 2.6. sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica (silicon dioxide, or SiO_2), usually in the from of quartz

2.1.3. COARSE AGGREGATE

Crushed granite metal obtained from a local source was used as a coarse aggregate. 20mm of coarse aggregate is used. They shall be strong, hard and durable. Specific gravity of coarse aggregate is 2.7.

2.1.4 FLY ASH

Class C fly ash has been used. It is collected from MSP READY MIX CONCRETE trichy. Fly ash, also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal.

2.1.5 WATER

Water is a chemicals compound with the chemical formula H_2O. A water molecule contains one oxygen and two hydrogen atoms covalent bonds. Water is a liquid at standard ambient temperature and pressure, but it often co-exists on earth with its solid state, ice, and gaseous state (water vapour or steam). Water also exists in a liquid crystal state near hydrophilic surfaces. portable water was used in control specimen only for mixing and curing purposes. pH-value of water is 7.2.

2.1.6 RESIN

Unsaturated isopthalic polyester resin are step growth polymer formed by the reaction of stochiometric mixture of unsaturated and saturated dicarboxylic acids or anhydrides with dihydric alcohols or oxides. These resin are dissolved in reactive monomers like styrene or acrylates to enhance reactively and processibility potential. The degree of unsaturation, and polyester composition and liquid monomer determine the complexity and physic chemical characteristics of the cross linked network. In view of the wide choice of the functional components, unsaturated polyester resin can be tailor- made with specified and exclusive properties.

2.1.7 ACCELERATOR

Accelerator play a major role in chemistry. Most chemical reaction can be hastened with an accelerant. Accelerants alter a chemical bond, speed up a chemical process, or bring organisms back to homeostasis. Accelerants are not necessarily catalysts as they may be consumed by the process. An accelerant can be any substance that can bond, mix or disturb another substance and cause an increase in the speed of a nature, or artificial chemical process. Methyl ethyl ketone peroxide (MEKP) is an accelerator. It starts the polymerization reaction

2.1.8 CATALYST

Catalyst in the increase in rate of a chemical reaction due to the participation of a substance called a catalyst. A catalyst may participate in multiple chemical transformations. Cobalt octate acts as a catalyst. It accelerates the reaction.

2.1.9 STEEL FIBER :

Concrete is weaker in tension. Steel reinforcement is added in concrete for increasing tensile strength. Reinforcing schemes are generally designed to designed to resist tensile stresses in particular regions of the concrete that might cause unacceptable cracking and/or structural failure. Modern reinforced concrete can contain varied reinforcing materials made of steel, fibers, polymers or alternate composite material in conjunction with rebar or not. 0.5mm diameter and 10mm length of stainless steel fibers is used in the steel fiber reinforced concrete for increasing tensile strength.

III.EXPERIMENTAL METHODOLGY

Test specimen used for the investigation are cubes and cylinders specimens. The dimension of the cubes used is 150x150x150 mm, the dimension of the cylinder of the cylinder is 150mm dia an depth of about 300mm have been used. All the specimens used investigation are of uniform size. The details of the test specimen are shown in table 1.

Table 1 Details of test Specimen

S.No	Notation	Types of Specimen	Remark
1	C	conventional concrete	M20
2	P	Polymer concrete(PC)	cement: 100% fly ash, water is replaced by resin
3	F	Steel fiber reinforced concrete	1%,1.5%,2%,2.5% of steel fiber additionally added

IV. RESULTS AND DISCUSSIONS

The specimen were tested up to failure for ultimate loading under compressive, tensile. The first one represented as C is conventional cement concrete specimen. The second mix is represented as P is the polymer concrete where the cement is fully replaced by fly ash and water is fully replaced by resin. The third mix represented as F is fiber reinforced concrete where the steel fiber is additionally added for increasing strength of concrete.

