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An Experimental Study on Utilization of Pulverized Plastic in Concrete as Fine Aggregates

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Abstract— The construction industry suffers nowadays with lack of materials, mainly fine aggregates and increase in material costs. To reduce this, in this research, an attempt is made to replace used plastic as fine aggregate in the concrete. Plasic wastes are used in the form of pulverized plastic after undergoing the conversion process. Then, its suitability in concrete is tested by conducting tests like compression strength and split tensile strength test. From the results, a discussion is made on the effective percentage of replacement of utilized plastic in concrete. Thus, this helps in reducing plastic waste to be in a harmful state for our environment and is converted to an useful ingredient in concrete.

Keywords— Used Plastic, Fine Aggregate, Concrete, Compressive Strength, Split Tensile Strength

I. Introduction

Due to the swift evolution in the population and development in the country, lots of infrastructure enlargement are taking place. For such infrastructural projects, concrete is an effective building component which rules the world. The main ingredient of Concrete is the fine aggregate. Now construction industry is facing the paucity of fine aggregates. Hence, a trial is made to replace the fine aggregate by the used plastic waste in the pulverized form. The suitability of this replacement is checked by conducting the tests in 7 and 14 days compressive strength, also the split tensile strength tests are conducted for the same.

II. MATERIALS

A. *Plastic and Sand as Fine Aggregates*

The intention of this project is to evaluate the opportunity, of using Low Density Poly Ethylene (LDPE) bags as a substitute for the fine aggregate in concrete. Plastic has a major advantage such as durability, low weight, insulation property and high strength. Still, tests are made to confirm the same. LDPE bags are gathered from the dumping area and washed with water. Plastics are cut into pieces, made to dry thoroughly and it was heated, until they got melted. Melting of plastic was carried out at a temperature of 110 ºC-120 ºC. The soft plastic were poured into the container and then it was allowed to harden. Then it is broken into pieces which is fed into the pulverising machine.Then it is turned into the size of the sand.. The LDPE used in this project work is brownish white in color. The concrete mixes are arranged varying the Low Density Polyethylene content as 0%, 10%, 20%, 30% and 40% by weight with substitution of sand. The grading of sand conforming to IS 383:1970 is used in this work.

B. *Cement and Coarse Aggregates*

53 grade cement compatible to IS12269-1987 is used. The crumpled angular coarse aggregate which is collected from the nearby area is used, as termed in IS 2386 (Part I): 1963.

C. *Water*

The water used is of good quality, free from any external agent which retard the qualtiy of concrete and its pH value is in the range of 6 to 7.

III. REVIEW OF LITERATURE

Concrete though replaced with many alternatives for its ingredients, a proper ingredient is required which does some added value to the environment , thus in that basis many researches have tried their best to satisfy both the quality of concrete and the environment which is evidenced from [1] through [10].

IV. CONCRETE

M30 grade of concrete is planned using 53 grade Dalmia Cement and 0.45 Water with Cement Fraction. Cubes of size 100x100x100 mm were casted by filling up concrete in moulds up-to 3 layer, by applying a tamping rod of 25 blows in each layer and every time by changing the percentage of LDPE i.e. 40%, 30%, 20%, 10% and 0% in the weight of Fine aggregate. The cubes was de-moulded after 24 hours and reserved in the curing container for curing, and then it was tested after 7days, 14 days and 28 days. Later test results with optimum value is considered.

Fig. 1 Concrete Cube Moulds

Fig.2 Concrete Cylinder Moulds

Fig. 3 Curing of Concrete Cubes

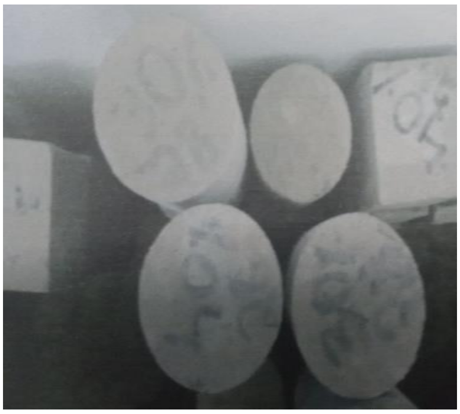

Fig. 4 Curing of Concrete Cylinders

A. *Compressive Strength*

It is the strength of the concrete to resist the compressive load. The test is done on cubes after drying those in normal room temperature. After curing for 7, 14 and 28 days. In a compression testing machine, load is gradually acted at 300 KN per minute at a controlled rate. The peak load at which cube break were noted.

