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Strength Evaluation of Cement Concrete Pavement by using Polypropylene And Polyester Fiber as a Reinforced Material

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Abstract: *Road traffic is increasing steadily over the years. An international forecast predicts that such increase will continue in near future. Even in case of developed countries, there is a shortage of funds required for new infrastructure projects, both for constructing them and more significantly towards their maintenance and repairs. The position in the context of a developing country like India is obviously far worse. As a result, more and more roads are deteriorating, and the existing pavement structure is often found to be inadequate to cope up with the present traffic. Most of our bituminous pavements today, which are badly suffering from distresses like rutting, shoving, cracking etc., are overdue for rehabilitation/strengthening. This will involve huge cost and consumption of scarce physical resources like aggregates and bitumen. Cost effectiveness of PCC overlays bituminous overlay, therefore, needs to be examined. PQC roads on average have proved to be quite cost effective besides giving an additional life of 20 to 30 years on average. PQC stands for Pavement Quality Concrete made with larger size aggregates following IRC specifications and laid over a Dry Lean Concrete (DLC), concrete subbase course. PQC construction is explicitly used for highway concrete pavements and runway pavements to take heavy loads.*

Keywords: Rehabilitation, Innovative, Asphalt Pavement, Strengthening

I. INTRODUCTION

Most of our bituminous pavements today, which are badly suffering from distresses like rutting, shoving, cracking etc., are overdue for rehabilitation/strengthening. This will involve huge cost and consumption of scarce physical resources like aggregates and bitumen. Cost effectiveness of PCC overlays bituminous overlay, therefore, needs to be examined. PQC roads on average have proved to be quite cost effective besides giving an additional life of 20 to 30 years on average. Road traffic is increasing steadily over the years. An international forecast predicts that such increase will continue in near future. Even in case of developed countries, there is a shortage of funds required for new infrastructure projects, both for constructing them and more significantly towards their maintenance and repairs. The position in the context of a developing country like India is obviously far worse. As a result, more and more roads are deteriorating, and the existing pavement structure as a whole is often found to be inadequate to cope up with the present traffic.

1.1 Problem Statement

Most of the existing flexible pavements in the network broadly have thin bituminous layers. These bituminous pavements, in general, have a problem that they get deteriorated with time.

1.2 Scope of work

The scope of this work is to improve performance of Pavement quality concrete by using polypropylene fiber. And reduces cost of construction as well as maintenanceofpavement quality structure.

1.3 Objectives

objective of proposed work is:

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1) The Main Parameters of the Study Is to find out the Compressive Strength, Flexural Strength. using with polypropylene and Polyester fiber.
2) To study the effect of fiber in road pavement
3) To improve the strength of the pavement structure
4) To reduce the maintenance cost of pavements
5) To improve the life span of concrete.

II. LITERATURE REVIEW

1) Strength Evaluation of Cement Concrete Pavement by Using Polypropylene and Polyester Fiber as Reinforced Material By (DEC 2021): - Aatif Irshad Khan MTech Schloar, Department of Civil Engineering, Mewar University, Chittorgarh, Rajasthan.

The study found that The Compressive Strength of Control mix concrete is less than the rest of the three mixes but the mix of concrete with polyester and polypropylene increased the compressive strength of the concrete. According to result we found that the compressive strength of Concrete mix with both 1.8 % and 0.5% of polypropylene and polyester fiber is 48.76 N/mm2 at 7 days and 52.76 N/mm2 at 28 days.

2) An Experimental Study to Compare the Strength Characteristics of Concrete using Polypropylene Fiber and Polyester Fiber Admixtures BY (MAY 2017): Garikapati, Sontineni Kanakambara Rao, P Mohana Ganga Raju.

This paper outlines an experimental study that compares the strength characteristics of polymer fiber concrete to the plain cement concrete. However, the fiber polymers may serve as admixtures, which might result in certain changes in concrete, like low rate of water absorption, high-range water reduction, greater strength and goodness in elasticity. The parameters of investigation included fresh properties of different fiber reinforced concrete, compressive strength, split tensile strength and flexural strength. Various tests conducted on the standard concrete specimens with polypropylene and polyester fiber as admixtures in varying percentages, 0%, 0.3%, 0.5%, 0.7%, 0.9%, and 1.1% of the total weight of the cement.

3) Researched on Modified polyester synthetic fiber concrete (MPFC), Monofilament polypropylene synthetic fiber reinforced concrete (MPSFC), Reticular polypropylene synthetic fiber reinforced concrete (RPFC), and Polyacrylonitrile synthetic fiber reinforced concrete (PSFC) By (2018): - Yue Chen.et.al.

It has been concluded that the fiber content and cost benefit analysis have certain influence on the performance of synthetic fiber reinforced concrete and the application of fiber reinforced concrete in the airport pavement has great economic benefits and broad prospects for development

4) A Review Study of Polymer Fibre Reinforced Concrete with Conventional Concrete Pavement By (MAY 2017): - Tariq Ahmad Sheikh, Er. Mohit Bajaj.

The compressive strength, split tensile strength, flexural strength and modulus of elasticity increase with the addition of fiber content as compared with conventional concrete. By replacing cement with polypropylene dosage, it helps to saving the cement content in concrete.

5) Experimental Studies And Application Of Fiber Reinforced Concrete By (2014):- Amit Rai, Dr. Y.P.Joshi.

They study different types of fibers and their application. The improvement in concrete properties by polypropylene fibers, they analysed that compressive strength which is increased about 16%. The flexural strength of polypropylene fibers is improved about 30%. They study the different types of fibres and the concrete properties. Fiber addition improves ductility of concrete Slump test were examined to find out the workability and consistency of fresh concrete. The efficiency of all fiber reinforcement is dependent upon achievement of a uniform distribution of the fibers in the concrete, their interaction with the cement matrix, and the ability of the concrete to be successfully cast or sprayed.

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6) Experimental studied on flexure strength on polypropylene fiber Reinforced concrete and considered the impacts of polypropylene fiber on the flexure strength of cement By (2014): - Komal Bedi.

