STRENGTH CHARACTERISTICS OF HDPE CONCRETE

Sudarshan[1], Manjulavani[2], V Bhikshma[3]

[1]ME Student, Lab Asst., Civil Engineering Dept., Osmania University, Hyderabad
[2]Professor of Civil Engineering, JNTU, Hyderabad
[3]Professor of Civil Engineering, Osmania University, Hyderabad

Abstract

In this research work, an attempt is made to investigate high density polyethylene fibre reinforced concrete (HDPE) for M30 grade concrete. In this experimental work the percentage of HDPE considered is 0 to 6%. A series of trial mixes have been conducted for the investigation to obtain the desired target strength of HDPE concrete with varying percentages. The mechanical properties are evaluated for all percentages. A total of 78 cubes, 39 cylinders and 39 prisms of standard specimens have been considered. The strength property of HDPE concrete is encouraging the results. As the HDPE is non bio degradable waste disposable material is much useful for the concrete works in durability aspects. The flexural capacity of the concrete also very much improved, hence encouraging the research

Keywords: *HDPE-FRC, NBD, Cement*

----------***----------

1. INTRODUCTION

1.1 Objectives

1. To mix high density polyethylene small pieces in cement concrete.
2. To study the strength properties of the concrete by using HDPE.
3. To improve the strength properties of the concrete by using certain Additives.

1.2 Composite

HDPE fibres (high density polyethylene).

Fibre enables to produce a hardened concrete which has:

- Improved surface quality
- Greater impact resistance
- Increased damage resistance

1.3 Non Bio Degradable Materials

- Fibre plastics
- Jute plastics
- Textile waste
- Polythene covers
- Plastics covers
- Disposable glass
- Water bottles
- Fiber reinforced plastic sheets
- Cement bags

In present investigation cement bags are used (NBD). CIPET (Central institute of plastics engineers & technology) certified that the above bags come under HDPE fibers.
HDPE fibers:

1.4 The Properties for HDPE

Properties: Physical Properties of HDPE fibers CIPET: (Central Institute of Plastic Engineers & Technology)

2. TEST RESULTS

Sl. No.	Test	Test Method	Result	Unit
1.	Tensile breaking load at yield	IS:9755:1999/IS:1969	61.79	Kg
2.	Tensile breaking load at break	IS:9755:1999/IS:1969	2.78	Kg
3.	Tensile elongation break	IS:9755:1999/IS:1969	26.91	%
4.	Identification	CIPET Method	High Density Polyethylene (HDPE)	-

2.1 Factors Influencing the Fibre Reinforced Concrete

- Aspect ratio
- Minimum effective length
- Critical length
- Orientation of fibres
- Volume of fibres
- Spacing of fibres
- Size of coarse aggregate
- Workability & compaction of concrete

2.2 Applications

Asbestos: Sheets, Pipes, tiles and corrugated roofing elements, wall linings.

Glass: Sewer pipes, thin concrete shell roofs, storage tanks, precast panels, curtain wall facing, cloth, mat tape, utility service boxes

Polypropylene: Facing panels, prestressed piles, and foundation piles.

Nylon: Road patching material, heavy-weight coating for under water pipe, manhole covers.

Carbon: Scaffold boards, corrugated units for floor construction, single & double curvature membrane structure.

Steel: Bridge decks, Industrial flooring, concrete pipe airport runway, pressure vessels, blast and earthquake construction, manhole covers, prestressed beams, repairs works, dams and for special purposes.