4.1 COMPRESSIVE STRENGTH FOR CUBE

Table 2 Compressive strength for conventional concrete cube

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	600	22.5	26.67
2	590	22.2	26.22
3	580	22.5	25.78

Average compressive strength of conventional concrete cube at 28 days= 26.22N/ mm^2

Table 3 Compressive strength for polymer concrete cube for 9%

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	1200	22.5	53.33
2	1400	22.5	62.22
3	1350	22.5	60.00

Average compressive strength of polymer concrete cube at 28 days= 58.51 N/ mm^2

Table 4 Compressive strength for fiber reinforced concrete cube for 1%

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	900	22.5	40.00

2	900	22.5	40.00
3	950	22.5	42.22

Average compressive strength of fiber reinforced concrete cube at 28 days= 40.74N/mm^2

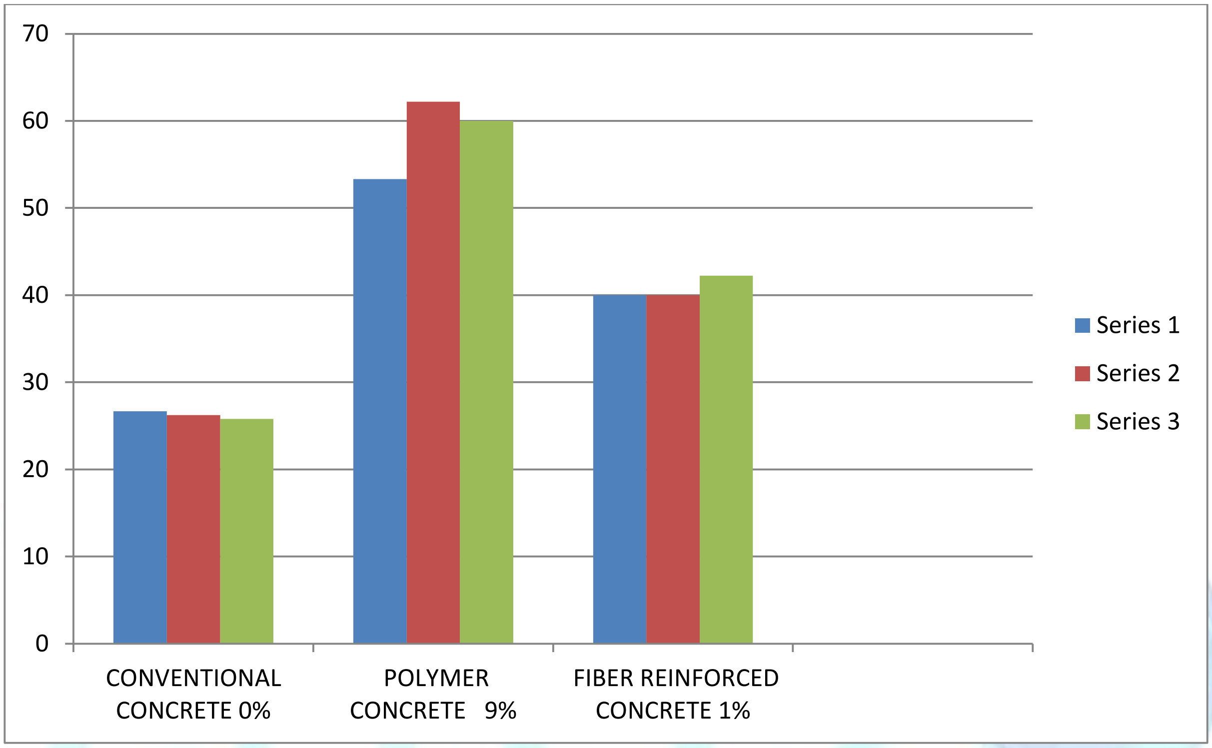

Figure 1 Comparison of compressive strength results

Table 5 Compressive strength for polymer concrete cube for 12%

Specimen No	**Load (N)x10^3**	**Area (mm^2) x10^3**	**Compressive strength at 28 days (N/mm^2) (P/A)**
1	1550	22.5	68.88
2	1600	22.5	71.11
3	1500	22.5	66.67

Average compressive strength of polymer concrete cube at 28 days= 68.87 N/mm^2

Table 6 Compressive strength for fiber reinforced concrete cube for 1.5%

Specimen No	**Load (N)x10^3**	**Area (mm^2) x10^3**	**Compressive strength at 28 days (N/mm^2) (P/A)**

1	1100	22.5	48.88
2	1150	22.5	51.11
3	1150	22.5	51.11

Average compressive strength of fiber reinforced concrete cube at 28 days=50.36N/mm^2