The trial customized was under taken to test standard concrete beam (150 X 150) mm with a span 700 mm for examining strength in flexure. The specimens were contrasted with no fiber and polypropylenes fiber of force 0.89 kg for each cum of cement. To give premise to flexure, reference examples were thrown without polypropylene fiber. The test outcomes demonstrated that the mechanical properties of flexural strength coming about because of included of polypropylene fiber was generally high.

7) Effect Of Polypropylene Fibre on High Strength Concrete By (2013): - MR. Mehul J. Patel et al.

The paper deals with the effects of addition of various proportions of polypropylene fibers on the properties of high strength concrete. An experimental program was carried out to explore its effects on compressive, tensile, flexural, shear strength and plastic shrinkage cracking. A notable increase in flexural, tensile and shear strength was found. The maintain of the investigation program is first to prepare the strength of concrete of grade M40 with locally available ingredient and then to study the effect of different proportion of Polypropylene fiber in the mix and to find optimum range of Polypropylene fiber content is 0.5%,1.0%,1.5% in the mix. The concrete specimens were tested at different age level for mechanical properties of concrete, namely, cube compressive strength, split tensile strength, flexural strength and other test were conducted for cement, chemical admixture, coarse aggregate & fine aggregate.

8) Explored Suitability of Cement Reinforced with Engineered Fiber for The Development Of Pavements By (2013): - Rakesh kumar.

Author quickly talked about the impacts of expansion of polypropylene discrete and fibrillated fiber on the properties of a clearing evaluation concrete mix of 48 Mpa compressive strength at 28-days. Six cement blends were thrown with fiber measurements 0.05%, 0.10% and 0.15%. The properties, for example, settlement, compressive strength, drying shrinkage, and scraped spot resistance of the concrete were assessed.

III. METHODOLOGY

In order to make proper mix of fiber Reinforced concrete following materials are to be used: -

3.1 Cement

IS mark 43 grade cement (Brand-ACC cement) was used for all concrete mixes. Thecement used was fresh and without any lumps.

3.2 Crush Sand

The artificial sand produced by proper machines can be a better substitute to river sand. The sand should be sharp, clean and course. The grains should be of durable material. The grain sizes must be such that it should give minimum voids. The presence of clay and silt retards the setting of the cement and makes the mortar weaker and the walls or the slab leaks and holds dampness. The sand in the mortar does not add any strength but it is used as an adulterant for economy and with the same it prevents the shrinkage and cracking of mortar in setting. The sand must be of proper gradation in the concrete mix design we are varying the percentage of crush sand.

3.3 Coarse aggregate

Locally available coarse aggregates having the maximum size of 10 mm and20mm were used in the present work. Testing of coarse aggregates was done as per is:383-1970. no aggregate which has water absorption more than 2% shall be used in concrete mix. 10mm aggregates used Were First sieved through 10mm sieve and then through 4.75 mm sieve and 20mm aggregates were firstly sieved through 20mm sieve. They were then washed to remove dust and dirt and were dried to surface dry condition.

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3.4 Polypropylene Fiber

Polypropylene fibers are new generation chemical fibers. They are manufactured in large scale and have fourth largest volume in production after polyesters, polyamides, and acrylics.

Polyester fiber

Polyester fibers are used in fiber-reinforced concrete (FRC) for pavements and overlays and precast structures. In this study polyester fiber used as reinforced material to enhance mechanical properties of cement concrete pavement.

3.5 Admixtures and superplasticizers

Plasticizers, also called Water Reducers, impart Plasticizing effect in wet concrete; are organic substances or combination of organic and inorganic substances. Basic constituents of Plasticizers are lignosulphonates, their derivatives; acid of hydroxylated carboxylic acids, their derivatives; and Carbohydrates

3.6 Water

Potable tap water was used for mixing the concrete preparation and for the curing of specimen. It shall meet the requirement stipulated IS: 456. Portable water is generally considered satisfactory for mixing and curing.

3.7 Mix Proportion

Grade Designation = M40 (1:1.2:0.35)
Type of Cement = OPC 43
Size of the Coarse aggregate = 10 and 20mm
Fine Aggregate = crushed sandand river sand
Min cement content = 450 kg/cu-m
Admixture: -BASF MR1126SM Super Plasticizer
Water: - Potable Bore Well – Water Tanker
Max W/C ratio = 0.35
Type of aggregate = Crushed Angular

IV. RESULTS AND DISCUSSIONS

Compressive strength of concrete at 7 days and 28 days.

It is the characteristic strength of concrete. It is the most important aspect of concrete to withstand in compressive force. Cubes of M40 grade concrete of size 150x150x150 mm cube were casted and tested after curing. This test was performed on CTM machine. Concrete cubes for compressive strength trail at 7 days and 28 days

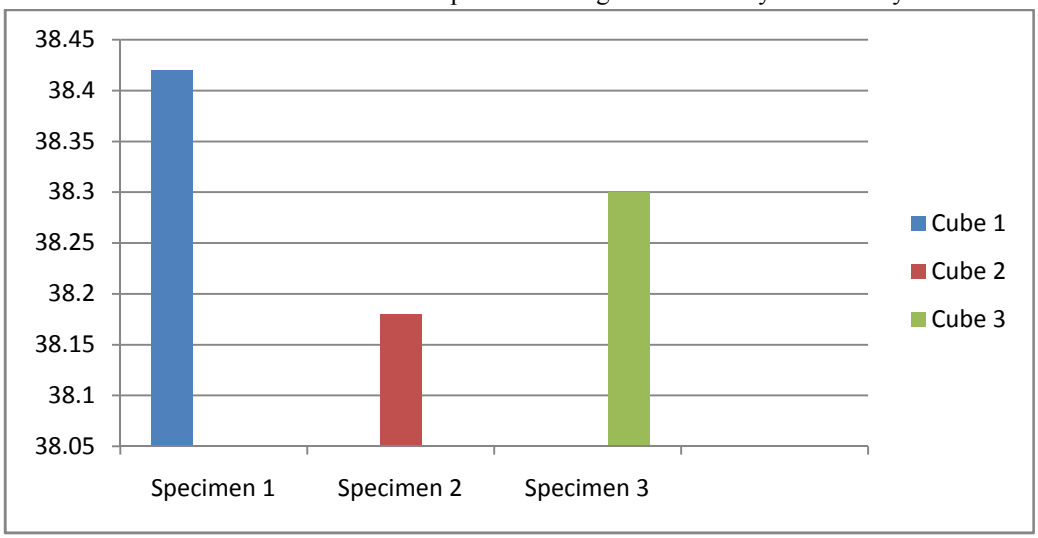

Figure 4.1 Compressive Strength Of Polypropylene Fiber For 7 Days (Chart 1)

