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Geosynthetics in Roads & Pavements

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ABSTRACT: Geosynthetics have been used to reinforce the base layer of rigid pavement systems for the past thirty years. However, and in spite of the good field evidence that geosynthetic reinforcements can improve pavement performance, the specific conditions or mechanisms that enable and govern the reinforcement function are, at best, unclear as they have remained largely unmeasured. Overall, the selection of design parameters for geosynthetics has been complicated by the difficulty in associating their relevant properties to the improved pavement performance. Field evidences indicate that geosynthetic reinforcements can improve pavement performance. Yet, the specific conditions or mechanisms that enable and govern the reinforcement function are, at best, unclear as they have remained

- largely unmeasured. Significant research has been recently conducted with the objectives of:
 - (i) Determining the governing mechanisms and relevant properties of geosynthetics that contribute to the enhanced performance of pavement systems,
 - (ii) Developing appropriate analytical, laboratory and field methods capable of quantifying the above properties for geosynthetics, and
 - (iii) Enabling the prediction of pavement performance depending on the various types of geosynthetics used

KEYWORDS: Geosynthetic, Pavements,

I. INTRODUCTION

Environment and safeguarding of natural resources and recycling of wastes materials. Actually many industries are producing a significant number of products which Concrete is a versatile material for construction. All ingredients of concrete are natural origin. India is developing country and needs high infrastructures such as airports, dams, bridges, highways etc. Concrete is the backbone for infrastructure development of whole world. The large amount of concrete is being utilized in constructing Civil Engineering structures.

Research concerning the use of by-products to augment the properties of concrete has been going on for many years. In the recent decades, the efforts have been made to use industry by-products such as fly-ash, silica fume, ground granulated blast furnace slag (GGBS), glass cullet, etc. in Civil Engineering constructions. The potential applications of industry by-Products in concrete are as partial aggregate replacement or as a partial cement replacement, depending on their chemical composition and grain size. The use of these materials in concrete comes from the environment constraints in the safe disposal of these products and restricting consumption of natural resources.

Big attention is being focused on the incorporate scrap. In the last 20 years, a lot of works concerning the use of several kinds of urban wastes in building materials industrials process have been published. Many researches have been extended to study new kinds of wastes to investigate deeply particular aspects. The addition of wastes, apart from the environment benefits, also produces good effects on the properties of final products

The concrete has many advantages such as good compressive strength, durability, impermeability, specific gravity and fire resistance. But at the same time concrete has certain bitter properties like-

- 1) Very low tensile strength
- 2) Brittleness
- 3) Less resistance to cracking
- 4) Heavy weight (density)



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5) Shrinkage cracks

Some remedial measures can be taken to minimize these bitter properties of concrete.Concrete has capacity to enhance its properties with the help of other suitable constituents.

Concrete is the second most consumed sunstance on earth; on average, each person used nearly 3 tonnes a year. Through time, different materials have been addded to concrete in order to improve or alter its properties. The addition of fibers, such as steel, glass, polymeric materials carbon, cellulose and nylon to freshconcrete in order to improve specific charactristics such as compressive srtength, toughness, flexural srtength, flexural-toughness.

II. AIM

This Research paper aims for learning of concept of how to increase the compressive strength and reduce the crack of concrete pavement by using poly fibre(geosynthetic).

III. OBJECTIVES OF THE STUDY

- The use of poly fiber in concrete a relatively a new development in the world of concrete technology and lot of research must go in this material is actively use in concrete pavement construction.
- To increase the compressive strenght of concrete pavement .
- To increase the durability of concrete pavement.
- To reduce the crack.

IV. MATERIALS USED

- 1) Aggregate
- 2) Cement
- 3) Sand
- 4) Water
- 5) Polypropylene fibre

4.1 AGGREGATE:

Aggregates are inert granular materials such as sand, gravel or crushed stone that, along with water and Portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemical or coatings of clay and other fine materials that could cause the deterioration of concrete. The purpose of the aggregates within this mixture is to provide a rigid skeletal structure and to reduce the space occupied by the cement paste. Both coarse aggregates (particle sizes of 20mm to 4.75 mm) and fine aggregates (particle sizes less than 4.75 mm) are required but the proportions of different sizes of coarse aggregate will vary depending on the particular mix required for each individual end use. The mere fact that the aggregates occupy 70-80 per cent of the volume of concrete, their impact on various characteristics and properties of concrete is undoubtedly considerable. Generally aggregates can be classified as normal weigh taggregates, light weight aggregates and heavy weight aggregates can also be classified on the basis of the size of the aggregates as coarse aggregates and fine aggregates.

