

(An ISO 3297: 2007 Certified Organization) Vol. 5, Special Issue 9, May 2016

Experimental Study on Effect of Geosynthetic Fibres on Compressive and Tensile Strength of Cement Concrete

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ABSTRACT: Geosynthetics is the term used to describe a range of generally polymeric products used to solve civil engineering problems. Geosynthetics are available in a wide range of forms and materials, each to suit a slightly different end use, they also produce greater resistance to impact, abrasion and cracking of concrete structures. The purpose of the study is to investigate the strength variation at different percentage of fibres by comparing the results with that of conventional concrete. The main aim of this project is to study the increase in percentage of concrete strengths and obtain optimum percentage of fibre that can be used in the practice.

KEYWORDS: Geosynthetic fibre, Compressive strength and Tensile strength.

I. INTRODUCTION

Geosynthetics have become very good established construction materials for most of the civil engineering works, because of their improving properties it is used worldwide. Navadays it has been utilised to carry out to solve the critical problems in each and every engineering aspects. The experiment and research is carried out by various departments and development of this new technique is carried out. Because of this significant application of geosynthetic this paper focusing on the development of its application in the construction field as the replacement to the steel used in the concrete as reinforcement. Geosynthetics are sheet of tensile elements with a regular network of apertures, usually constructed as polyethylene. The most common use is for reinforcement of unstable soil and waste masses. Geosynthetics are synthetic products used to stabilize terrain. This includes eight main product categories they are geotextiles, geogrids, geonets, geomembranes, geosynthetic clay liners, geofoam, geocells and geocomposites. Geonets are formed by a continuous area extrusion of parallel sets of polymeric ribs at acute angles to one another.

II. REVIEW AND UTILIZATION

Yetimoglu and Salbas, 2003, Tang et al., 2007a, Tang et al., 2007b, Ahmad et al., 2010[9] and Consoli et al., 2011. In comparison with conventional geosynthetics (strips, geotextile, geogrid, etc.), the advantages of using discrete fibre are as follows, (i) The discrete fibres are simply added and mixed randomly in mixing with cement, lime, or other additives. (ii) Randomly distributed fibres limit potential planes of weakness that can develop in the direction parallel to the conventionally oriented reinforcement. (iii) The inclusion of fibre only changes the physical properties of soil and has no impact on the environment. For these reasons, researchers have shown an increasing interest in mechanical behaviours of fibre., Yetimoglu et al., 2005, Consoli et al., 2007, Ibraim et al., 2012 and Plé and Lê, 2012. The results indicate that the discrete fibre reinforcement can significantly improve the mechanical performances. They concluded that the fibre reinforcement benefit on the mechanical properties is governed by the interfacial friction and cohesion.

Perkins S.W. (2000) During past decades, application of geosynthetics for stabilization has become wider and wider. Various types of synthetics are used right now in different cases of soil improvement like geotextiles, geogrids, geonets, geofibers and etc. There have been wide efforts on reconnaissance of geosynthetic application effects on geotechnical properties of reinforced soil such as Constitutive modeling of geosynthetics, [9]



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III. SCOPE OF THE WORK

This work was undertaken to solve the problems faced during the execution of the work. Navadays we are facing lot many problems in the supply of raw materials and other finished products. Hence to minimize these problems this study is carried out.

Some of the objectives listed as below:

- The recent development in using alternative building or construction material which is economical and environmental friendly.
- Using of materials or giving importance to locally and cheaply available materials and also easily available.
- Navadays the demand for the steel is higher hence cost of the materials also increased so to reduce the cost of construction and to improve the toughness.

By keeping these points and objectives this work is carried out to check its suitability and its utilization in the present scenario.

IV. MATERIALS USED IN THE WORK

A. Cement:

In this present work Portland Pozzolona (flyash based) with brand name Ultratech Cement was used for the concrete mixes. The cement is fresh and free from lumps. The testing of cement was carried out based on IS 1489(Part I) : 1991. The specific gravity of the cement was found 3.05. The other physical properties of cement are as follows:

SI.No	Particulars	Result obtained based on the experiment	As per standard			
1	Fineness	310 m²/kg	Not less than 300 m ² /kg			
2	Normal Consistency(%)	33	28-35			
3	Soundness					
3a	By Le-chateliers Expt.(mm)	1.0 mm	Not more than 10 mm			
4	Setting Time(min)					
4a	Initial Setting time	75 minutes	Not less than 30 minutes			
4b	Final Setting time	480 minutes	Not more than 600 minutes			
5	Compressive Strength (MPa)					
5a	3 days	20 MPa	Not less than 16 MPa			
5b	7 days	28 Mpa	Not less than 22 MPa			
5c	28 days	40 Mpa	Not less than 33 MPa			
6	Temperature during the test	29 ⁰ C	$28^{\circ} \text{ C} \pm 2^{\circ}$			

Table 1. Properties of Cement

*Experimental results as per Ultratech (PPC) Cement. These values obtained based on the preliminary tests conducted before the main works start. Based on the observed values the mix design is carried out by knowing the proper water-cement ratio.



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B. Fine Aggregate:

The fine aggregates used in this work is locally available river sand with the maximum of 4.75 mm size as per the IS 383-1970. The specific gravity of the sample is 2.51, water absorption is 1.0% and fineness modulus is 2.59.

C. Coarse Aggregate:

The fine aggregates used in this work is locally available coarse aggregate with the maximum of 20 mm size as per the IS 383-1970. The specific gravity of the sample is 2.70, water absorption is 0.66% and fineness modulus is 7.04. D. Geosynthetic Fibre:

The fibre used in this work is brought from the supplier. The specific gravity of the sample is 1.050 and discrete fibres are used with 1.12 mm diameter, 60 mm length and the aspect ratio of 54. The tensile strength of the fibre sample was found to be 1.40 kN/m.