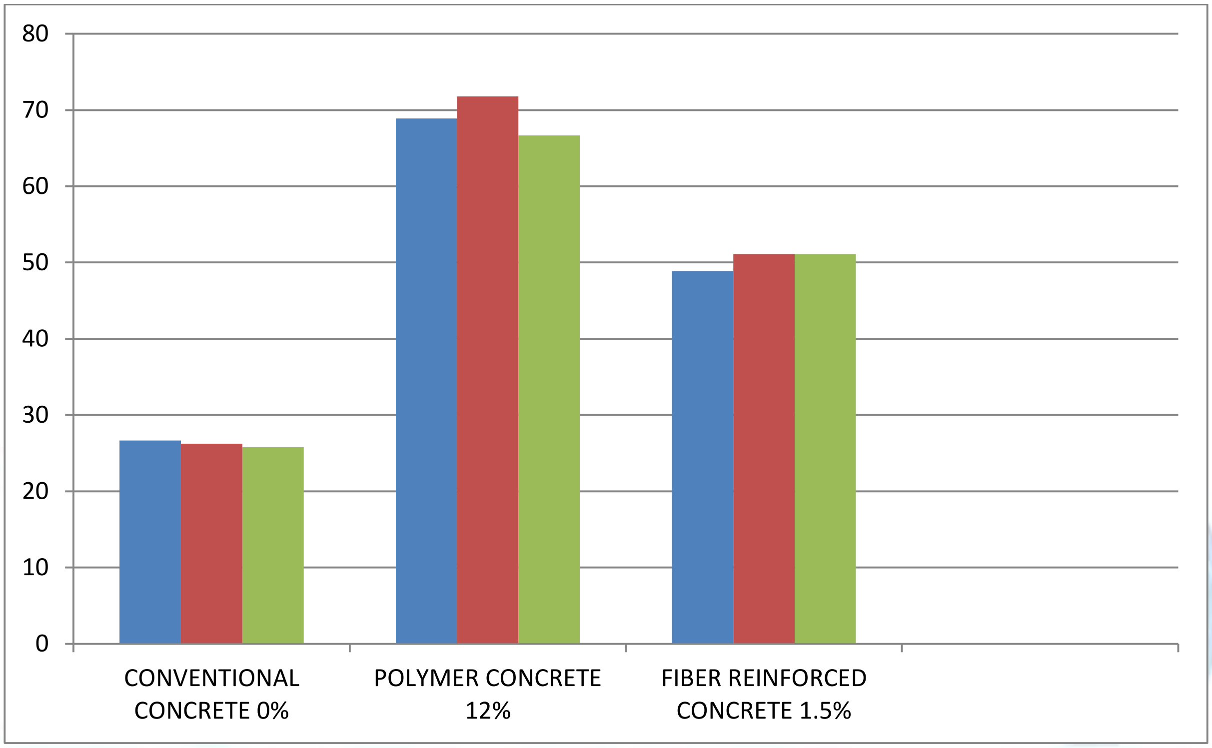

Figure 2 Comparison of compressive strength results

Table 7 Compressive strength for polymer concrete cube for 15%

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	1600	22.5	71.11
2	1500	22.5	66.67
3	1700	22.5	75.56

Average compressive strength of polymer concrete cube at 28 days= 71.11N/mm^2

Table 8 Compressive strength for fiber reinforced concrete cube for 2 %

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	1200	22.5	53.33
2	1350	22.5	60.00
3	1280	22.5	56.88

Average compressive strength of fiber reinforced concrete cube at 28 days= 56.73N/mm^2

