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A Study on Strength and Durability of Concrete Using Corn Cob Ash and Polyethylene Fiber

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Abstract - concrete by making an efficient concrete mix design blending with Corn Cob Ash and with addition of various percentages of polyethylene fiber (0%, 0.5%, 1%, 1.5% & 2%) in concrete has been undertaken. Development of efficient concrete mix design plays an important & vital role in producing eco-economical concrete. Corn Cob Ash partially replaced by cement in concrete for evaluating the workability and strength of concrete along with flexural & split tensile strength. This study has been done by varying (10%) Corn Cob ash on partial replacement of cement and with addition of various percentages of polypropylene fiber (0%, 0.5%, 1%, 1.5%& 2%) in concrete. About twenty-four trial mix, control mix and other variation mix were developed for M25 & M30 grade of concrete. Compressive strength 7 days and 28 days using cube (150mm x 150mm x 150mm) specimen, flexural strength for 28 days using beam (700mm x 150mm x 150mm) and splitting tensile strength for 28 days using cylinder (300mm length x 150mm diameter) were evaluated for this study by casting these in institute lab. All these concrete specimens were cured for 7 days and 28 days in deep water tank on normal 27+2 C degree atmospheric temperature.

Key Words: Concrete, Compressive Strength, Corn Cob Ash, Polyethylene fiber, Durability.

1. INTRODUCTION

Polyethylene fiber is a thermoplastic polymer because of its thermoplastic nature it contribute in glue powers which hold the solid combine along these lines lessen the pace of dying, plastic shrinkage and break. The capacity of haphazardly scattered filaments is to connect over the breaks that give some post splitting pliability. In the event that the strands like Polyethylene filaments which are sufficient and impeccably attached to the material, allows the FRC to convey essential worries over a generally enormous strain limit in post breaking state. Various sorts of Polyethylene strands can be utilized to strengthen concrete. Utilization of Polyethylene filaments lessens the age of splits.

1.1 Objectives of Study

(a) To reduce the crack developed in concrete due to shrinkage of concrete.

(b) To increase the compressive, tensile and flexural strength of concrete using Polyethylene fiber.

(c) To reduce the freezing and thawing damage in concrete and fire damage also.

(d) To increase in resistance to failure due to impact load in concrete.

(e) To analyze workability of fresh concrete.

1.2 Advantages:

- Increased fatigue, impact and absorption resistance
- It increases tensile and flexural strength, increases ductility of concrete, control the crack propagation and ability to resist load after cracking.
- Research is needed to establish the long-term Durability of Concrete containing Polyethylene fibre.
- The Microstructure properties of Concrete can be explored.
- Further investigation can be done by adding chemical admixtures to increase the workability of Polyethylene fiber concrete. PEF is resistant to most chemicals so improve the overall performance of structure.
- The hydrophobic surface not being wet by cement paste result in resistance to balling effect.

2. LITERATURE REVIEW

[1] Afrah Abdulwahhab (2018) Mechanical properties of concrete by using polyethylene fibers obtained from plastic cans, higher tensile and flexural strength obtained by using this type of fiber. This Polyethylene fiber is more durable than other types of fibers since it does not rust with time like steel fibers types. Compressive strength in this research increased from 37.4 MPa to 49.3 MPa, flexural strength increased from 3.5 MPa to 9.89 MPa, and tensile

strength increased from 2.9 MPa to 5.1 MPa.

[2] Komalpreet Singh(2017) have investigated Rapid increase in greenhouse gas induces mischievous impact on environment. In this study, carbon dioxide emission can be reduced to some extent by replacing some amount of cement with corn cob ash. The performance of concrete at high temperature was also studied. This paper investigates the effect of elevated temperature on strength property of ordinary concretes of grade M25, containing Corn Cob Ash (CCA) at various replacement levels of cement. The cube samples were subjected to high temperature of 1500C, 3000C, 4500C and 6000C for 2 hour duration in a muffle furnace. The samples were tested for compressive strength after air cooling to the room temperature. It can be seen that at normal temperature, compressive strength of the concrete decreases as the CCA content increases. The compressive strength of concrete increased significantly for all the mixes including control mix when the temperature was raised to 3000C. The recommended maximum replacement content of cement with CCA and elevated temperature was 10% and 3000 C respectively.