V. MIXDESIGN

Grade of Concrete	:M25		
Cement Used	: Ultratech (PPC-Flyash Based)		
Tarhet strength	$:fck + 1.65s = 33.25 \text{ N/mm}^2$		
Cement Content	: 425.78 Kg/m ³		
Water/Cement ratio	: 0.45		
Fine aggregateContent(Sand)	: 517.51 Kg/m ³		
Coarse aggregate Content	$: 1183 \text{ Kg/m}^3$		

Table 2: Design Mix Proportions

Cement (Kg/m ³)	Fine aggregate(Kg/m ³)	Coarse aggregate(Kg/m ³)	Water
1	1.215	2.78	0.45

VI. SPECIMEN PREPARATION

Cubes and cylinders to be kept ready before the actual mix starts.. The bolts of the mould are to be tightened carefully otherwise the concrete slurry may amount from the mould during the compaction. The moulds are cleaned and oiled to all contact surfaces and the concrete is filled in three layers with 25 gentle blows to each layers. Then the surface is to be levelled by using trowel. After 24 hours the moulds to be demoulded and mark them accordingly and keep it for curing to the required days.

VII. TEST FOR CONCRETE SPECIMENS

A. Tesingtof concrete cubes specimen for compressive strength:

After the prescribed date the test is to be done for concrete cubes, to calculate the compressive strength of concrete cubes by using the compressive testing machine (CTM) having capacity of 200 tone was used. The compressive strength is in terms of "N/mm²". The Compressive strength is calculated by using the formula. The compressive strength test is very important test compared to all other. The moulds having size 15cmx15cmx15cm is generally used. The compressive test conducted at 7 and 28 days respectively in general. Load is applied gradually till the specimen break.

$$Compressive strength = \frac{Maximum \ load \ at \ Failure}{Area}$$
$$Cs = \frac{P}{A}$$

B. Testing of concrete cylinders specimen for tensile strength:

The concrete is strong in compression but weak in tension, so to improve its tensile strength tension material to be added before concrete is placing or while mixing. Here in this work geosynthetic discrete fibre is used as tensile



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material. Usually in laboratory split tension test is conducted to check its tensile capacity. The Compressive testing machine(CTM) having 200 ton capacity was used to determine the strength of concrete cylinders. Tensile strength of the concrete cylinder is determined by using below given formula.

$$Tensilestrength = \frac{Maximum load at failure}{Tsp = \frac{2P}{\pi DL}}$$
Area

P= Max. Load at failure, L= Length & D= Diameter of the specimen.

C. Test for measurement of workability:

Workability is one of the most important aspect. This test is done for the fresh concrete. Usually slump and compaction factor tests are generally carry out in the laboratory. The slump cone test is generally conduct in the field also to check the workability of the mix. Slump test consist of a frustum cone in which freshly prepared concrete to be poured then uniformly and gently the blows should be given and then the surface is levelled and then the cone is lifted with proper care to measure the slump in millimetres.

VIII. RESULT ANALYSIS SHEET

Table 3: Effect of fibre on strength, workability and water absorption for different proportions.

% Fibre	0	0.125	0.25	0.50	0.625
Cement	1	1	1	1	1
7 days Comp Strength N/mm ²	22.22	22.89	23.78	32	28.15
7 days tensile Strength N/mm ²	2.78	2.87	3.39	3.63	3.48
28 days Comp Strength N/mm ²	34.45	35.11	36.29	46.89	41.18
28 days tensile Strength N/mm ²	3.89	3.91	4.10	4.26	4.19
Slump Value in mm	45	41	38	36	34
Water Absorption at 28 days(%)	1.72	1.66	1.56	1.32	1.34

This graph shows the development of tensile as well as compressive strength for 7 days & 28 days and workability, also the water absorption varies as the variation in the percentage of fibre.



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Graph 1 Comparison of Compressive Strengths at 7 & 28 days

This graph shows the details about the compressive strength variation according the variation with respect to the variation in percentage of fibre content. The maximum strength achieves for a fibre content of 0.5%. The below graph shows the details about the variation of tensile strength.



Graph 2 Comparison of Tensile strengths at 7 & 28 days



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IX. CONCLUSION

The following conclusion may be drawn from the present investigation carried out for the different percentage of fibre added for the concrete in replacement of steel as reinforcement. It gives much better results for the controlled mixes. By the observed result it shows much better improvement for the fibre increased upto 0.5%. At each level when increase the fibre content it shows better compressive as well as the tensile strengths. Hence it improves its strength by increasing the percentage of fibre upto 0.5% fibre content and then decreases for both compressive and tensile strength. Because of higher the percentage of fibre the voids become lesser and concrete obtained is more compact.

- For each percentage increase there will be increase in compressive as well as tensile strength.
- It shows that maximum fibre can be used in the concrete is only 0.5% after that the value decreases gradually.
- As the fibre content increases the workability decreases compared to fresh concrete without any fibre content.
- It shows as the percentage of fibre increases the water absorption decreases gradually.

This study concludes that the increase in percentage of discrete fibre can improves the compressive and tensile strengths supplementary to the steel reinforcement but the proper care and decision must be taken by the engineers before the execution of work.

ACKNOWLEDGEMENT

The authors are greatful to Dr.Srinath Shetty K, Head of the department and other teaching and non-teaching staff members of NMAMIT for their constant support and guidance for making this work a very successful one. We are thankful to the Department of Civil Engineering, NMAMIT, Nitte for providing laboratory facilities to carry out these work and experiment.

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