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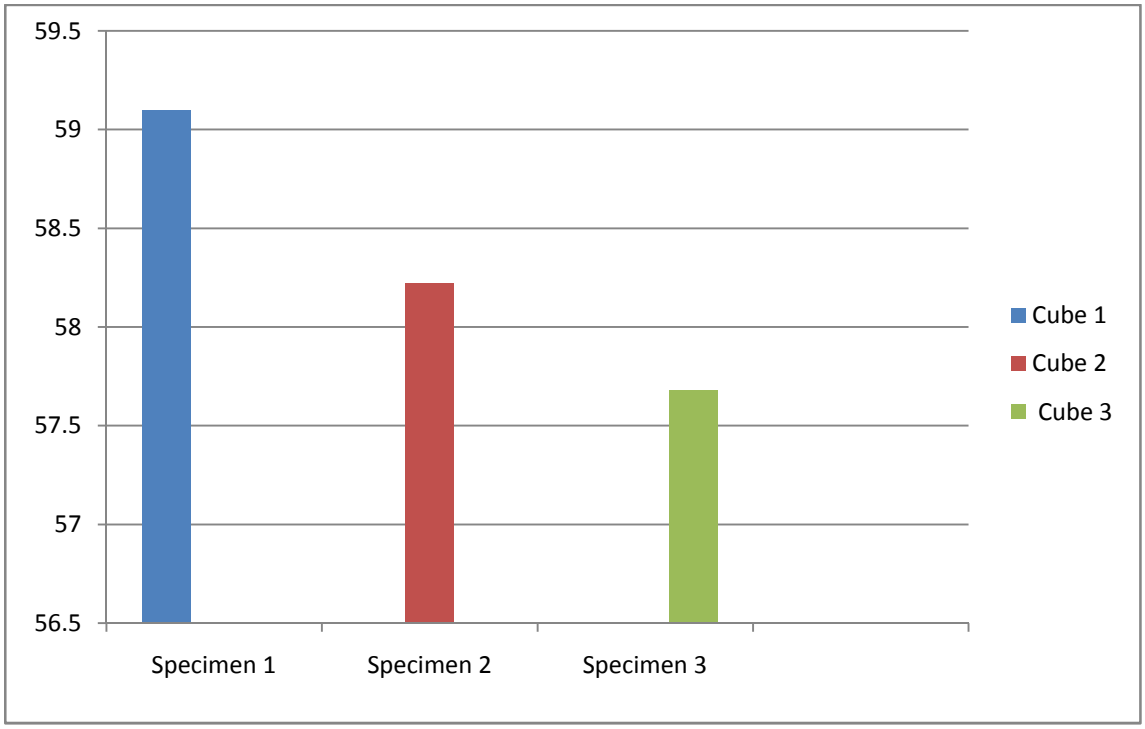

Figure 4.2 Compressive Strength Of Polypropylene Fiber For 28 days (Chart 2)

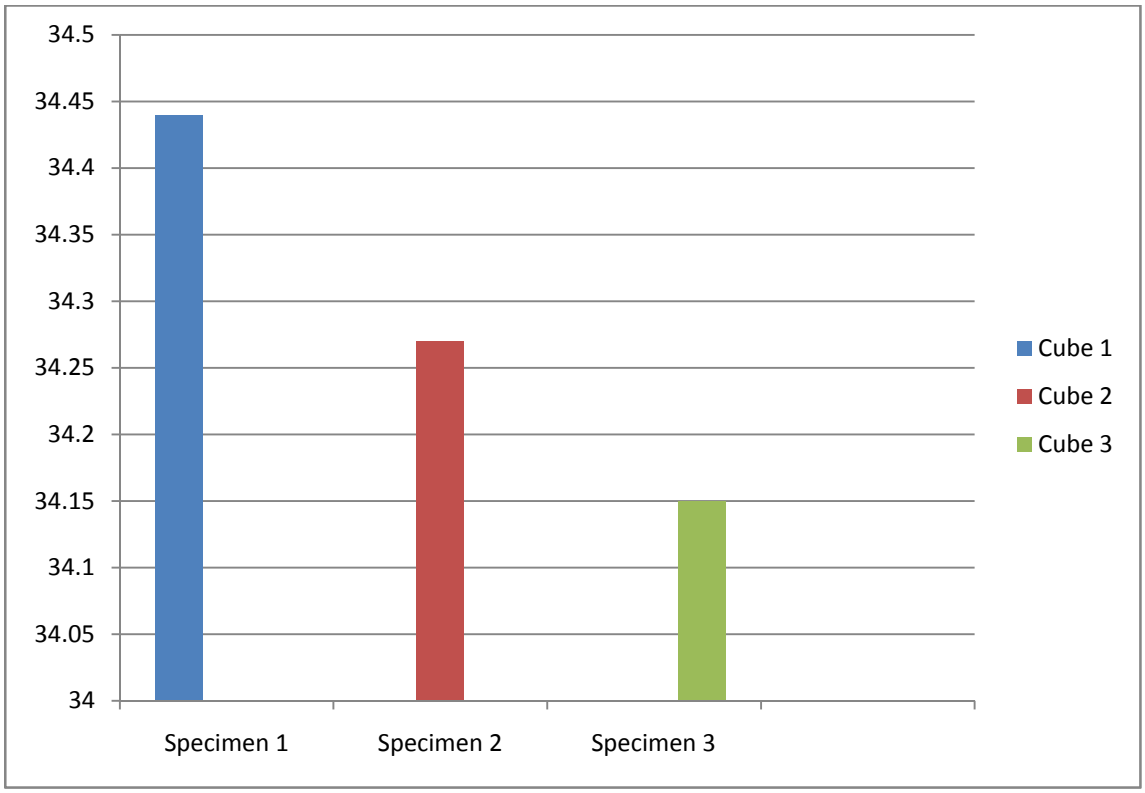

Figure 4.3 Compressive Strength Of Polyester Fiber For 7 Days (Chart 3)