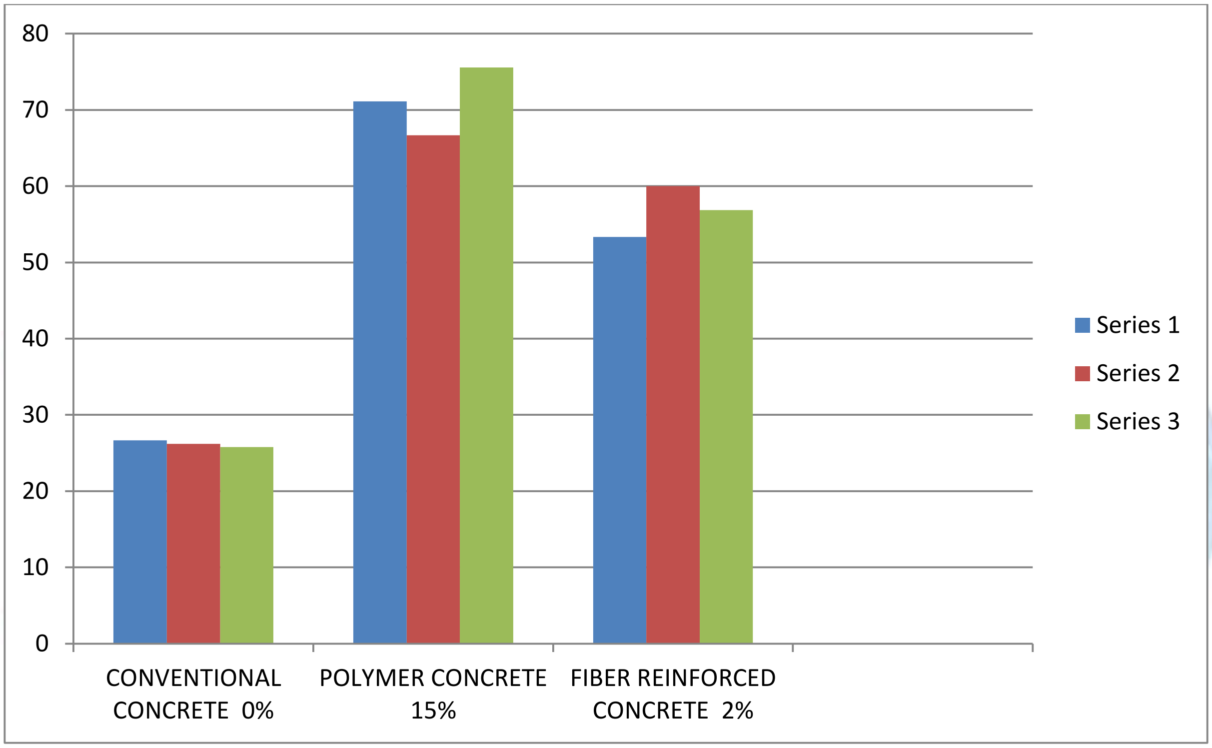

Figure 3 Comparison of compressive strength results

Table 9 Compressive strength for polymer concrete cube for 18 %

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	1776	22.5	79.93
2	1680	22.5	74.66
3	1820	22.5	80.80

Average compressive strength of polymer concrete cube at 28 days= 78.15N/mm^2

Table 10 Compressive strength for fiber reinforced concrete cube for 2.5 %

Specimen No	Load (N)x10^3	Area (mm^2) x10^3	Compressive strength at 28 days (N/mm^2) (P/A)
1	1320	22.5	58.66
2	1400	22.5	62.22
3	1420	22.5	63.11

Average compressive strength of fiber reinforced concrete cube at 28 days= 61.33N/mm^2