4.1.1 COARSE AGGREGATE:

Aggregates most of which retained on 4.75-mm BIS Sieve are known as coarse aggregates. The

various types of coarse aggregates described as:

i) Uncrushed gravel or stone which results from natural disintegration of rock.

ii) Crushed gravel or stone when it results from crushing of gravel or hard stone.

iii) Partially crushed gravel or stone when it is a product of the blending of above two The graded coarse aggregate is demarcated by its nominal size i.e. 40 mm, 20 mm, 16 mm and 10 mm. Regarding the characteristics of different types of aggregates, crushed aggregates tend to improve the strength because of interlocking of angular particles, while rounded aggregates improved the flow because of lower internal friction. Crushed stone aggregates



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of nominal size 20 mm and 10 mm in the proportion of 50:50 were used throughout the experimental study. The aggregates were washed to remove dust and dirt and were dried to surface dry condition.

4.2 CEMENT:

The Portland pozzolana cement is a kinker blended cement which is produced by either intergrinding of OPC clinker along with gypsum and pozzlanic materials in certain proportions or grinding the OPC clinker,gypsum and pozzolanic material separately and thoroughly blending them in certain proportions.

Pozzolana is a natural or artificial material containing silica in a reactive form. It may be further discussed as siliceous or siliceous and aluminous material which in itself possesses little, or no cementitious properties but will in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. It is essential that pozzolana be in a finely divided state as it is only then that silica can combine with calcium hydroxide (liberated by the hydrating Portland cement) in the presence of water to form stable calcium silicates which have cementitious properties.

4.3 FINE AGGREGATE (SAND):

Aggregates most of which passes 4.75-mm BIS Sieve known as fine aggregates

i) **Natural sand** - Fine aggregates resulting from the natural disintegration of rock andwhich have been deposited by streams or glacial agencies.

ii) Crushed stone sand - Fine aggregates produced by crushing hard stone.

iii) **Crushed gravel sand** - Fine aggregates produced by crushing natural gravel. According to the size, the fine aggregates may be classified as coarse, medium or fine aggregates. Depending upon the particle size distribution, the fine aggregates are divided into four grading zones as per BIS: 383-1970 that are zone I, zone II, zone III and zone IV. The grading zones become finer from grading zone I to grading zone IV. The sand confirming to zone II was used in this study shown in Figure 3.3. The properties of fine aggregates such as specific gravity and fineness modulus were determined and are given in Chapter IV.

4.4 WATER:

Fresh and clean tap water was used for casting the specimens in the present study. The water was relatively free from organic matter, silt, oil, sugar, chloride and acidic material as per BIS: 456-2000.

4.5 POLYPROPYLENE FIBRE:

Polypropylene fibre was first used to reinforce concrete in the 1960s. Polypropylene is a synthetic hydrocarbon polymer, the fibre which is made using extrusion processes by hot-drawing the material through a die. Polypropylene fibres are produced as continuous mono- filaments, with circular cross section that can be chopped to required lengths, or fibrillated films tapes of rectangular cross section. Polypropylene fibres are hydrophobic and therefore have the disadvantages of poor bond characteristics with cement matrix, a low melting point, high combustibility and a relatively low modulus of elasticity. Long polypropylene fibres can prove difficult to mix due to their flexibility and tendency to wrap around the leading edges of mixer blades.

Polypropylene fibres are tough but have low tensile strength and modulus of elasticity; they have a plastic stress-strain characteristic. Monofilament polypropylene fibres have inherent weak bond with the cement matrix because of their relatively small specific area. Fibrillated polypropylene fibres are slit and expanded into an open network thus offering a larger specific surface area with improved bond characteristics. Polypropylene fibre contents up to 12% by volume are claimed to have been used successfully with hand-packing fabrication techniques, but volumes of 0.1% of 50 mm fibre in concrete have been reported to have caused a slump loss of 75 mm. Polypropylene fibres have been reported to reduce unrestrained plastic and drying shrinkage of concrete at fibre contents of 0.1 to 0.3% by volume.Polypropylene Micro Fibre was procured from Bajaj Reinforcement Nagpur and was used in the present study. Specifically engineered and manufactured ISO 9001-2000 certified facility for use as concrete reinforcement at the recommended dosage rate of 1 kg per cubic meter for effective performance.

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(Fig.1 Polypropylene Micro Fibre)

Table 1: Chemical and Physical Properties of Polypropylene Micro Fibre

Characteristic	Material Properties	Characteristic	Material Properties	
Fibre Length	20 mm	Type/Shape	Monofilament Fibre	
Absorption	Nil	Diameter	30 micron	
Specific Gravity	0.90	Thermal Conductivity	Low	
Tensile strength	4.5 kgf	Melt Point	162 ° C (324 ° F)	
Acid and Salt	High	Electrical Conductivity	Low	
Resistance				

V. LITERATURE REVIEW

1. Yogesh Iyer Murthy, Apoorv Sharda, Gourav Jain (2012) In the present investigation, the compressive strength, flexural strength and workability of concrete containing varying proportions of glass fiber as replacement of fine aggregate is studied. The result of these parameters is compared to those of standard M30 grade concrete. The increase in compressive strength is nominal while the flexural strength increased significantly as expected with the increase in percentage of glass fiber. Also, significant reduction in the slump value of the glass fiber reinforced concrete was observed with increase in glass fiber content. The preliminary investigations reveal that the use of this industrial waste is not only improving the properties of concrete but also provides a safe and efficient means of disposal of such non-biodegradable wastes.