[3]Jay Patel, Kunal Patel, Gaurav Patel (2012) have concentrated on usage of lake fly debris as a fractional supplanting in fine total with utilizing fine fly debris and alccofine in high quality cement for example they supplant the alccofine and fine fly debris fractional with concrete and lake fly debris as a substitution of fine total and have made different variety in all blends Compressive quality for utilizing 6% alccofine as a concrete substitution and 10% lake debris as a substitution in fine total got high quality For flexural quality and elasticity for utilizing 6% alccofine as a concrete substitution and 10% lake debris as a substitution in fine total couldn't get the craving quality . Maximum Flexural

Strength 4.84 N/mm2 getting at using 6% Alccofine and 10% pond ash usage at 28th day. The maximum split tensile strength of cylinder getting maximum at using 6% Alccofine and 10% pond fly ash at 56th day.

3. METHODLOGY

Corn cob ash (CCA) is obtained by burning of corn cob waste. CCA has about 70% of combined content of SiO_2 and CaO. The compressive strength of concrete increased significantly for all the mixes including control mix when the temperature was raised to 3000C. The recommended maximum replacement content of cement with CCA and elevated temperature was 10% and 3000C respectively.

Table 3.1: Chemical Properties of Corn Cob Ash

Chemical Composition	Value
Cao	12%
SiO2	64.56%
Fe2O3	5.12%
Al2O3	9.42%

Fig.3.1. Corn Cob Ash

3.1 Polyethylene Fibers

- Chemical inertness makes the fibers resistant to most chemicals.
- The hydrophobic surface not being wet by cement paste helps to prevent chopped fibers from balling effect during mixing like other fibers.
- The water demand is nil for Polyethylene fibers.
- The orientation leaves the film weak in the lateral direction which facilitates fibrillations. The cement matrix can therefore penetrate in the mesh structure between the individual fibrils and create a mechanical bond between matrix and fiber.

Fig.3.2 Polyethylene Fibers

4. EXPERIMENTAL STUDY

4.1 Grading of Fine Aggregate

Fineness Modulus =cumulative percentage retained on spe cified

sieves /100

Fineness Modulus = 311/100 = 3.11 ≈ 3.11

According to IS: 383-
1970 the fineness modulus lies in zone III

Table 4.1 Sieve Analysis of Fine Aggregate

Sieve Size (mm)	Average weight retained in gm	Cumulative weight in gm	% cumulative in gm	% Passing	Limit as per IS 383
10	0	0	0	0	100
4.75	3.5	3.5	0.35	99.65	95-100
2.36	56	25.5	2.55	97.45	85-100
1.18	219	81.5	8.15	91.85	75-100
600	583	300.5	30.05	69.95	60-79
300	105	883.5	88.35	11.65	12-40
150	12.0	988.5	98.85	1.15	0-10
PAN	0.00	1000	100	0	
Total		1000	1000	311	

4.2 Grading of Coarse aggregate (20mm)

Table 4.2 Sieve Analysis of Coarse Aggregate (20mm)

Sieve Size (mm)	Average weight retained in gm	Cumulative weight in gm	% cumulative in gm	% Passing	Limit as per IS 383
40	0.0	0.0	0.0	100	100
20	1176.5	57.825	57.825	40.175	85-100
10	735	37.75	94.575	4.425	0-20
4.75	79	3.95	100	0.475	0-5
2.36	9.5	0.475	100	0	
1.18	0.0	0	100	0	
600	0	0	100	0	
300	0	0	100	0	
150	0	0	100	0	
PAN	0	0	100	0	
Total	2000	2000	758.3	0	

Fineness Modulus =cumulative percentage retained on specified sieves /100

Fineness Modulus = 758.925/100 = 7.58825 ≈ 7.58

4.3 Grading of Coarse aggregate (10mm)

Table 4.3 Sieve Analysis of Coarse Aggregate (10mm)