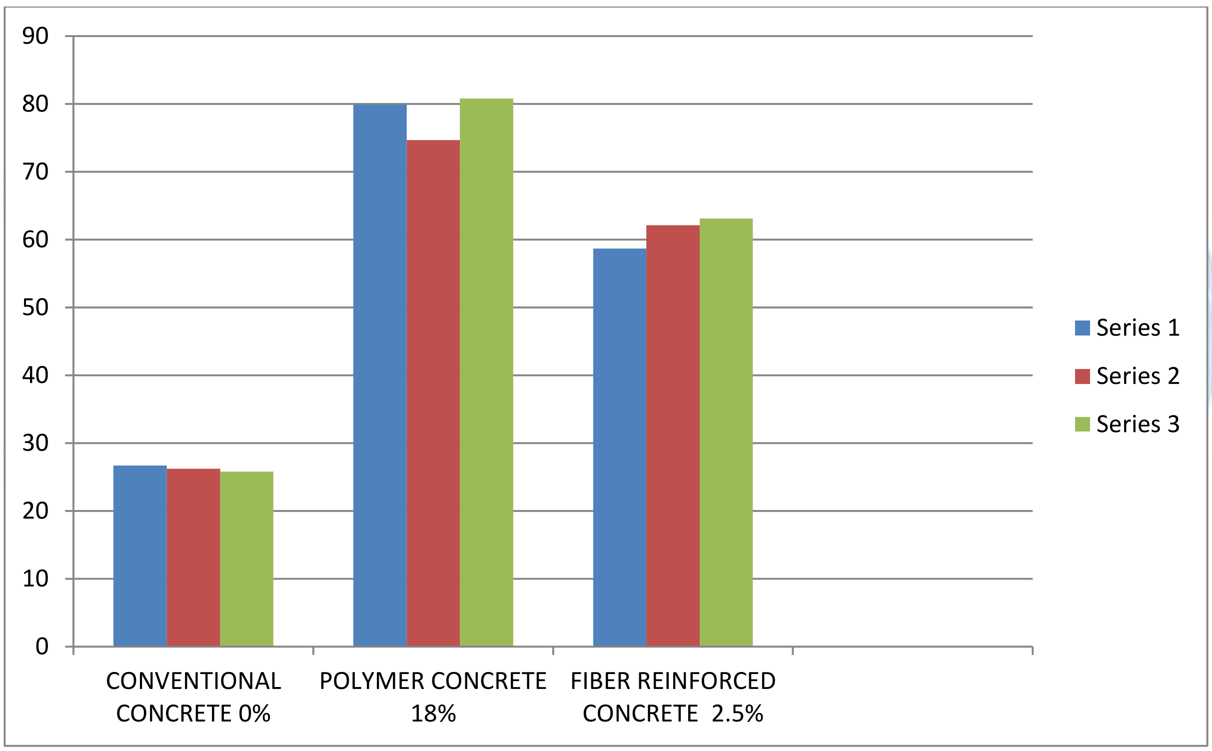

Figure 4 Comparison of compressive strength results

4.2 TENSILE STRENGTH FOR CYLINDER

Table 11 Tensile strength for conventional concrete cylinder

Specimen No	Load (N)x10^3	Tensile strength at 28 days (N/mm^2)

1	158	2.24
2	174	2.46
3	165	2.33

Average tensile strength of conventional concrete cylinder at 28 days=2.34N/mm^2

Table 12 Tensile strength for polymer concrete cylinder for 9%

Specimen No	**Load (N)x10^3**	**Tensile strength at 28days (N/mm^2)**
1	302	4.27
2	318	4.49
3	340	4.81

Average tensile strength of polymer concrete cylinder at 28 days=4.52 N/mm^2

Table 13 Tensile strength for fiber reinforced concrete cylinder for 1%

Specimen No	**Load (N)x10^3**	**Tensile strength at 28 days (N/mm^2)**
1	200	2.83
2	210	2.97
3	220	3.11

Average tensile strength of fiber reinforced concrete cylinder at 28 days= 2.97 N/mm^2