3. MATERIALS AND PROPERTIES

3.1 Constituents & Characteristics

Oxide-Constituent	% Content	Percentage
Cao (Line)	60-67	63.9
SiO2 (Silica)	17-25	22.4
Al2 O3 (Alumina)	3.0-8.0	4.6
Fe2O3 (Iron Oxide)	0.5-6.0	3.6
MgO (Magnesia)	0.1-4.0	1.8
Alkalies (K2O,Na2O)	0.4-1.3	0.9
SO3 (Sulfurtrioxide)	1.0-3.0	1.98

3.2 Physical Properties of O.P.C (53 Grade)-Ultra Tech Brand

Sl. No.	Properties	Test Results
1	Fineness of cement (sieve no.9)	3.5%
2	Specific Gravity	3.14
3	Normal Consistency	32%
4	Initial setting time	70 minutes
5	Final setting time	225 minutes
6	Compressive Strength (3 days)	33.5 N/mm^2
	Compressive Strength (7 days)	45.0 N/mm^2
	Compressive Strength (28 days)	56.8 N/mm^2

3.3 Quantity of Materials required for 1cum of concrete (By volume)

Sl. No.	Cement	Fine Aggregate	Coarse Aggregate	Water Content
1.	400 / 1440	610/1710	1141/1585	180/1000
2.	0.278	0.359	0.725	0.176
3.			2% entrapped air	0.02
			Total Volume	**1.558 cm**

Weight of materials required for 1 batch(30kg)Mix

Sl. No.	Cement	Fine Aggregate	Coarse Aggregate	Water Content
1.	30/2.87	1.534 x 10.45	2.87 x 10.45	0.44 x 10.45
2.	10.45	16.03	30.0	4.6

Sl. No.	% OF HDPE	Wt of HDPE (gm/cc)
1	0.5	10.6
2	1.0	21.2
3	1.5	31.8
4	2.0	42.4
5	2.5	53.00
6	3.0	63.6
7	3.5	74.2
8	4.0	84.8
9	4.5	95.4
10	5.0	106.0
11	5.5	116.6
12	6.0	127.2

Calculation for 1% HDPE
Weight = 0.0386*1/100*100*100*100*0.055=21.23 grams.
Weight of fibres for varying % of HDPE for 1 m^3 of concrete

Sl. No.	% of HDPE	Wt. of HDPE (gm/m^3)
1.	0.5	275
2.	1.0	550
3.	1.5	825
4.	2.0	1100
5.	2.5	1375
6.	3.0	1650
7.	3.5	1925
8.	4.0	2200
9.	4.5	2475
10.	5.0	2750
11	5.5	3025
12.	6.0	3300

For 1% HDPE
0.0386M3 of concrete weight of jute is 21.23 grams
1 cu. m the weight of jute = (1 / 0.0386) x 21.23 = 550 grams/cu. M

4. RESULTS & DISCUSSION

28 - Days Compressive Strength with varying % of HDPE by volume

Sl. No.	ID No	% of HDPE	Ultimate Load (kN)			Average Load (kN)	Average strength (N/mm²)
			Sample-1	Sample-2	Sample-3		
1	S1	0.0	930	990	930	950.0	42.23
2	S2	0.5	930	970	1000	966.7	42.97
3	S3	1.0	1000	950	975	975.0	43.34
4	S4	1.5	950	1020	980	983.3	43.71
5	S5	2.0	970	1000	1000	990.0	44.00
6	S6	2.5	1000	940	960	996.7	44.3
7	S7	3.0	1000	1040	990	1010	44.90
8	S8	3.5	1000	1040	990	1010.0	44.90
9	S9	4.0	950	980	995	975.0	43.34
10	S10	4.5	960	920	865	915.0	40.67
11	S11	5.0	800	850	825	825.0	36.67
12	S12	5.5	710	800	730	746.7	33.20
13	S13	6.0	700	680	720	700.0	31.10

Combination of 28 Days Compressive Strength of HDPE Fiber Reinforced Concrete (0% and 3%)

Sl. No.	% of HDPE	Load (kN)	Average Load (kN)	Average Strength (N/mm^2)
1	0.0	930	950.0	42.23
2	0.0	990		
3	0.0	930		
4	3.0	1000	1010	44.90
5	3.0	1040		
6	3.0	990		

Modulus of elasticity of M-30 grade of concrete with 0 % of HDPE.

