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Effects of Polypropylene fibres on the strength properties Of fly ash based concrete

K.Murahari[#], .Rama mohan Rao p [*]

 # M.tech (Structural engineering) Student ,VIT University, Vellore, Tamil Nadu
** Assistant Professor (SG), CDMM, VIT University, Vellore, Tamil Nadu*

ABSTRACT: *The scope of present investigation deals with the strength properties of concrete containing polypropylene fiber , and class C fly ash. With different proportions. In this study Various mixture of class C fly ash in ratio of 30%, 40% and 50% was used in the concrete mix containing polypropylene fiber of volume fractions of 0.15,0.20,0.25,0.30 was used for all fly ash concrete mixes.. Each series consists of cubes , cylinders and prisms as per IS standard. A series of tests were carried out to find out the compressive strength, split tensile strength, flexural strength at the age of 28 days. The above said mixtures with Fly ash containing polypropylene fiber in different volume fractions with different water cement ratio were compared in this study .At the age of 28 days each mixtures were tested and analysed in order to find out the best efficient mixture in favouring of strength characteristics of concrete mix .*
Keywords: *Water ratio -fly ash- concrete-, Polypropylene fiber -strength properties*

I. INTRODUCTION

Polypropylene (PP) is a versatile and widely used polymer, Polypropylene (PP) resins are a general class of thermoplastics produced from propylene gas. Propylene gas is derived from the
cracking of natural gas feedstock's or petroleum by-products. Under broad ranges of pressures and temperatures, propylene generally polymerizes to form very long polymer chains. However, to make polypropylene resins with controlled configurations of molecules (tactility) at reasonably acceptable commercial rates, special catalysts are required.

Polypropylene (PP) fibers belong to the newest generation of large-scale, manufactured chemical fibers, having the fourth largest volume in production after polyesters, polyamides and acrylics [1, 2]. PP is one of the most successful commodity fibers, reaching a world production capacity of four million tons a year. Due to its low density (0.9 gm/cc), high crystalline, high stiffness and excellent chemical/bacterial resistance, is tactic PP is widely used in many industrial applications such as nonwovens, industrial ropes, packaging materials, furnishing products, etc. PP fiber has potential, high-volume applications in the carpet, textile, apparel and industrial textile markets.

Fly ash has a high amount of silica and alumina in a reactive form. These reactive elements complement hydration chemistry of cement. Hydration chemistry of Cement When cement reacts with water, the hydration of cement begins. On hydration, cement produces C-S-H Gel. This C-S-H Gel binds the aggregates together and strengthens the concrete. However, one more compound is produced on hydration that is so different in behavior. It is none other than the Calcium Hydroxide Ca(OH)2. In construction industry, it is generally referred to as Free Lime. Aggressive environmental agents like water, sulphates, CO2 attack this free lime leading to deterioration of the concrete. It is not only the chemistry provided by fly ash that compliments chemistry of cement, but also the physical properties of fly ash improve the theology and microstructure of concrete by a great extent. Fly ash, on itself, cannot react with water, it needs free lime, produced on hydration of Portland cement, to trigger off its Pozzolanic effect. Once it is triggered, it can go on and on. In simple words, it means a much longer life for concrete structure. Specific benchmarks have been set up to evaluate the performance of concrete with respect to durability - mainly Strength and Permeability. This means to produce a durable and long lasting concrete, it must possess: High strength and Low permeability.

Due to its thermoplastic nature, PP fiber is manufactured using conventional melt spinning. Subsequent multistage drawing imparts tensile strength and enhances mechanical properties required for industrial applications. Synthesis of PP polymer involves stereo regular polymerization of propylene gas using Ziegler-Natta catalysts [3]. Only is tactic polypropylene is useful for fiber applications among the three stereoisomers. Since only a simple monomer, i.e., propylene gas, is involved in the synthesis of PP, this fiber is relatively inexpensive to produce as compared to other high volume textile fibers such as polyesters, acrylics and nylons. The major products of PP fibrous materials are monofilaments, multifilament yarns, staple fibers and yarns, nonwoven textiles (spunbond, meltblown), tapes, split filament, ropes, carpet backing, etc. Crystallinity of

isotactic PP is about 70%, and the molecular weight of fiber grade PP is in the range of 80,000 to 300,000gm/mole. Since the advent of stereo-regular isotactic polypropylene (PP), the fiber has been used in many industrial applications, as well as in carpets and apparel, due to its high degree of crystalline, good handle, strength and a high enough melting point for normal use. The potential commercial importance of unmodified polypropylene (PP) fiber in the
carpet and textile industries has led to research to develop an aqueous dyeing process for the highly-hydrophobic fiber, consistent with the established coloration processes in use for other high-volume fibers (cotton, nylon, polyester and acrylic). Despite substantial research conducted around the globe, a commercially viable and sustainable aqueous dyeing process of PP based on demand-activated manufacturing has not been realized.