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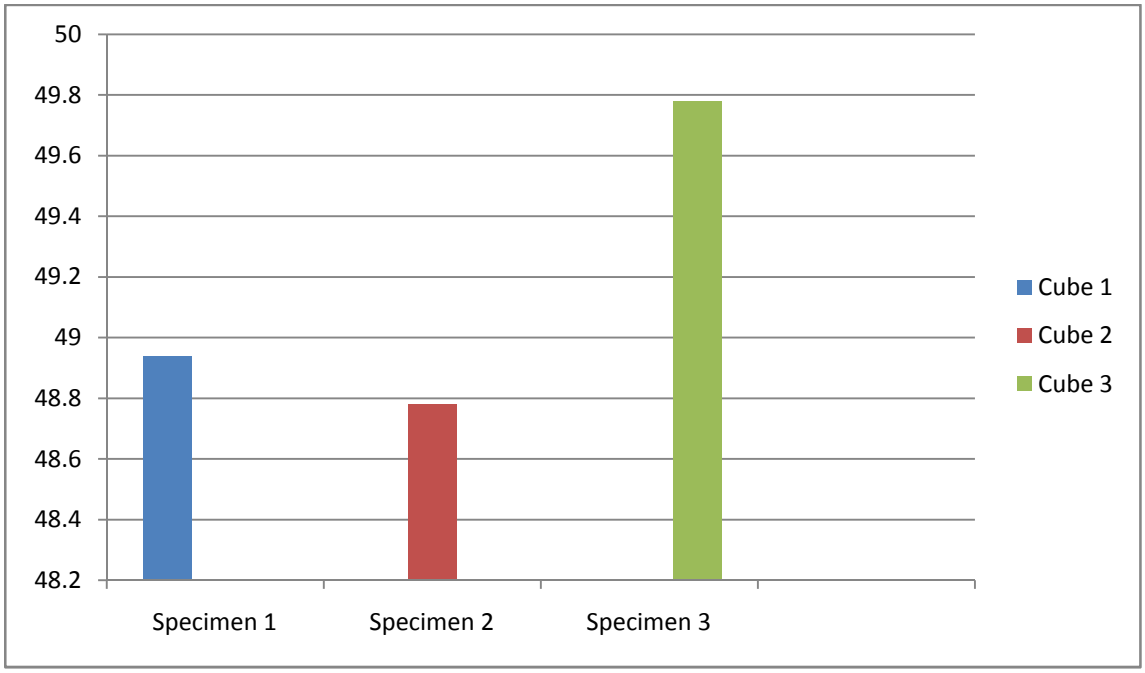

Figure 4.4 Compressive Strength Of Polyester Fiber For 28 Days (Chart 4)

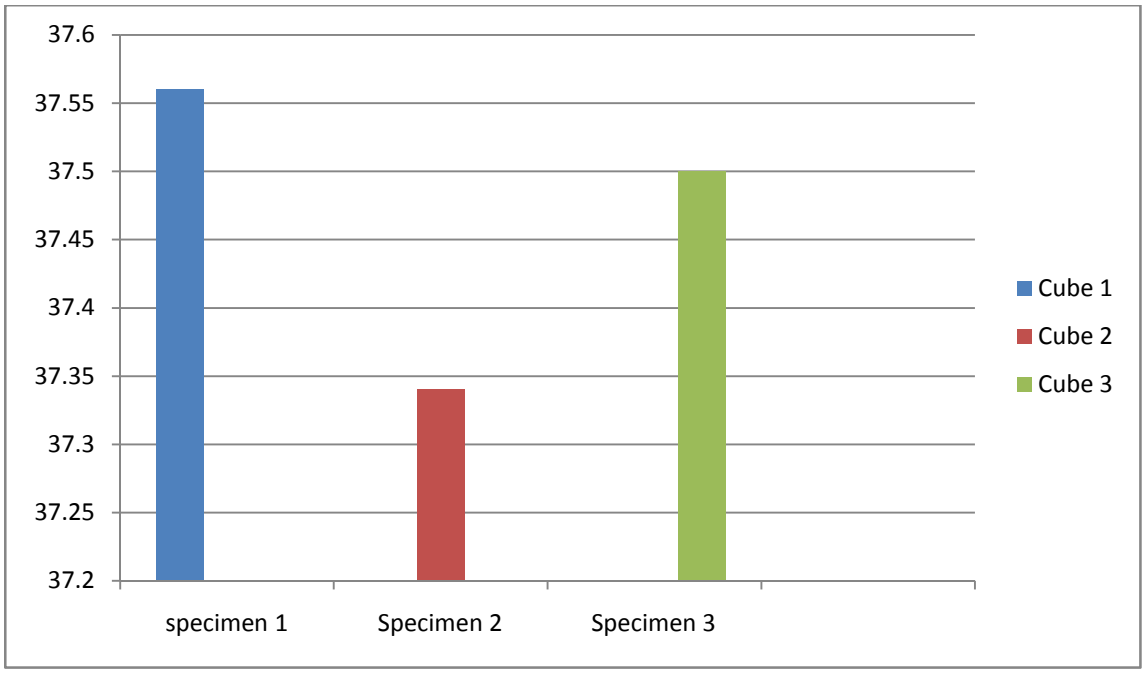

Figure 4.5 Compressive Strength Of Polypropylene& Polyester Fiber 7 days (Chart 5)