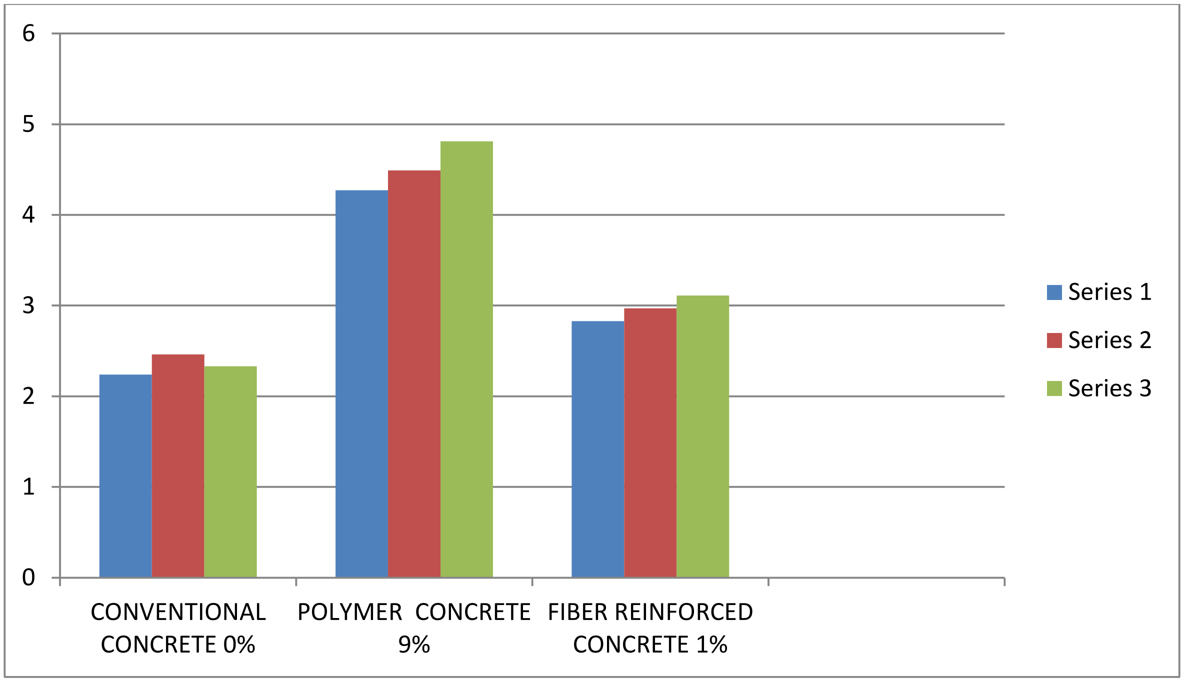

Figure 5 Comparison of tensile strength results

Table 14 Tensile strength for polymer concrete cylinder for 12 %

Specimen No	**Load (N)x10^3**	**Tensile strength at 28days (N/mm^2)**
1	356	5.03
2	387	5.47
3	367	5.19

Average tensile strength of polymer concrete cylinder at 28 days=5.23 N/mm^2

Table 15 Tensile strength for fiber reinforced concrete cylinder for 1.5 %

Specimen No	**Load (N)x10^3**	**Tensile strength at 28 days (N/mm^2)**
1	250	3.5
2	270	3.8
3	275	3.9

Average tensile strength of fiber reinforced concrete cylinder at 28 days=5.23 N/mm^2