By utilizing techniques such as multiple reactor configurations, polymerizing other gases such as ethylene or butane in conjunction with propylene to form copolymers, using special additives to control crystalline, etc., different types of PP resins can be produced.

1.2 Advantageous polypropylene fibres are

- easy process ability,
- low specific gravity,
- almost zero water adsorption,
- good chemical resistance,
- good antistatic character as well as wide availability and Low cost.

II. MATERIALS USED

- flyash
- Cement
- Polypropylene
- Fine aggregates
- Coarse aggregates
- water

2.1 Fly Ash Properties

- Fly ash obtained from thermal power plant at NLC (NEYVELI LIGNITE CORPORATION) in India was used in the investigation.
- The specific gravity of fly ash was 1.96.
- Class C fly ash is used in the investigation.

2.2 Coarse Aggregates properties

- Coarse aggregates were used with 20 mm & 12mm nominal size.
- 12mm aggregates was used 40% in coarse aggregates.
- 20mm aggregates was used 60% in coarse aggregates.
- The specific gravity of coarse aggregates is 2.7.

2.3 Cement Properties

- Ordinary Portland cement 53 grade conforming to IS: 12269-1987 was used.
- The specific gravity of cement is 3.2.

2.4 Objective

- To study the effect on mechanical properties of concrete due to Polypropylene fibre.
- To carry out experimental investigations for comparative study with varying Polypropylene fibre, coarse aggregate , fine aggregate and water-cement ratio.

III. LITERATURE REVIEW

Rana A. Mtasher, Dr. Abdulnasser M. Abbas & Najaat H. Nema, In the Strength Prediction of Polypropylene Fiber Reinforced Concrete” test results showed that the increase of mechanical properties (compressive and flexural strength) resulting from added of polypropylene fiber was relatively high. D. L. Venkatesh Babu, In this Flexural Behavior of Hybrid (Steel-Polypropylene) Fibre Reinforced Concrete Beams” test results showed that use of Hybrid(steel-polypropylene) Fibre reinforced concrete improves flexural performance of the beams during loading.

- Martínez-Barrera , Fernando Ureña-Nuñez , Osman Gencel, Witold Brostow Gonzalo, This paper Mechanical properties of polypropylene-fiber reinforced concrete after gamma irradiation" have showed that the compressive strength and the elastic modulus are the highest for concrete with 1.5 vol% of PP fibers. Improvement of the strength and elastic modulus – dependent on PP fiber concentration, marble particle sizes and the applied dose. N.Angelidis, C.Y.Wei, investigate the Measurements have been made of the effect of mechanical strain on potential distributions and resistance of unidirectional and multidirectional carbon fiber epoxy laminates. The effects of current flow direction and technique for current introduction on piezo-resistance have been studied. It was found that uniform current introduction at sample edges produced by sputtered Au–Cr contacts across the entire cross-section produced consistently low values of gauge factor of 1.75 for current flow parallel to the fibres and 2.7 for transverse current flow. Non-uniform current introduction, produced variously by local point introduction of current, or use of viscous adhesives producing intermittent contact, resulted in a wide range of apparent gauge factors ranging from 20.6 to 28.9. These anomalous values may be explained by a model in which the high anisotropy of resistance in unidirectional CFRP maintains initial non-uniform current throughout the sample. Under mechanical strain points of fibre contact will change, altering the distribution of current carrying fibres and leading to local changes in current. Thus changes in potential difference between two points produced by mechanical strain will not be exclusively caused by changes in local resistance. The presence of transverse plies in multidirectional laminates ensures that in plane non-uniform current distributions are largely eliminated, and the effect on piezo-resistance of non-uniform current introduction is minimized.