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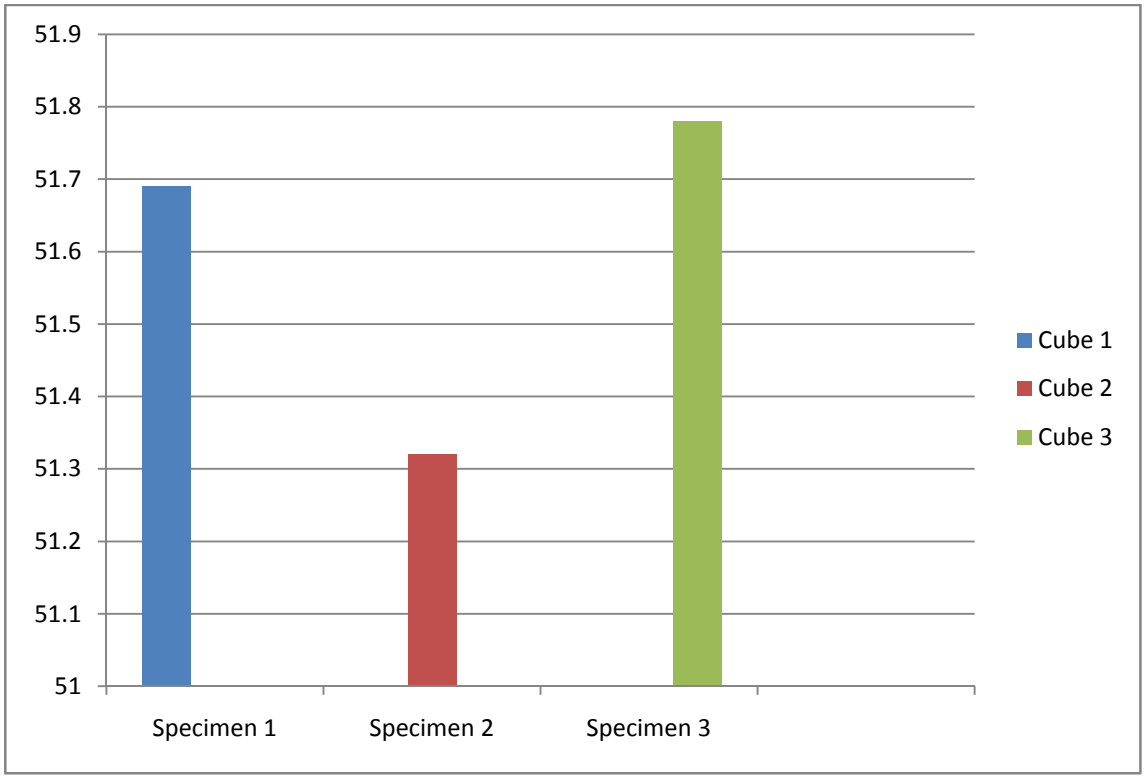

Figure 4.6 Compressive Strength Of Polypropylene& Polyester Fiber 28 days (Chart 6)

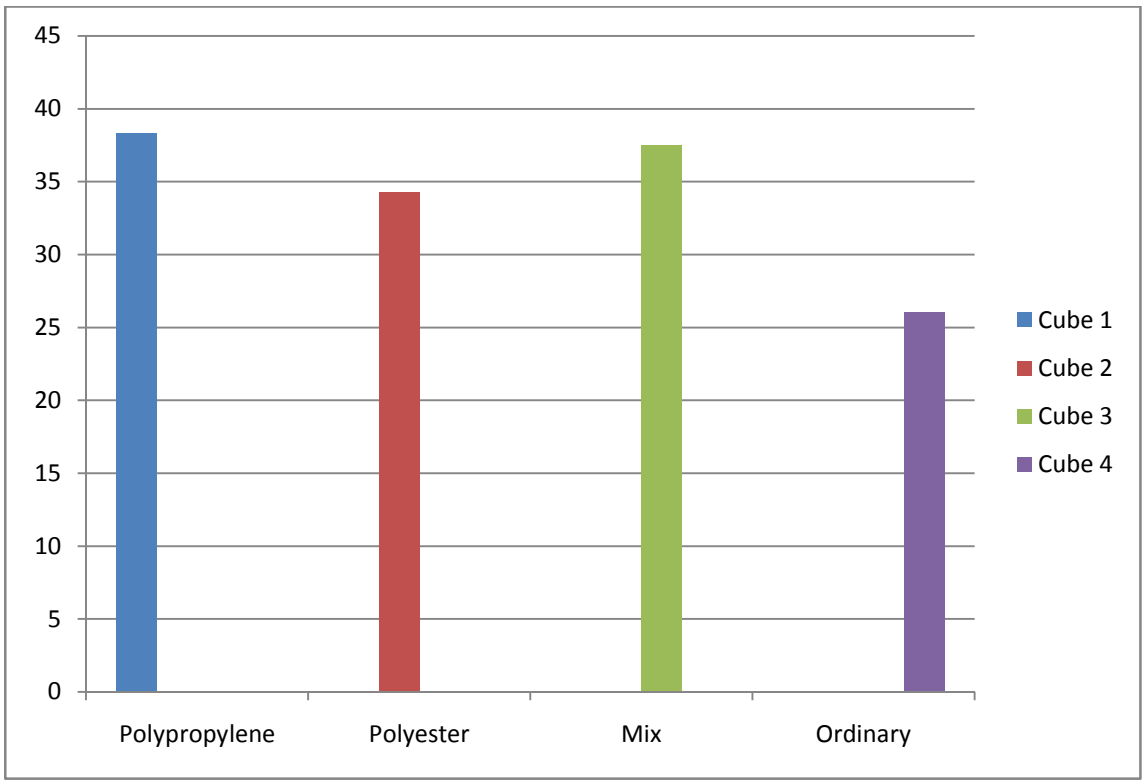

Figure 4.7 Compressive Strength Of Polypropylene Fiber, Polyester Fiber & Ordinary Concrete For 7 Days (Chart 7)