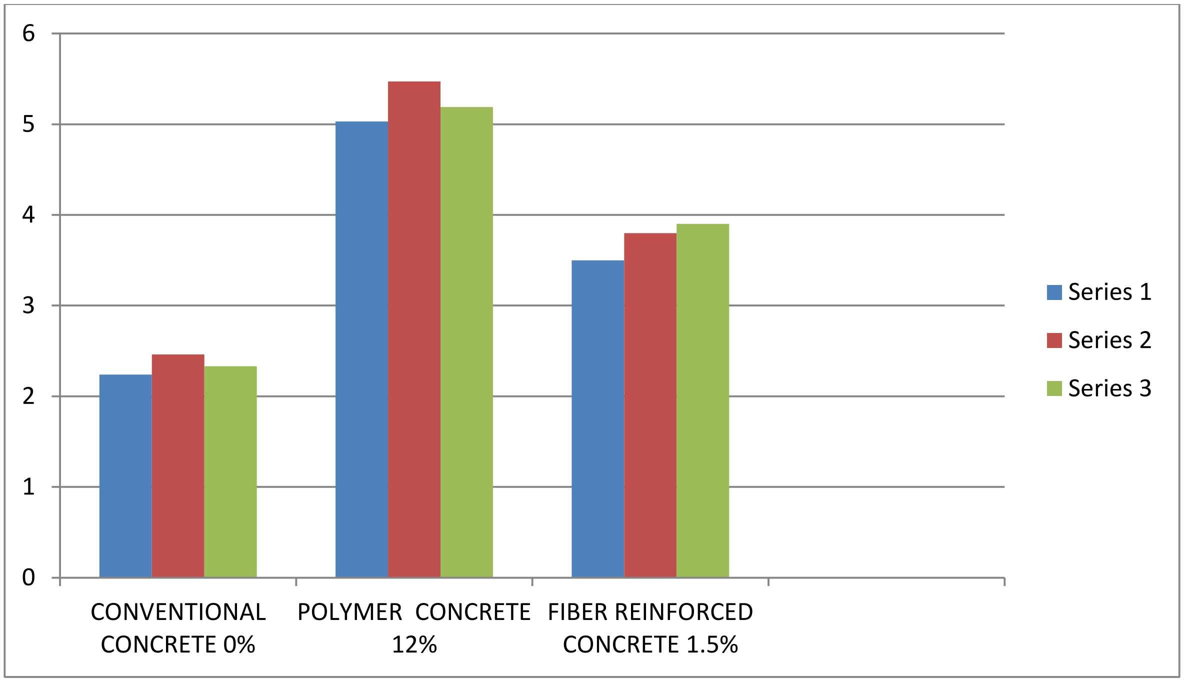

Figure 6 Comparison of tensile strength results

Table 16 Tensile strength for polymer concrete cylinder for 15 %

Specimen No	Load (N)x10^3	Tensile strength at 28days (N/mm^2)
1	406	5.74
2	456	6.45
3	430	6.08

Average tensile strength of polymer concrete cylinder at 28 days=6.09 N/mm^2

Table 17 Tensile strength for fiber reinforced concrete cylinder for 2 %

Specimen No	Load (N)x10^3	Tensile strength at 28 days (N/mm^2)
1	290	4.1
2	279	3.9
3	285	4.03

Average tensile strength of fiber reinforced concrete cylinder at 28 days=2.6N/mm^2

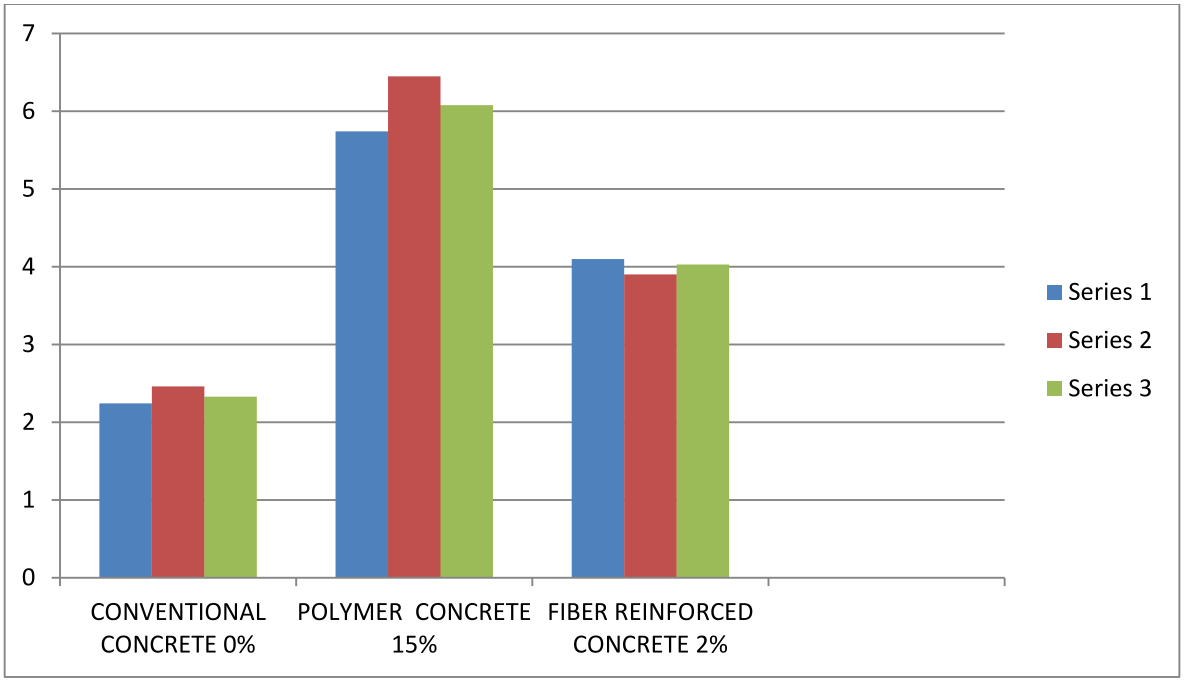

Figure 7 Comparison of tensile strength results

Table 18 Tensile strength for polymer concrete cylinder for 18 %

Specimen No	**Load (N)x10^3**	**Tensile strength at 28days (N/mm^2)**
1	516	7.21
2	506	7.15
3	538	7.61