Sieve Size (mm)	Average weight retained in gm	Cumulative weight in gm	% cumulative in gm	% Passing	Limit as per IS 383
12.5	0.0	0.0	0.0	100	100
10	42	42	2.1	97.9	85-100
4.75	1348	1390	93.9	30.5	0-20
2.36	488	1878	100	6.1	0-5
1.18	122	2000	100	0	
600	0		100	0	
300	0		100	0	
150	0		100	0	
PAN	0		100	0	
Total	2000		566.5		

Fineness Modulus =cumulative percentage retained on specified sieves /100

Fineness Modulus = 566.5/100 = 5.66

5. RESULT AND DISCUSSION

5.1 Workability of Concrete

5.1.1 Slump Test

Table No. 5.1 Slump for Control mix of M25 & M30 Grade

S. No.	Control Mix	Slump (mm)
1	M25	75
2	M30	90

Table No. 5.2 Slump with 10% Corn Cob Ash and Polyethylene Fiber

S.No.	Polyethylene fiber%	Slump	
		M25	M30
1	0.0	70	80
2	0.5	68	78
3	1.0	64	75
4	1.5	61	72
5	2.0	59	70

Table no.5.2 shows the comparison of slump for various fiber content percentages. It is observed that as the Polyethylene fiber content in concrete increases, slump of concrete decreases accordingly hence the workability decreases. So concrete with 0% fiber has highest workability and concrete with 2.0% has lowest workability.

5.2 Compressive Strength Test

Table 5.3 Compressive Strength of M25 grade

Polyethylene fiber%	Compressive Strength(N/mm²)		
	7Days	14Days	28Days
0.0	16.09	21.46	26.82
0.5	17.95	23.78	29.93
1.0	20.52	26.94	33.64
1.5	21.24	27.85	34.82
2.0	18.17	22.24	27.70

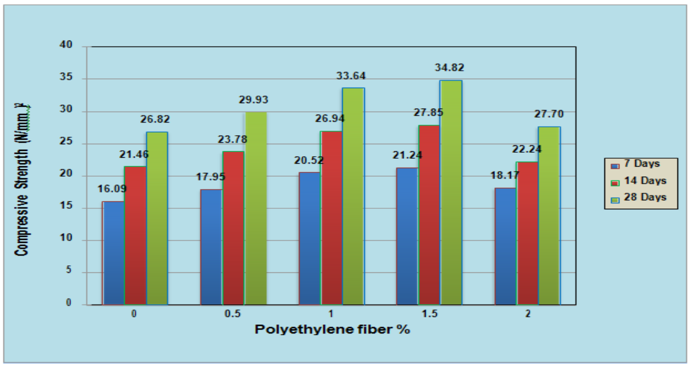

Fig 5.1 Comparative Compressive Strength of M25 Grade

It was observed from figure 5.1 that minimum compressive strength was obtained at 0% addition of Polyethylene fiber while optimum compressive strength was obtained at 1.5% addition of Polyethylene fiber for 7, 14 and 28 days curing period of cubes. It was observed that optimum percentage increment in compressive strength of concrete was 29.82% at 28 days of curing respectively.

Table 5.4 Compressive strength of M30 grade

Polyethylene fiber%	Compressive Strength(N/mm²)		
	7Days	14Days	28Days
0.0	19.60	26.50	32.67
0.5	20.41	26.12	33.47
1.0	21.50	28.46	35.84
1.5	22.80	29.47	36.79
2.0	21.71	28.76	35.60

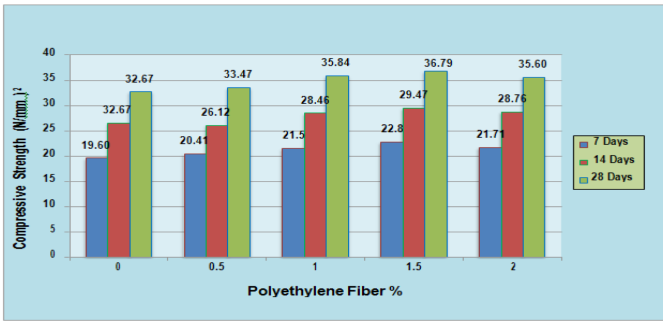

Fig 5.2 Comparative Compressive Strength of M30 Grade

It was observed from figure 5.2 that minimum compressive strength was obtained at 0% addition of Polyethylene fiber while optimum compressive strength was obtained at 1.5% addition of Polyethylene fiber for both 14 days and 28 days curing period of cubes. It was also observed that optimum percentage increment in compressive strength of concrete was 12.61% at 28 days of curing respectively.