Compressive Strength = “L/A” N/mm^2, L is the Failure load in N, A is the Area of cube in mm^2

B. *Split tensile Strength*

This test is done on concrete cylinders of 150x300 mm size. The testing is done on concrete Cylinder after 7, 14 and 28 days of curing. Split tensile strength $T = 2P/\pi DL$ P = Load, D = Diameter of the cylinder mould L = Length of cylinder mould

Fig. 5 Compression Testing

Fig. 6 Split Tensile Testing

Fig. 7 Failed Cylinder

V RESULTS AND DISCUSSION

The tests are conducted on 3 samples for each type for both Compressive strength and Split tensile strength tests and the results obtained are tabulated below and from the inference of the graphs plotted, an optimum amount of LDPE to be added is decided.

TABLE I

COMPRESSIVE STRENGTH TEST RESULTS AT 7 DAYS

Replacing of sand by pulverized plastic	Weight (kg)	Density (kg/m^3)	Average density (kg/m^3)	Failure Load (KN)	Compress ive strength (N/mm^2)	Average compressive strength(N/mm^2)
0% LDPE+100% FA	2.47	2470	2446.67	346.5	34.65	34.58
	2.41	2410		341.7	34.17	
	2.46	2460		349.2	34.92	
	2.34	2340		388.4	38.84	

10 % LDPE+90% FA	2.33	2330	2333.33	390.1	39.01	38.91
	2.33	2330		388.9	38.89	
20% LDPE+80% FA	2.20	2200	2200	322.3	32.23	32.69
	2.22	2220		328.9	32.89	
	2.18	2180		329.5	32.95	
30% LDPE+70% FA	2.16	2160	2136.66	312.4	31.24	31.10
	2.14	2140		309.3	30.93	
	2.11	2110		311.5	31.15	
40% LDPE+60% FA	2.00	2000	2010	219.8	21.98	21.73
	2.01	2010		216.9	21.69	
	2.02	2020		215.3	21.53	

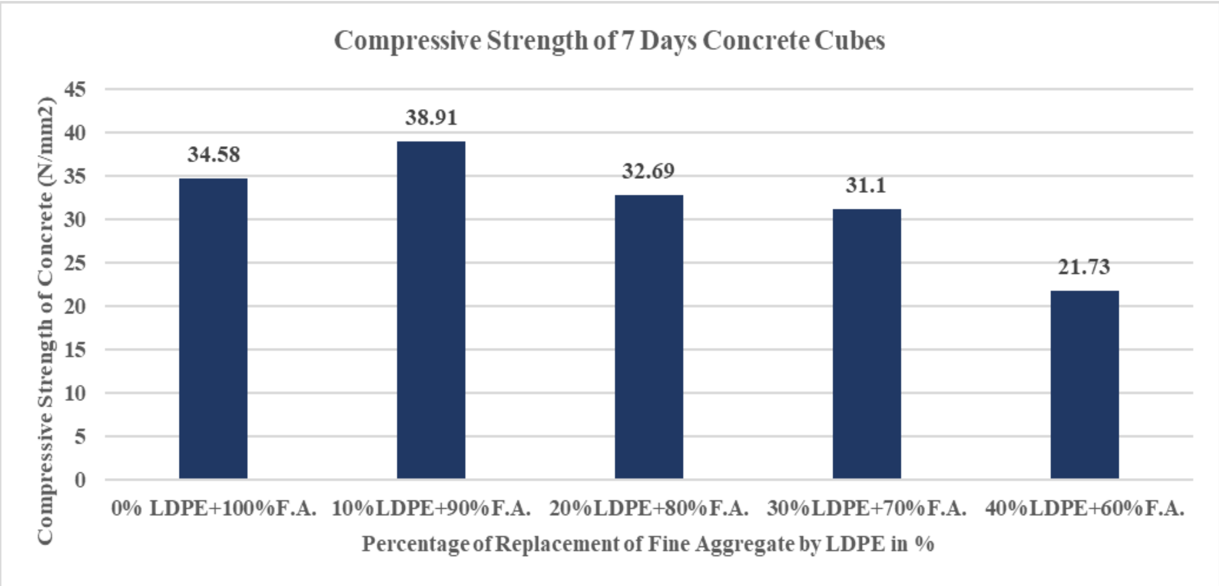

Fig. 8 Compressive Strength of cubes after 7days

At 7 Days, Compressive strength is highest in 10% replacement only compared to all its counterparts