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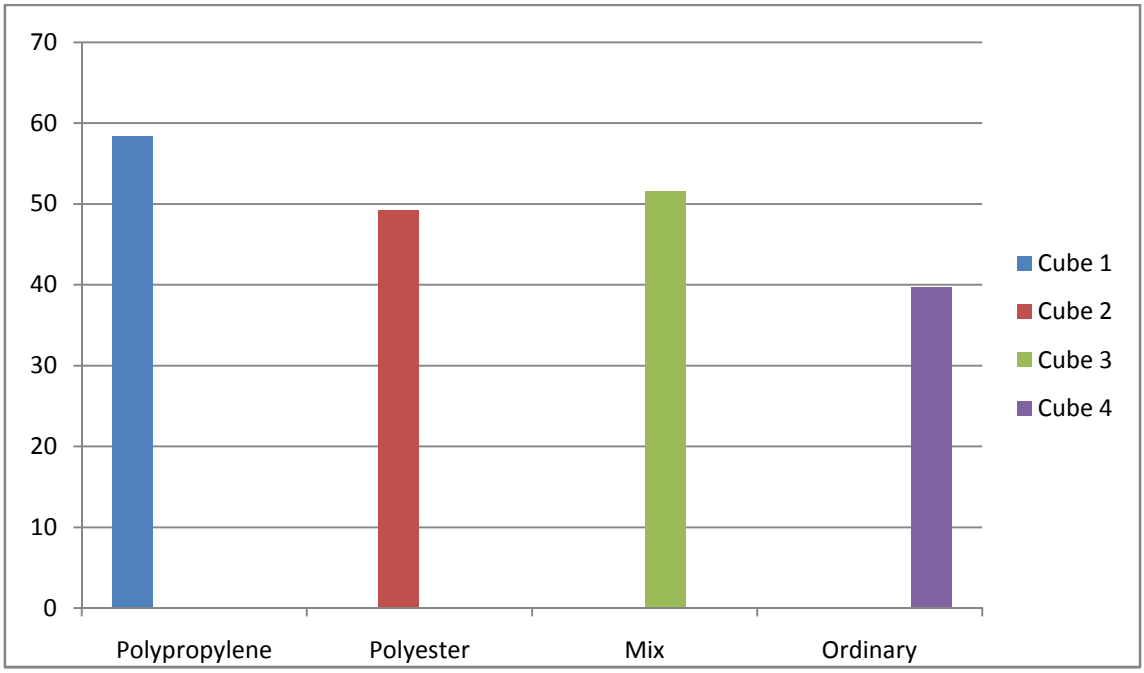

Figure4.8 Compressive Strength Of Polypropylene Fiber, Polyester Fiber & Ordinary Concrete For 28 Days (Chart 8)

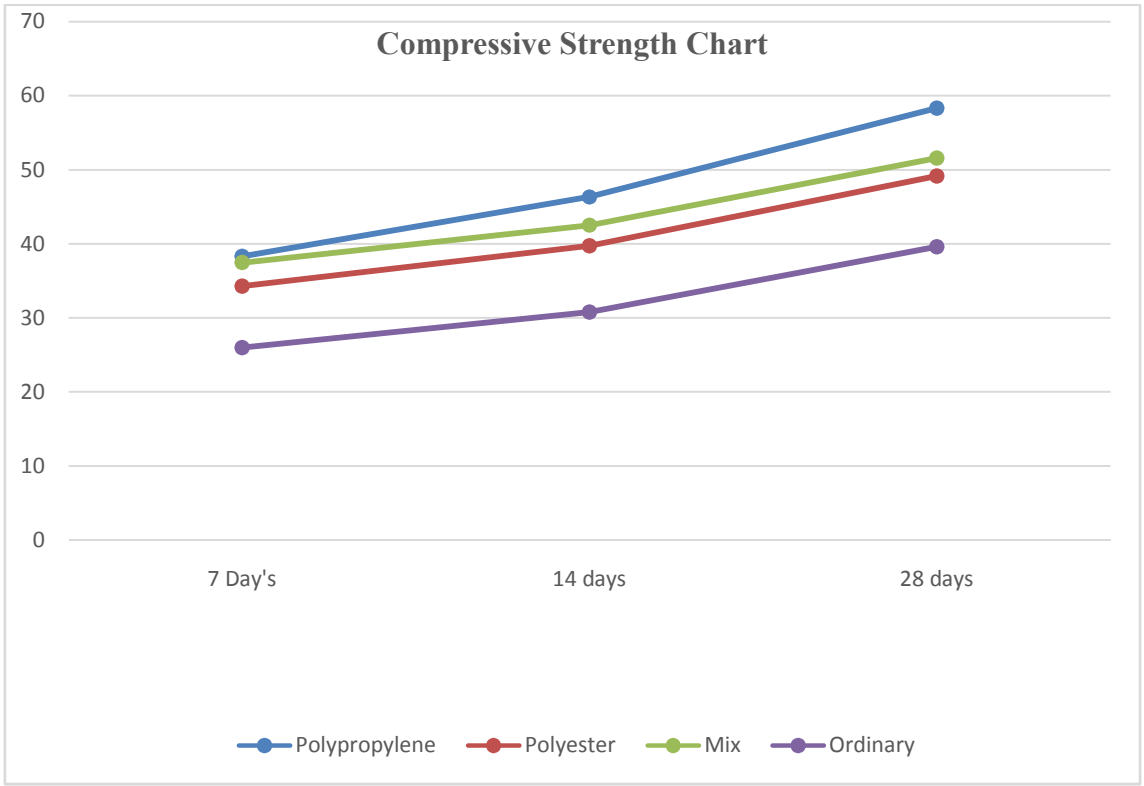

Figure4.9Compressive Strength Of Polypropylene Fiber, Polyester Fiber & Ordinary Concrete For 7 Days, 14 Days & 28 Days (Chart 9)

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Flexural Strength of Concrete at 7 and 28 Days

Cement Concrete pavement resists the entire load due to flexural action of slab. So, this flexural strength is very important aspect of rigid pavement. For flexural strength test beam samples of dimension 150x150x600mm were casted. These flexural strength specimens were tested under third point loading as per IS 516 1959, using universal testing machine. M40 grade concrete specimen was casted as a beam for testing of flexural strength of concrete, 28 days