2. Saman Khan,Roohul Abad Khan, Amadur Rahman Khan ,Misbahul Islam SamanNayal (2015) This paper represents comparative experimental study on mechanical performance of polypropylene fibre reinforcedconcrete (PFRC) under compression and split tensile loading. The cube compressive strength and cylinder splittensile strength of conventional concrete and polypropylene fibre reinforced concrete were determined in the laboratory. The M25 and M30 grades of concrete mixes and polypropylene mono-filament macro-fibres of length 35mm at volume fractions of 0.0%, 0.5%. 1.0%, 1.5%, 2.0%, 2.5% and 3.0% were used in the research. All specimens were tested at curing age of 28 days. In this paper the relationship between cube compressive strength and cylinder split tensile strength for conventional and polypropylene fibre reinforced concrete were established and compared with standards. The study suggested the significant improvement in compressive and tensile strength for concrete mixes reinforced with polypropylene fibres. The samples with added polypropylene fibres of 1% and 1.5% showed better results in comparison with the others.

3.Ms.Amreen N. Ali, Mr. Milind. V. Mohod (2015) Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. In recent years, cement concrete pavements are being adopted in many new road projects in India in view of their longer services lives, lesser maintenance requirements and smoother riding surface.



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This paper presents a comprehensive review on work done on fiber reinforced concrete pavement using polypropylene, steel, hybrid and glass fibers. Polymer fiber reinforced concrete pavement is a recent advancement in the field of reinforced concrete pavement design. Polymer fiber reinforced concrete pavements are more efficient than ordinary cement concrete pavements. Various issues and behavior of fiber reinforced concrete in pavement are also discussed.

4.Anjali Gargav, Dr.J.S.Chauhan (2016 Geopolymer Concrete (GPCs) is a new class of concrete based on an inorganic alumina silicate binder system compared to the hydrated calcium silicate binder system of concrete are activated by alkaline liquids to produce the binder. The basic material used for the activation of the geopolimerization process is Fly ash, also to replace the use of conventional Portland cement. The binding agent is the only difference to the ordinary Portland cement concrete. To activate content in fly ash, sodium hydroxide solution and sodium silicate solution was used in combination. The geopolymer possesses the advantages of rapid strength gain, elimination of water curing, good mechanical and durability properties and are eco-friendly and sustainable alternative to Ordinary Portland Cement (OPC) based concrete. In the construction industry mainly the production of Portland cement causes the emission of air pollutants which results in environmental pollution. It reduces 80 - 90% CO2 emissions.

VI. EXPERIMENTAL SETUP

6.1 Grade of concrete:

Grade of concrete was taken as M20 and the Mix design was done as per IS: 10262–1981 and IS: 456-2000 Mortar Mix Proportion for M20 Percentage of polypropylene fibre Polyoropylene fibre replacement with cement 0.5%, 1%, 2%, 6%, 8%, 12%. Materials Cement: Portland Pozzolana cement - J K LAXMI • Sand: River sand • Aggregate: 20 mm, 40 mm, etc. • Water :Potable water, Drinking water. **6.2 PREPARTION OF MOULDS** 6.2.1 MIX CALCULATIONS: Examples of concrete mix proportioning For M20 Grade concrete A-1 Design stipulations for proportioning a) Grade designation : M20 (1:1.5:3) b) Type of cement : PPC (J K Laxmi) c) Maximum nominal size of aggregates : 20 mm d) Minimum cement content $: 300 \text{ kg/m}^3$ e) Maximum water cement ratio : 0.4 : 100 mm (slump) f) Workability g) Exposure condition : Severe (for reinforced concrete) h) Degree of supervision : Good i) Type of aggregate : Crushed angular aggregate j) Maximum cement content : 450 kg/m3 **6.3 TEST DATA FOR MATERIALS** a) Cement used : PPC (J K Laxmi) b) Specific gravity of cement : 3.15 d) Specific gravity of Coarse aggregate : 2.74 Fine aggregate : 2.74 e) Water absorption Coarse aggregate : 0.5 percent Fine aggregate : 1.0 percent f) Free (surface) moisture Coarse aggregate : Nil (absorbed moisture also nil) Fine aggregate : Nil g) Sieve analysis Coarse aggregate : Conforming to Table 2 of IS: 383

: Conforming to Zone I of IS: 383

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Fine aggregate



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6.4 PROCEDURE OF CASTING CUBES

We tried to check the **Compression test** by preparing test cubes from the freshly prepared concrete of partially replacement of cement with marble powder. We carried out different tests using different percentage of polypropylene fibre they are as follows 0.5%, 1%, 2%, 6%,8%,12%.