.TABLE II
COMPRESSIVE STRENGTH TEST RESULTS AT 14 DAYS

Replacement of Fine aggregate by LDPE	Weight (kg)	Density (kg/m^3)	Average density (kg/m^3)	Failure Load (KN)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
0% LDPE+100% FA	2.46	2460	2460	385.0	38.50	38.69
	2.47	2470		386.7	38.67	
	2.45	2450		389.2	38.92	
10 % LDPE+90% FA	2.34	2340	2303.3	402.1	40.21	40.17
	2.33	2330		401.2	40.12	
	2.34	2340		401.9	40.19	
20% LDPE+80% FA	2.23	2230	2226.6	352.3	35.23	35.54
	2.22	2220		354.6	35.46	
	2.23	2230		359.5	35.95	
30% LDPE+70% FA	2.10	2100	2133.3	325.4	32.54	32.45
	2.14	2140		319.1	31.91	
	2.16	2160		329.3	32.93	
40% LDPE+60% FA	2.01	2010	2003.3	239.8	23.98	23.70
	1.99	1990		236.9	23.69	
	2.01	2010		234.4	23.44	

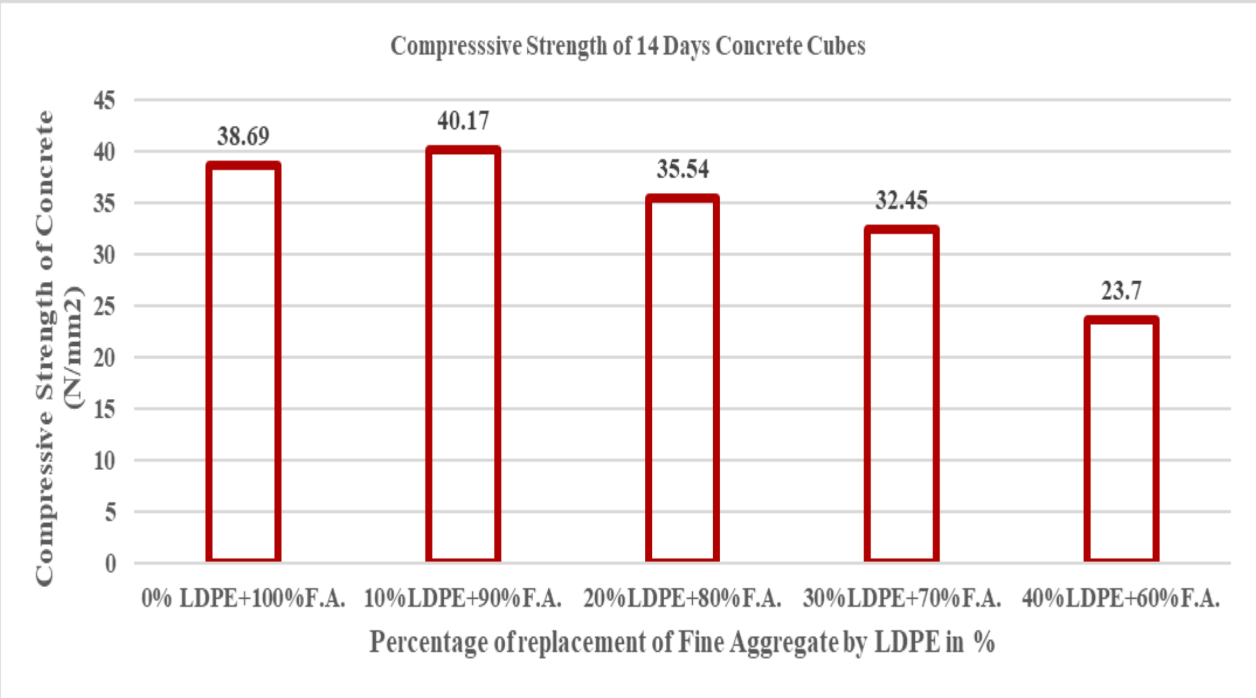

Fig. 9 Compressive Strength of cubes after 14 days

At 14 Days, Compressive strength is highest in 10% replacement only compared to all its counterparts.