5.3 Split Tensile Strength of Concrete

Table 5.5 Splitting Tensile Strength of M25 grade

Polyethylene fiber%	Splitting Tensile Strength(N/mm²)		
	7Days	14Days	28Days
0.0	1.38	1.79	2.24
0.5	1.49	1.94	2.41
1.0	1.66	2.18	2.73
1.5	2.02	2.58	3.26
2.0	1.39	1.77	2.27

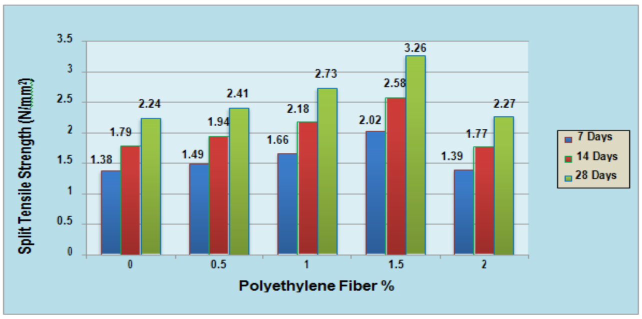

Fig 5.3 Comparative Splitting Tensile Strength of M25 Grade

It was observed from figure 5.3 that minimum split tensile strength was obtained at 0% addition of Polyethylene fiber while optimum split tensile strength was obtained at 1.5% addition of Polyethylene fiber at 14 and 28 days curing of cubes. It was also observed that optimum percentage increment in split tensile strength of concrete was 45.53% at 28 days of curing respectively.

Table 5.6 Splitting Tensile Strength of M30 grade

Polyethylene fiber%	Splitting Tensile Strength(N/mm^2)		
	7Days	14Days	28Days
0.0	1.99	2.97	3.33
0.5	2.42	3.33	3.97
1.0	2.51	3.48	4.12
1.5	2.22	3.29	3.64
2.0	2.04	3.06	3.41

It was observed from figure 5.4 that minimum split tensile strength was obtained at 0% addition of Polyethylene fiber while optimum split tensile strength was obtained at 1.0% addition of Polyethylene fiber at 14 and 28 days curing of cubes. It was also observed that optimum percentage increment in split tensile strength of concrete was 23.72% at 28 days of curing respectively.

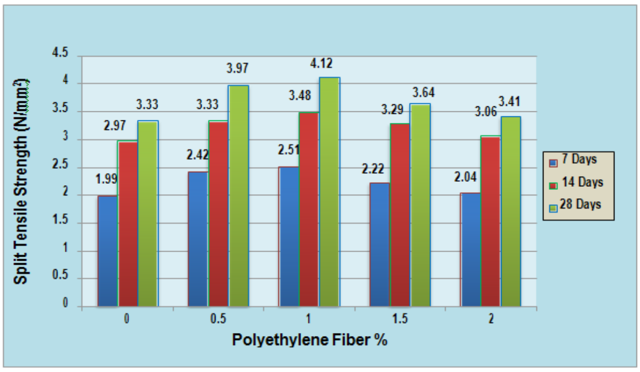

Fig 5.4 Comparative Splitting Tensile Strength of M30 Grade

5.4 Flexural Strength of Concrete

Table 5.7 Flexural Strength of M25 grade

Polyethylene fiber%	Flexural Strength (N/mm^2)	
	7Days	28Days
0.0	1.58	2.6
0.5	1.76	2.9
1.0	2.01	3.3
1.5	2.07	3.4
2.0	1.67	2.7