Sl. No	Load (kn)	δ C1	Δ C2	δ C3	δ avg	Stress (f=P/A)	Strain (e=δ/l)	E = f/e
1	0	0	0	0	0	0	0	0
2	10	0.6	0.6	0.6	0.6	0.57	$0.6*10^{-5}$	95000
3	20	1.2	1	1.2	1.13	1.13	$1.13*10^{-5}$	100000
4	30	1.8	1.4	1.8	1.67	1.7	$1.67*10^{-5}$	101796
5	40	2.4	2.2	2.4	2.33	2.26	$2.33*10^{-5}$	96996
6	50	3.2	2.8	3.3	3.1	2.83	$3.1*10^{-5}$	91290
7	60	4.0	3.6	4	3.87	3.4	$3.87*10^{-5}$	87855
8	70	4.8	4	4.8	4.53	3.96	$4.53*10^{-5}$	87417
9	80	5.6	4.8	5.6	5.33	4.53	$5.33*10^{-5}$	84991
10	90	6.8	5.6	6.9	6.43	5.1	$6.43*10^{-5}$	79316
11	100	8.0	6	8	7.33	5.66	$7.33*10^{-5}$	77217
12	110	8.8	6.6	9	8.13	6.23	$8.13*10^{-5}$	76630
13	120	9.6	7.2	10	8.93	6.8	$8.93*10^{-5}$	76148
14	130	10.2	7.8	11.1	9.7	7.36	$9.7*10^{-5}$	75876
15	140	11.2	8.4	12.2	10.6	7.92	$10.6*10^{-5}$	74717
16	150	11.8	9	13.4	11.4	8.49	$11.4*10^{-5}$	74474
17	160	12.8	9.6	14.6	12.33	9.06	$12.33*10^{-5}$	73479
18	170	13.4	10.2	15.8	13.13	9.62	$13.13*10^{-5}$	73267
19	180	14.2	10.8	17	14	10.19	$14.0*10^{-5}$	72786
20	190	15.0	12	18.3	15.1	10.75	$15.1*10^{-5}$	71192
21	200	16.0	12.8	19.6	16.1	11.32	$16.1*10^{-5}$	70311
22	210	16.8	13.4	20.9	16.46	11.88	$16.46*10^{-5}$	72175
23	220	17.6	14.2	22.3	18.03	12.45	$18.03*10^{-5}$	69052
24	230	18.2	15	23.6	18.93	13.02	$18.93*10^{-5}$	68780
25	240	19.2	15.4	24.8	19.8	13.58	$19.8*10^{-5}$	68586
26	250	20	15.6	26.2	20.6	14.15	$20.6*10^{-5}$	68689
27	260	21	15.8	27.6	21.47	14.71	$21.47*10^{-5}$	68514
28	270	21.8	16.5	29	22.43	15.28	$22.43*10^{-5}$	68123
29	280	22.8	17	30.4	23.4	15.85	$23.4*10^{-5}$	67735
30	290	23.6	17.8	31.9	24.43	16.41	$24.43*10^{-5}$	67172
31	300	25	19	33.3	25.77	16.98	$25.77*10^{-5}$	65891
32	310	25.8	19.8	34.8	26.8	17.54	$26.8*10^{-5}$	65448
33	320	26	20.6	36.4	27.67	18.11	$27.67*10^{-5}$	65450
34	330	27	21.5	38	28.83	18.67	$28.83*10^{-5}$	64759

Table – 1: Modulus of elasticity of M-30 grade of concrete with 3.0 % of HDPE.