Average tensile strength of polymer concrete cylinder at 28 days=7.32N/mm^2

Table 19 Tensile strength for fiber reinforced concrete cylinder for 2.5 %

Specimen No	**Load (N)x10^3**	**Tensile strength at 28 days (N/mm^2)**
1	301	4.25
2	300	4.24
3	295	4.17

Average tensile strength of fiber reinforced concrete cylinder at 28 days=2.83N/mm^2

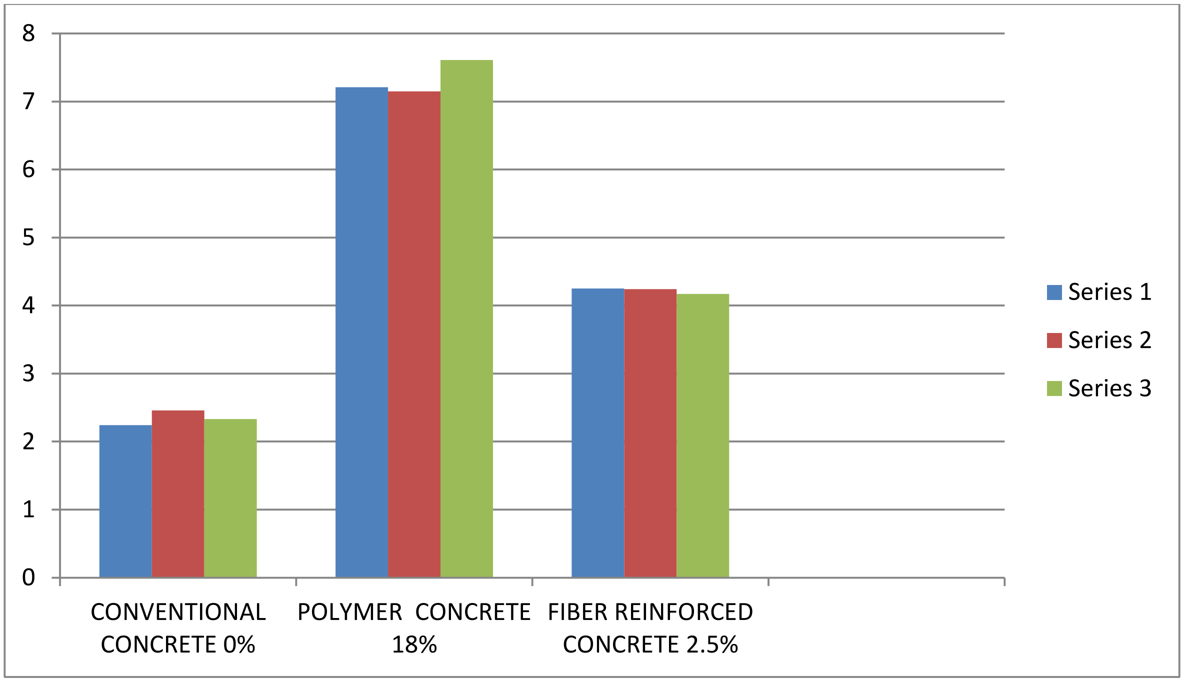

Figure 8 Comparison of tensile strength results

V. CONCLUSIONS

SUMMARY AND CONCLUSION

After a complete study the following conclusions were draw from the test results,

- Conventional concrete made from m20 concrete gives a compressive strength of 26.22 N/mm^2, tensile strength of 2.34 N/mm^2 in 28 days.
- Using of polymer concrete and using steel fiber enhances the strength of concrete.
- Compressive strength of polymer concrete is 3 times greater than conventional concrete.
- Compressive strength of steel fiber reinforced concrete is 2.3 times greater than conventional concrete.
- Tensile strength of polymer concrete is 4.5 times greater than conventional concrete.
- Tensile strength of steel fiber reinforced concrete is 2.8 times greater than conventional concrete.

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