Fiber 1%	Designation	Flexural strength (N/mm^2) at 28 days'	Average (N/mm^2)
Polypropylene	B-1	5.34	5.34
	B-2	5.42	
	B-3	5.27	
Polyester	B-1	5.12	5.16
	B-2	5.20	
	B-3	5.18	
Mix	B-1	5.08	4.87
	B-2	4.87	
	B-3	4.68	

Table 4.1: Flexural strength (N/mm^2) of concrete with various levels of crush sand along with polypropylene fiber (For 28 Day's)

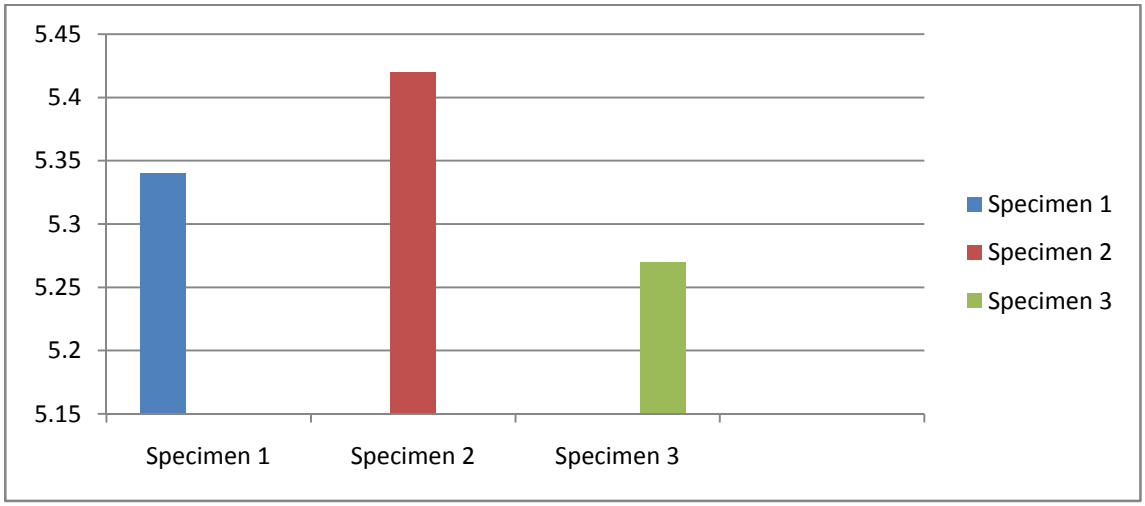

Figure 4.10 Flexural Strength Of Polypropylene Fiber 28days (Chart 10)

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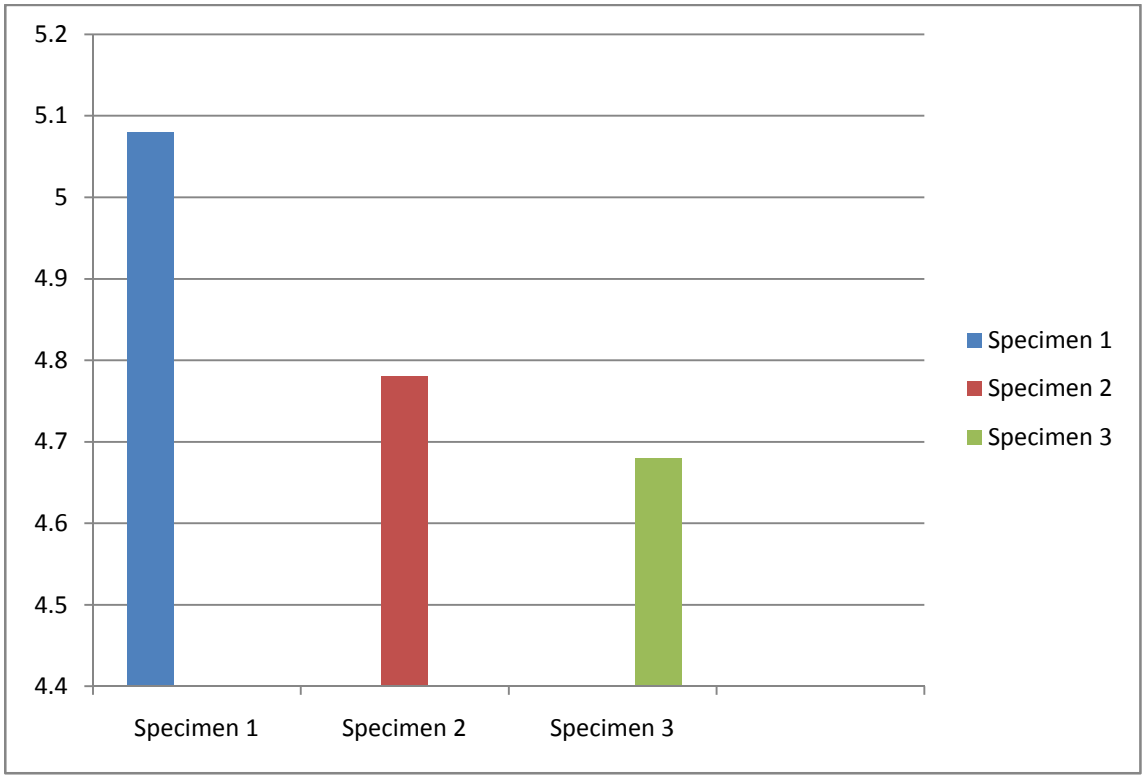

Figure 4.11 Flexural Strength Polyester Fiber 28 days (Chart 11)