TABLE III

COMPRESSIVE STRENGTH TEST RESULTS AT 28 DAYS

Replacement of Fine aggregate by LDPE	Weight (kg)	Density (kg/m^3)	Average density (kg/m^3)	Failure Load (KN)	Compressive strength (N/mm^2)	Average compressive strength (N/mm^2)
	2.46	2460		435.3	43.53	
0% LDPE+100% FA	2.44	2440	2450	435.4	43.54	
	2.45	2450		434.9	43.49	43.52
	2.35	2350		452.3	45.23	
10 % LDPE+90% FA	2.35	2350		451.8	45.18	
	2.33	2330	2343.33	452.5	45.25	45.22
	2.23	2230		372.3	37.23	
20% LDPE+80% FA	2.22	2220	2226.6	374.6	37.46	
	2.23	2230		373.9	37.39	37.36
	2.15	2150		352.4	35.24	
30% LDPE+70% FA	2.15	2150		353.6	35.36	
	2.13	2130	2143.33	353.9	35.39	35.33
	2.01	2010		259.8	25.98	
40% LDPE+60% FA	2.03	2030		258.7	25.87	
	2.01	2010	2016.67	258.9	25.89	25.91

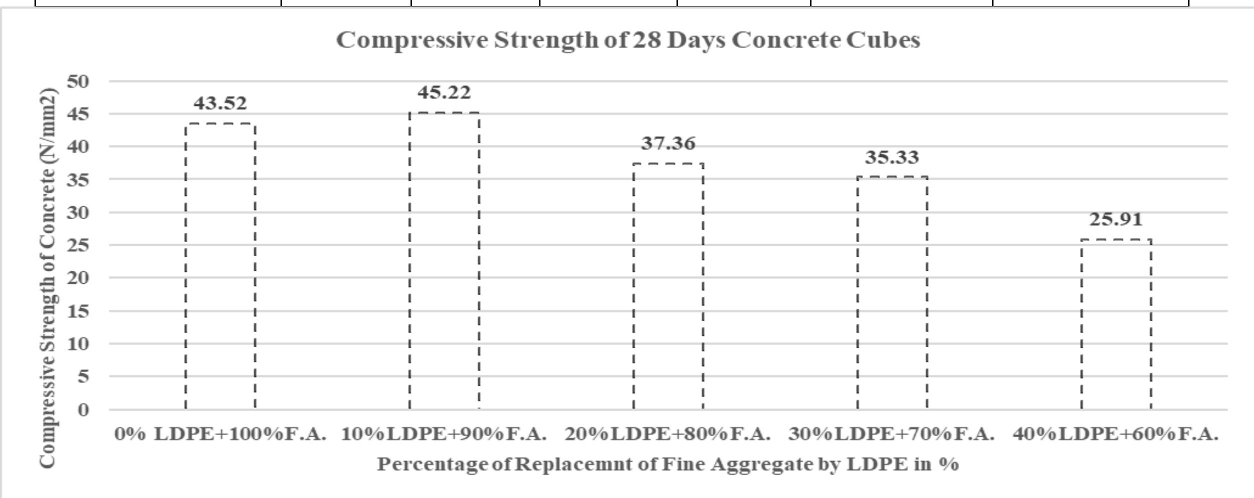

Fig. 10 Compressive Strength of cubes after 28 days

At 28 Days, Compressive strength is highest in 10% replacement only compared to all its counterparts.