N.Banthia, M.Pigeon, From the literature review, the substantial volume of work conducted by researchers of different laboratories world-wide confirmed that the aqueous dyeing of generic, unmodified PP fiber is of significant importance for textile, carpet, apparel, sportswear and a variety of other product applications. Most of the work carried out by researchers included the modification of PP fiber in some form or another, paths which although they impart disability, increase the total fiber costs two to three times above that of generic PP because of utilization of a variety of modifying chemicals, additives, co monomers or components. Another disadvantage of the fiber modification route is that it adversely affects the mechanical and physical properties of the fiber. The low cost and good physical/aesthetic properties, the two basic motivations for utilizing generic PP fiber in textiles and carpets, have been outweighed by the disadvantages and limitations of modifying the fiber solely to impart aqueous disability.

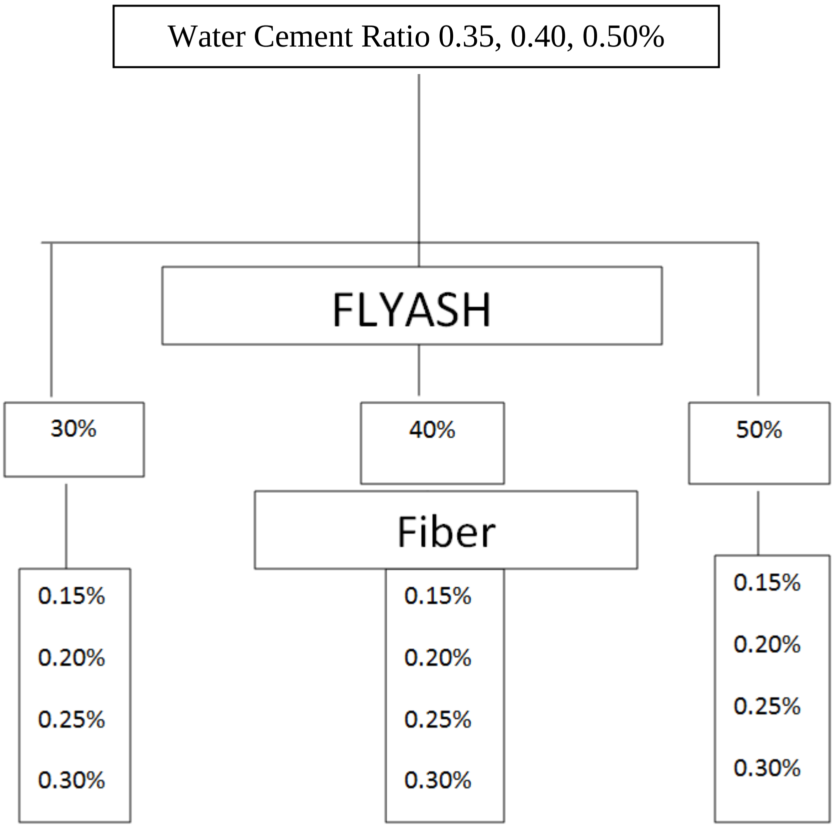
Brostow.W, Datashvili.T, The primary purpose of the aqueous dyeing of PP fiber in its generic, unmodified form is to exploit the advantages this fiber offers to the market place and, at the same time, create new product markets for this inexpensive fiber in high volume consumption areas such as tufted carpets, towels, apparel, sportswear and technical textiles. These product markets are governed today by demand-activated manufacturing, and hence can only be realized by developing flexible, aqueous batch and continuous dyeing processes for generic PP consistent with commercially-established coloration technologies already in use for other high-volume, commodity fibers.