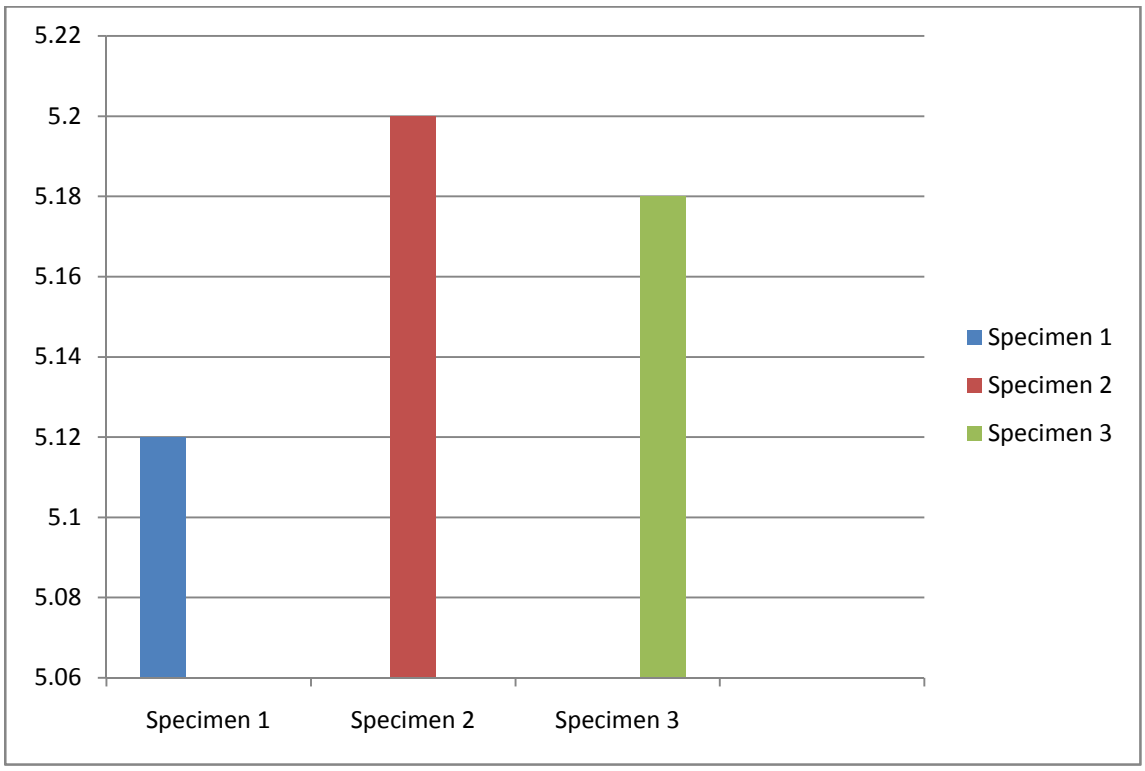

Figure 4.12 Flexural Strength Polypropylene &Polyester Fiber 28 days (Chart 12)

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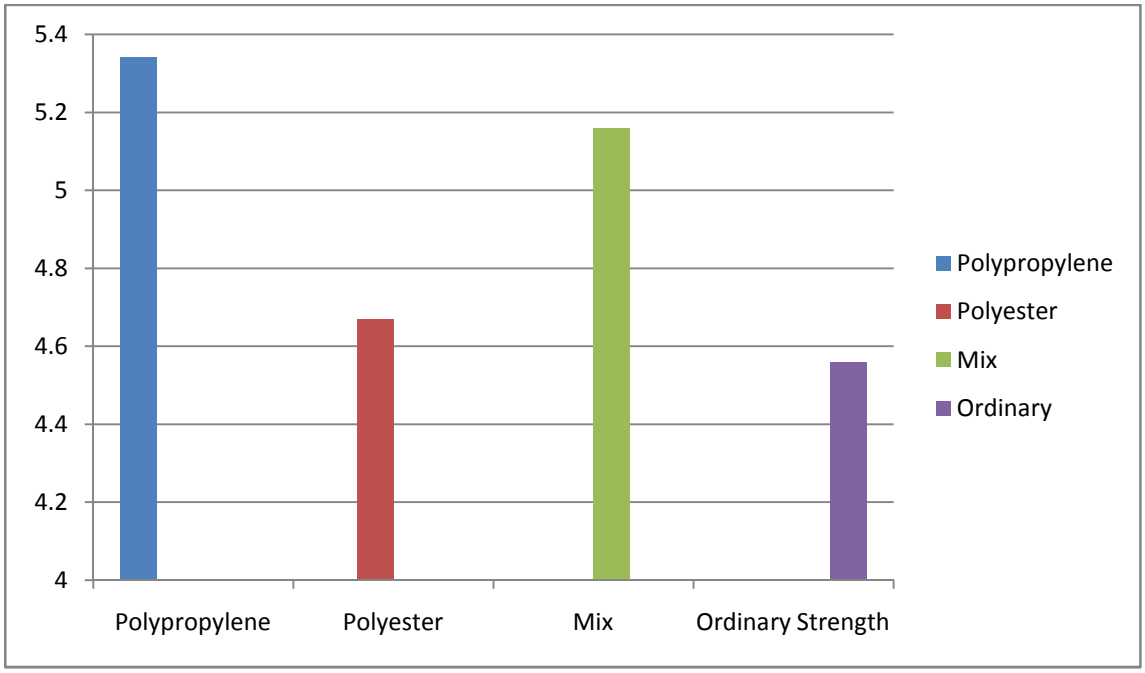

Figure 4.13Average Flexural strength of polypropylene Fiber, Polyester Fiber &Mix Fiber 28 days (Chart 13)

V. CONCLUSION

After carried out of various specimens, i.e., cubes and beams of varying percentage of polypropylene polyester and both combine fibers with use of 100% crush sand following conclusion are drawn.

1. Compressive strength of concrete increases by 30.16 %, 18.56 % & 22.30 %. with the use of different fiber along with Crush sand with1% of polypropylene and polyester fiber respectively and both fibers combine with 0.5% + 0.5% However, at each replacement of these two fibers with fine aggregate &Crush sand, it is observed that with polypropylene fiber the strength is increased with the increasing age.
2. The flexural strength increases by 0.24%, 0.23%& 0.21% when compared to ordinary mix without Crush sand but using Polypropylene, polyester & both combine fiber of volume of concrete at 28-days.
3. Pavement strengthening and rehabilitation is a problem of immediate concern and this activity will figure dominantly in the developing plants for the coming year.
4. Advantages of concrete overlay included fuel saving, good riding quality hard surface no effect of slippage of oil design precision, absence of penetration of water good reflectivity characteristics, easily available of binder of favourable cost economic.

VI. ACKNOWLEGEMENT

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