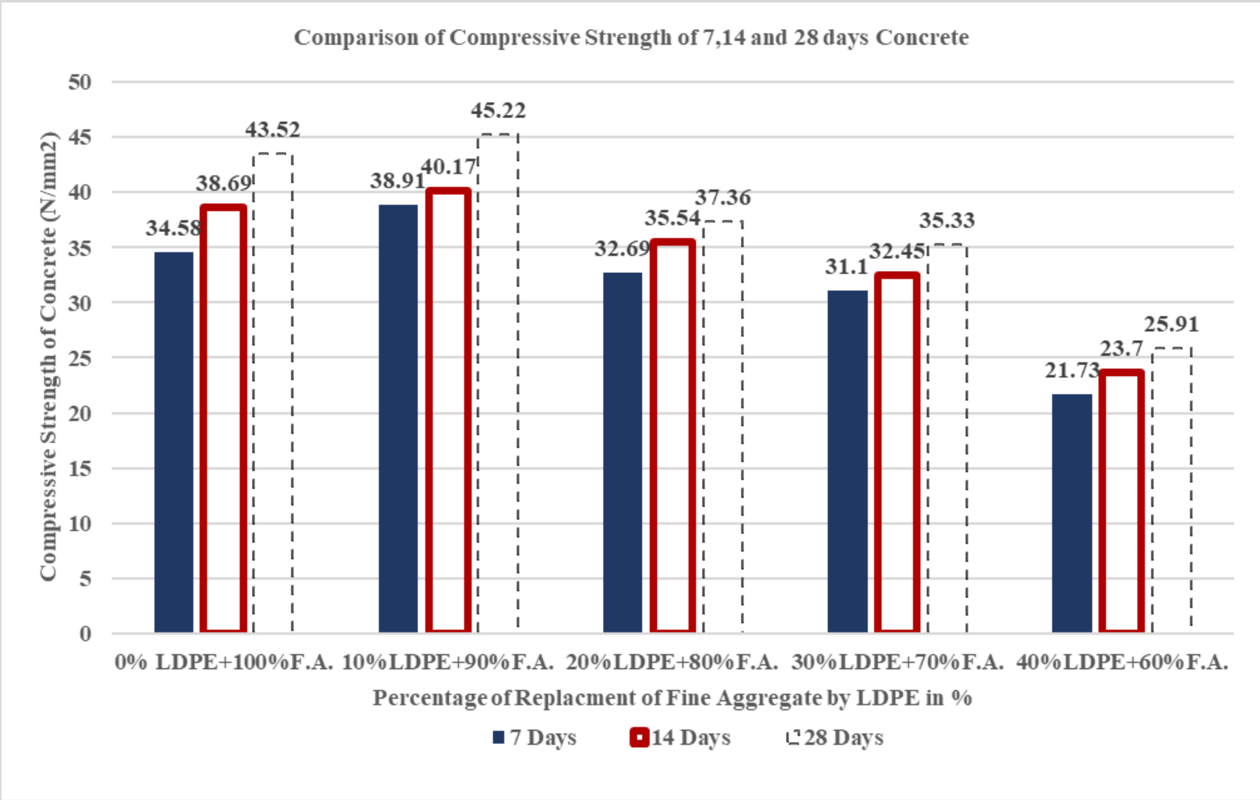

Fig. 11 Comparison of Compressive Strength of cubes after 7, 14 and 28 days

From the graphs, it has been ascertained that the compressive strength of cubes with the LDPE 10% LDPE + 90% FA increases, after that the compressive strength decreases, therefore it can be concluded that the optimum compressive strength is at 10% LDPE + 90% FA.

TABLE IV

SPLIT TENSILE STRENGTH TEST RESULTS AT 7 DAYS

Replacement of Fine aggregate by LDPE	Weight (kg)	Density (kg/m^3)	Average density (kg/m^3)	Failure Load (KN)	Split tensile strength (N/mm^2)	Average Split tensile strength (N/mm^2)
0% LDPE+100% FA	14.04	2649.0	2641.5	169.03	2.39	2.39
	13.95	2632.1		171.1	2.40	
	14.01	2643.4		168.2	2.38	
	13.80	2603.7		187.9	2.66	

10% LDPE+90% FA	13.82	2607.5	2602.5	191.0	2.68	2.66
	13.76	2596.2		186.5	2.65	
20% LDPE+80% FA	13.60	2566.0	2561.6	181.36	2.55	2.53
	13.58	2562.3		180.12	2.53	
	13.55	2556.6		179.0	2.50	
30% LDPE+70% FA	13.45	2537.7	2540.2	164.5	2.35	2.35
	13.48	2543.4		165.0	2.37	
	13.46	2539.6		163.0	2.33	
40% LDPE+60% FA	13.13	2477.4	2469.2	157.5	2.17	2.15
	13.10	2471.7		152.2	2.15	
	13.03	2458.5		150.2	2.13	