- The concrete with E- glass fibre showed an increase in compressive strength of about11.45% at V_f = 2.0% and increase in split tensile strength of about 26.19% at V_f = 1.5%. The toughness indices of E - glass fibre concrete may be due to brittle character of the glass fibre [P.Baruah and S. Talukdar, 2007]. Glass fibre can restrain the expansion of specimens effectively. The expansion of composite decreases with increasing glass fibre volume fraction at each curing age for each set of concrete specimens. [Bing Chena, Juanyu Liub,2003].The addition of polypropylene fibres to plain concrete increases the compressive strength in the range of 4% to 17% and the reduction in maximum crack width is to an extent of 21% to 74% [K.Anbuvelan et al. 2007]. Cement matrix improves the flexural and tensile behavior of cement matrix. by the addition of glass fibres. The performance of these composites with aging depends on the matrix mix ingredients. The durability of Glass fibre reinforced cement composite improves with the addition of metakaolin to the concrete mix. [Shashidhara Marikunte et al 1997]. By replacing 35 -50% of cement with fly ash , there was 5-7% reduction in the water requirement forobtaining the designated slump, and the rate and volume of the bleeding water was either higher or about the same cosplitred with the control mixture [Ravina and Mehta, 2000]. The addition of steel and polypropylene fibers provide better performance for the concrete. The addition of fly ash in the concrete mixture may adjust the workability and strength losses caused by fibres. [Topcu and Canbaz, 2007]. Incorporating of fibres into plain mortar results decreases in compression strength, however the addition of pozzolanas helped this loss of strength. The addition of SF in glass fibre mortar improved the performance over the plain mortar. [R.M. de Gutie´rrez, 2005].

IV. MIX PROPORTION

- Fly ash : 30 % 40 % 50%
- Water cement ratio : 0.35% 0.40 % 0.50%

- Fibre dosage : 0.15% 0.20% 0.25% 0.30%



5.1 Testing for compressive strength

- The compressive strength of concrete is one of the most important properties of concrete. Compressive strength is a qualitative measure for other properties of hardened concrete. When concrete fails under compressive load it is a mixture of crushing and shear failure.The compressive strength is generally determined by testing cubes or cylinders made in laboratory or field or cores drilled from hardened concrete at site. Compression test conducted on hardened concrete using a compression testing machine of 2000 KN capacity available in structures lab . The compressive strength of result at the age of 28 days .

5.2 Split tensile strength

- The Spilt tensile test is carried out on a concrete cylinder of size 100 x 200 mm each were cast for three sets of Polypropylene fiber mix has been tested for 28 days split tension test and the test result are as tabulated below vide table1. According to the results, may be realized that there is no interference of adding polypropylene fiber in the splitting tensile strength.

5.3 Flexural strength of beam

- The flexural strength test is carried out on a concrete beam with loading at the third points according to ASTM C78.The loading machine should be able of applying the loads at a uniform rate without interruption. The beam size 500x100x100mm each were cast for three sets of Polypropylene fiber mix has been tested for 28 days flexural tension test, the test result are as tabulated below vide table1.According to the results, may be realized that there is no interference of adding Polypropylene fiber in the flexural tensile strength.

Table 1: Compressive Strength, Split Tensile Strength and Flexural Test Results on 28th Day

Water Cement Ratio	Flyash %	Fibre Dosage %	Compressive Strength N/mm^2	Split Tensile Strength Test N/mm^2	Flexural Test N/mm^2
0.35	30	0.15	69.18	14.27	18.13
		0,20	70.18	15.13	18.45
		0.25	74.84	15.85	18.53
		0.30	77.63	16.02	19.17
	40	0.15	62.84	13.28	15.98
		0,20	64.68	14.10	16.12
		0.25	67.87	14.98	17.02
		0.30	68.91	15.23	17.13
	50	0.15	52.67	10.14	13.34
		0,20	54.27	11.76	14.53
		0.25	57.08	12.45	14.21
		0.30	60.18	13.97	15.54
0.40	30	0.15	48.82	9.89	11.89
		0,20	52.17	10.23	12.45
		0.25	56.45	11.32	12.03
		0.30	58.17	11.98	13.92
	40	0.15	44.42	7.04	10.43
		0,20	46.32	7.56	10.23
		0.25	49.21	8.34	11.02
		0.30	51.34	8.89	11.21
	50	0.15	41.56	6.12	8.05
		0,20	43.45	6.58	8.17
		0.25	45.38	7.06	9.25
		0.30	47.23	7.54	9.87
0.50	30	0.15	39.89	4.97	6.32
		0,20	41.76	5.04	6.67
		0.25	43.12	5.24	7.46
		0.30	45.42	5.98	7.86
	40	0.15	33.87	3.09	4.34
		0,20	35.41	3.24	5.01
		0.25	38.23	3.63	5.34
		0.30	39.45	3.92	5.70
	50	0.15	22.23	2.14	2.97
		0.20	25.21	2.23	3.03
		0.25	27.15	2.54	3.43
		0.30	29.34	2.89	3.89