The method of compression strength of concrete cubes:

- The cube moulds are made for specimen size 15 x 15 x 15 cm.
- The metal moulds can be assembled and taken apart by bolting or unbolting.
- The concrete is hand compacted and then machine compacted.
- The specimens are covered with wet gunny bags for 24 hours and the immersed in curing tank containing fresh, clean water.
- These are kept in water for 7, 14 and 28 days and then taken out and tested under compression testing machine.
- The failure load divided by cross sectional area, i.e. 225 cm²gives the ultimate compression strength of the cubes.
- Two cubes each of 7, 14 and 28 days curing are tested and can give a good idea about the rate of increase of strength.
- Pozzolana Portland cement concrete shows about 70% strength gain in the first 7 days and remaining gain in the days thereafter.
- Thus from the 7, 14 and 28 days tests the pattern of strength acquiring can be studied and we modified that if needed.
- The co-relation of test result is done by testing on 3 specimens at each curing period.
- We compute the durability, impermeability and other characteristics from the test results.

VII. RESULTS & DISCUSSION

7.1. General

In this chapter the experimental results of all the cubes, with conventional concrete compared with Hybrid Fibre Reinforced Concrete (HFRC) are interpreted. Their behaviour throughout the test is described using recorded data on test, compressive test. Cubes, were tested for 7 days of curing and cubes, were tested for 28 days curing. The cubes cured in water tank for the period of 7 days and 28 days, the results compared between conventional concrete, individual fibre concrete and HFRC.

7.2. Concrete Strength

Here the strength of cubes, at different fibres were analysed. Compressive strength, Tensile Strength of each cube are compared with conventional concrete and Individual Fibre and Different Fibre mix proportion. For calculation of compressive strength of concrete the compressive testing machine was use.

7.3 Compressive Strength of Concrete

Compressive strength of concrete, out of many test applied to the concrete, this is theutmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether concreting done properly or not. For testing of concrete cubical moulds of size 150 mm x 150 mm x 150 mm are commonly used. Results of all specimens which are tested for Compressive strength are presented in the table.

Crushing strength in 28 days	0.5%	1%	2%	6%	8%	12%	Plain M20
7 days	445KN	481KN	505KN	515KN	410KN	200KN	280KN
14 days	590KN	560KN	590KN	265KN	400KN	200KN	290KN
28 days	660KN	600KN	610KN	240KN	410KN	260KN	480KN

COMPRESSIVE TEST

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VIII. COMPARISON CHART



Fig. 2.: Comparison Between Different % of Fibres



COMPRESSIVE STRENGTH FOR 7 DAYS CURING





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COMPRESSIVE STRENGTH FOR 7 DAYS CURING	PLAIN	0.5%	1%	2%	6%	8%	12%
	280	445	481	505	515	410	200



COMPRESSIVE STRENGTH FOR 14 DAYS CURING

Fig. 4: Comparison between compressive strength of 14 days curing

COMPRESSIVE STRENGTH FOR 14 DAYS CURING	PLAIN	0.5%	1%	2%	6%	8%	12%
	290	590	560	590	265	400	200

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COMPARISON BETWEEN COMPRESSIVE STRENGTH OF 28 DAYS CURING



Fig. 5: Comparison between compressive strength of 28 days curing.

COMPRESSIVE STRENGTH FOR 28 DAYS CURING	PLAIN	0.5%	1%	2%	6%	8%	12%
	480	660	600	610	240	410	260

IX. CONCLUSION

From the experimental study it is observed that 0.5% and 1% of polypropylene fibre used with replacement of cement gives better result than Normal Plain Cement concrete. But as the ratio increased to 6% to 12% and above the result decreases and it is found to be very low range as compared to Normal Plain Cement Concrete, 0.5% and 1%. So it is concluded that polypropylene fibre can be used as a partial replacement with Cement only up to 2%. So alternatively we may propose to replace some percentage of cement with polypropylene fibre. So that we may reduce the usage of cement and at the same time we may utilize the waste material for the building industry itself, by utilizing this waste materials we are also reducing environmental pollution to some extent.

X. FUTURE SCOPE

Its alternatively we may propose to replace some percentage of cement with polypropylene fibre. So that we may reduce the usage of cement and at the same time we may utilize the waste material for the building industry itself, by utilizing this waste materials we are also reducing environmental pollution to some extent.

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