Sl. No.	Load (kn)	δ C1	δ C2	δ C3	δ avg	Stress (f=P/A)	Strain (e=δ/l)	E = f/e
1	0	0	0	0	0	0	0	0
2	10	0.4	0.4	0.5	0.43	0.57	$0.43 *10^{-5}$	132558
3	20	1	0.8	1	0.9	1.13	$0.9 *10^{-5}$	125555
4	30	1.6	1.4	1.8	1.6	1.7	$1.6 *10^{-5}$	106250
5	40	2.4	2	2.5	2.3	2.26	$2.3 *10^{-5}$	98261
6	50	3.2	2.8	3.2	3.1	2.83	$3.1 *10^{-5}$	91290
7	60	4	3.4	4	3.8	3.4	$3.8 *10^{-5}$	89474
8	70	4.8	3.8	4.8	4.5	3.96	$4.5 *10^{-5}$	88000
9	80	5.6	4.6	5.5	5.2	4.53	$5.2 *10^{-5}$	87115
10	90	6.4	5.8	6.2	6.1	5.1	$6.1 *10^{-5}$	83606
11	100	7	6.6	7	6.9	5.66	$6.9 *10^{-5}$	82029
12	110	7.8	7.4	7.8	7.7	6.23	$7.7 *10^{-5}$	80909
13	120	8.6	8	8.8	9.1	6.8	$9.1 *10^{-5}$	77474
14	130	9.6	8.8	10	9.5	7.36	$9.5 *10^{-5}$	76154
15	140	10.5	9.8	11	10.4	7.92	$10.4 *10^{-5}$	75133
16	150	11.2	10.8	12	11.3	8.49	$11.3 *10^{-5}$	74725
17	160	12.2	11.6	13	12.3	9.06	$12.3 *10^{-5}$	73658
18	170	13	12.4	14	13.1	9.62	$13.1 *10^{-5}$	73435
19	180	14	13.2	15	14.1	10.19	$14.1 *10^{-5}$	72269
20	190	15	14	16	15	10.75	$15.0 *10^{-5}$	71667
21	200	16	15.5	17.2	16.2	11.32	$16.2 *10^{-5}$	69877
22	210	17	17	18	17.3	11.88	$17.3 *10^{-5}$	68671
23	220	18	17.8	19	18.3	12.45	$18.3 *10^{-5}$	68033
24	230	19.8	19	20	19.6	13.02	$19.6 *10^{-5}$	66429
25	240	21	19.8	21	20.6	13.58	$20.6 *10^{-5}$	65922
26	250	22.2	20.8	22.2	21.7	14.15	$21.7 *10^{-5}$	65207
27	260	24	21.6	23	22.9	14.71	$22.9 *10^{-5}$	64236
28	270	25.2	22.6	24	23.6	15.28	$23.6 *10^{-5}$	64746
29	280	26.2	23.6	25	26.1	15.85	$26.1 *10^{-5}$	60728
30	290	27.4	24.6	26.2	27.3	16.41	$27.3 *10^{-5}$	60110
31	300	29.2	25.5	27.2	28.3	16.98	$28.3 *10^{-5}$	60000
32	310	31	27	28.5	29.7	17.54	$29.7 *10^{-5}$	59057
33	320	32.2	29.2	29.5	31.1	18.11	$31.1 *10^{-5}$	58232
34	330	33.4	31	31	31.8	18.67	$31.8 *10^{-5}$	58711
35	340	35	32.4	32.5	33.3	19.24	$33.3 *10^{-5}$	57777
36	350	36.5	33.8	34	34.8	19.81	$34.8 *10^{-5}$	56925
37	360	38.2	35.2	35.5	36.3	20.37	$36.3 *10^{-5}$	56116

4. CONCLUSION

1. The HDPE concrete has shown slight improvement in all properties when compared with the conventional concrete.
   Compressive strength by 10.63%
   Split tensile strength by 15.76%
   Flexural strength by 13.9%
2. HDPE fibres are mainly drawn from cement bags, the entire construction site will be free from its own nbiodegradable waste, as one cum of HDPE fibre reinforced concrete requires 50 bags at 3.0% of fibres by volume.
3. HDPE fibre reinforced concrete it durable as it improved the strength gradually by 11.25% at 7days and 10.63% increase after 28days.
4. Jute plastic cement bags can be used immediately after using the cement in the site.
5. NBD – FRC can be used in sewerage pipes, manhole covers, compound walls, retaining walls etc.