Table 2: Compressive Strength, Split Tensile Strength and Flexural Test Results on 56 Days

Water Cement Ratio	Flyash %	Fibre Dosage %	Compressive Strength N/mm^2	Split Tensile Strength Test N/mm^2	Flexural Test N/mm^2
0.35	30	0.15	72.05	15.31	18.54
		0,20	74.64	15.58	18.35
		0.25	77.75	16.20	19.54
		0.30	79.25	16.75	19.97
	40	0.15	64.68	14.01	16.21
		0,20	67.74	14.89	17.20

		0.25	**68.91**	**15.23**	**17.31**
		0.30	**69,97**	**15.86**	**17.96**
	50	**0.15**	**54.37**	**11.67**	**14.35**
		0,20	**57.28**	**12.54**	**14.12**
		0.25	**60.34**	**13.79**	**15.45**
		0.30	**62.16**	**14.00**	**15.97**
0.40	**30**	**0.15**	**52.24**	**10.32**	**12.54**
		0,20	**54,78**	**11.23**	**12.63**
		0.25	**56.84**	**11.89**	**13.29**
		0.30	**59.72**	**12.01**	**14.01**
	40	**0.15**	**46.82**	**7.56**	**10.32**
		0,20	**49.41**	**8.43**	**11.20**
		0.25	**51.75**	**8.98**	**11.34**
		0.30	**52.68**	**9.97**	**11.97**
	50	**0.15**	**43.45**	**6.85**	**8.71**
		0,20	**45.88**	**7.60**	**9.52**
		0.25	**47.32**	**7.95**	**9.78**
		0.30	**49.02**	**8.02**	**10.12**
0.50	**30**	**0.15**	**41.46**	**5.40**	**6.76**
		0,20	**43.12**	**5.42**	**7.62**
		0.25	**45.24**	**5.89**	**7.68**
		0.30	**47.18**	**6.23**	**8.14**
	40	**0.15**	**35.41**	**3.42**	**5.10**
		0,20	**38.32**	**3.63**	**5.43**
		0.25	**39.54**	**3.92**	**5.70**
		0.30	**41.06**	**4.11**	**6.23**
	50	**0.15**	**25.31**	**2.32**	**3.30**
		0.20	**27.61**	**2.45**	**3.54**
		0.25	**29.43**	**2.98**	**3.98**
		0.30	**32.54**	**3.12**	**4.87**

VI. RESULT AND DISCUSSIONS

6.1. Compressive Strength: Compressive strength of concrete mixes made with and without fly ash and poly propylene fiber was determined at 28days as well as 56 days. The compressive strength by different types of concrete mix with respect to their compressive strength at the age of 28days varies also 56 days. The compressive strength of concrete gains maximum strength at early age was observed for all the fly ash and poly propylene fiber based concrete mixes when compared with concrete mixes (control concrete).From Table 1 & 2, it was found that Compressive strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in compressive strength as compared with normal plain concrete (without fibers).

6.2. Splitting Tensile Strength: Split tensile strength of concrete mixes made with and without fly ash and poly propylene fiber was determined at 28days as well as 56 days. The Split tensile strength by different types of concrete mix with respect to their Split tensile strength at the age of 28days varies also 56 days. The Split tensile of concrete gains maximum strength at early age was observed for all the fly ash and poly propylene fiber based concrete mixes when compared with concrete mixes control concrete. From Table 1 & 2, it was found that Splitting tensile strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in splitting tensile strength as compared with normal plain concrete (without fibers).

6.3. Flexural Test: Flexural strength of concrete mixes made with and without fly ash and poly propylene fiber was determined at 28days as well as 56 days. The Flexural strength by different types of concrete mix with respect to their Flexural strength at the age of 28days varies also 56 days. The Flexural of concrete gains maximum strength at early age was observed for all the fly ash and poly propylene fiber based concrete mixes when compared with concrete mixes control concrete. From Table 1 & 2, it was found that

Flexural strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in Flexural strength as compared with normal plain concrete (without fibers).

VII. CONCLUSION

- Compressive strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in compressive strength as compared with normal plain concrete (without fibers)
- Splitting tensile strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in splitting tensile strength as compared with normal plain concrete (without fibers).
- Flexural test of concrete gradually increases with the addition of Polypropylene fiber. There is increase in Flexural test as compared with normal plain concrete (without fibers).

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