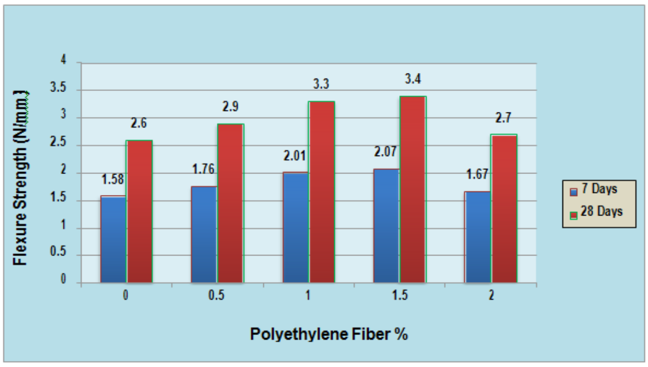

Fig 5.5 Comparative Flexural Strength of M25 Grade

It was observed from figure 5.5 that minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.5% addition of Polyethylene fiber at 14 and 28 days or curing respectively. It was also observed that optimum percentage increment in flexural strength of concrete was 30.76% at 28 days curing.

Table 5.8 Flexural Strength of M30 grade

Polyethylene fiber%	Flexural Strength (N/mm^2)	
	7Days	28Days
0.0	1.64	2.70
0.5	1.81	2.97
1.0	2.06	3.38
1.5	1.98	3.26
2.0	1.93	3.12

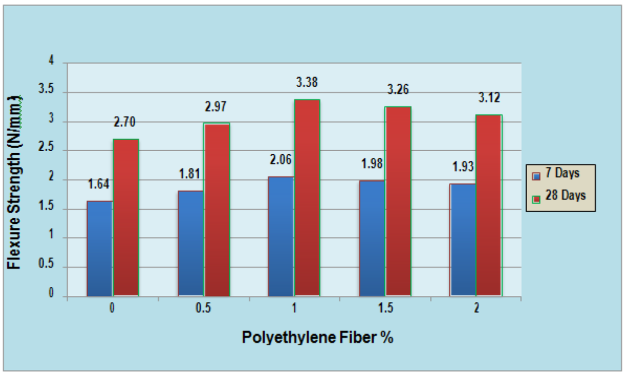

Fig 5.6 Comparative Flexural Strength of M30 Grade

It was observed from figure 5.6 that minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.0% addition of Polyethylene fiber at 14 and 28 days or curing respectively.

It was also observed that optimum percentage increment in flexural strength of concrete was 25.18 % at 28 days curing.

6. CONCLUSION

6.1 FOR M25

1. Compressive Strength: The compressive strength increased as increase the percentage (%) of Polyethylene fiber (0% to 1.5%) after 1.5% of PEF compressive strength decreases for both 14 days & 28 days cube strength. It was concluded that optimum percentage increment in compressive strength of concrete was 29.82% at 28 days of curing respectively.

2. Split Tensile Strength: The minimum split tensile strength was obtained at 0% addition of Polyethylene fiber while optimum split tensile strength was obtained at 1.5% addition of Polyethylene fiber at 14 and 28 days curing of cubes. It was concluded that optimum percentage increment in split tensile strength of concrete was 45.53% at 28 days of curing respectively.

3. Flexure Strength: It was noted that flexural strength of concrete increase gradually with addition of Polyethylene fiber and minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.5% addition of Polyethylene fiber at 14 and 28 days of curing respectively. It was concluded that optimum percentage increment in flexural strength of concrete was 30.76% at 28 days curing respectively.

6.2 FOR M30

1. Compressive Strength: The results revealed that minimum compressive strength was obtained at 0% addition of Polyethylene fiber while optimum compressive strength was obtained at 1.5% addition of Polyethylene fiber for both 14 days and 28 days curing period of cubes. It was concluded that optimum percentage increment in compressive strength of concrete was 12.61% at 28 days of curing respectively.

2. Split Tensile Strength: The results revealed that minimum split tensile strength was obtained at 0% addition of Polyethylene fiber while optimum split tensile strength was obtained at 1.0% addition of Polyethylene fiber at 14 and 28 days curing of cubes. It was concluded that optimum percentage increment in split tensile strength of concrete was 23.72% at 28 days of curing respectively.

3. Flexure Strength: It was noted that minimum flexural strength was obtained at 0% while optimum flexural strength was obtained at 1.0% addition of Polyethylene fiber at 14 and 28 days or curing respectively. It was observed that optimum percentage increment in flexural strength of concrete was 25.18 % at 28 days curing.

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