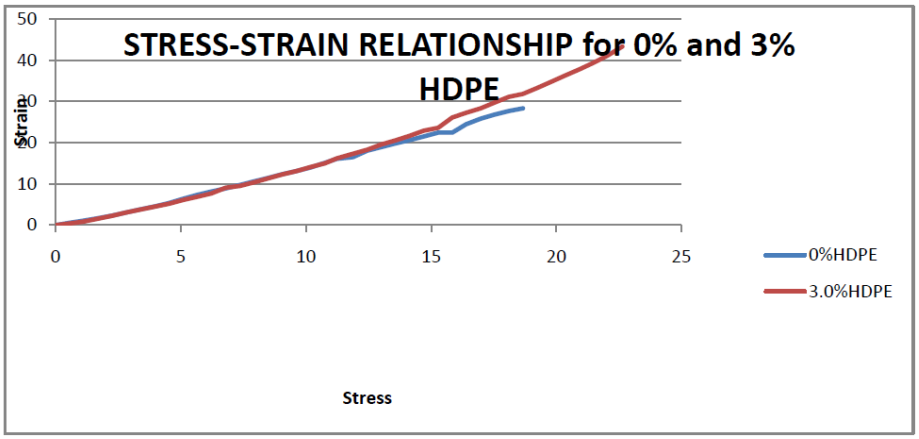
1. Further work can be investigated for durability for individual and mixture of fibres.
2. Further study by replacing the same amount of cement by volume.
3. Further study on scc

LIMITATIONS

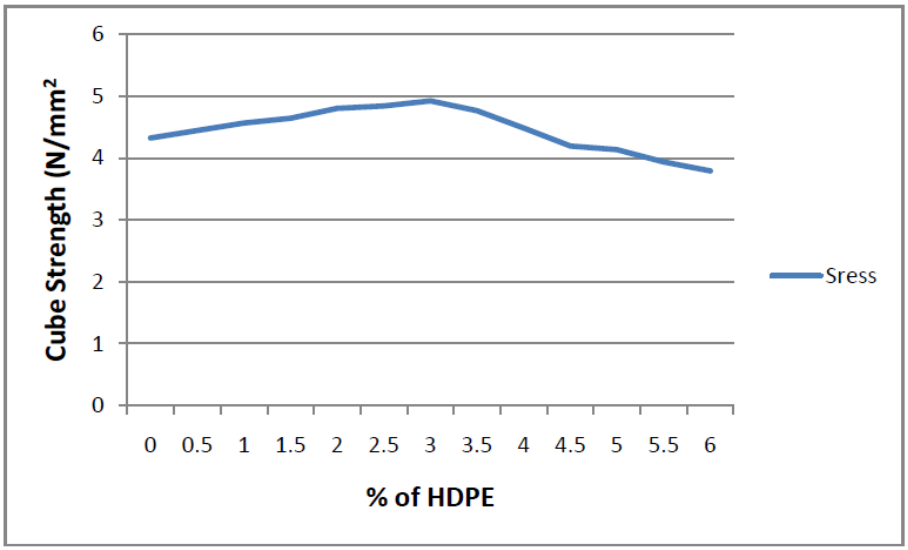
Aspect ratio should be 100 to 150.

REFERENCES

[1]. A.K. Shrivastava, A.K. Sahu, M.Shukla and A.Ksaclan "Impact resistance of fiber reinforced concrete " Advances in cement in concrete – pg – 80.
[2]. Ashour S.A. and Wafa, F.F (1993), "Flexural behavior of high strength fiber reinforced concrete beams". ACI Structural Journal, May-June 1993, Vol. 90, No.3, PP 279 – 287. Eight high – strength concrete beams with different



28 days Compressive Strength with varying % of HDPE



7 days Compressive Strength with varying % of HDPE