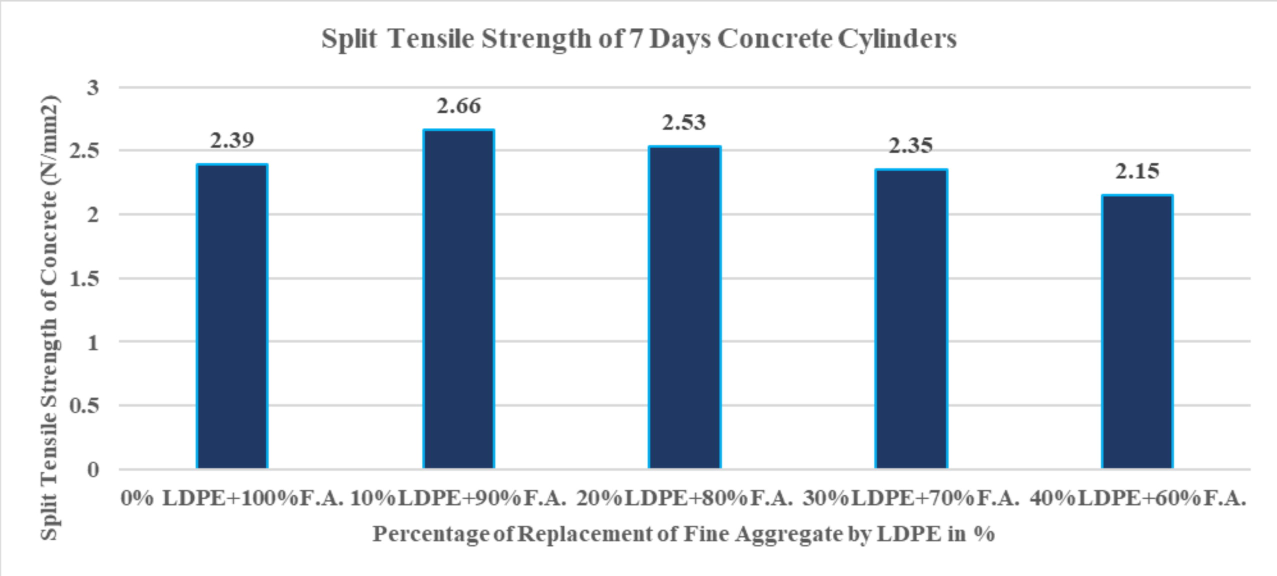

Fig. 12 Split tensile Strength of cylinder after 7 days

At 7 Days, Split Tensile strength is highest in 10% replacement only compared to all its counterparts.

TABLE V

SPLIT TENSILE STRENGTH TEST RESULTS AT 14 DAYS

Replacement of Fine aggregate by LDPE	Weight (kg)	Density (kg/m^3)	Average density (kg/m^3)	Failure Load (KN)	Split tensile strength (N/mm^2)	Average Split tensile strength (N/mm^2)
0% LDPE+100% FA	13.95	2632.1	2641.5	259.3	3.67	3.68
	14.01	2643.4		260.12	3.68	
	14.04	2649.0		261.2	3.69	
10 % LDPE+90% FA	13.76	2596.2	2602.5	282.0	3.98	4.03
	13.80	2603.7		285.0	4.03	
	13.82	2607.5		289.0	4.08	

20% LDPE+80% FA	13.55	2556.6	2561.6	280.1	3.96	3.98
	13.58	2562.3		281.32	3.98	
	13.60	2566.0		283.2	4.00	
30% LDPE+70% FA	13.45	2537.7	2540.23	255.0	3.60	3.68
	13.46	2539.6		261.5	3.70	
	13.48	2543.4		265.2	3.75	
40% LDPE+60% FA	13.13	2477.4	2469.2	235.0	3.33	3.36
	13.10	2471.7		238.2	3.37	
	13.03	2458.5		239.0	3.38	

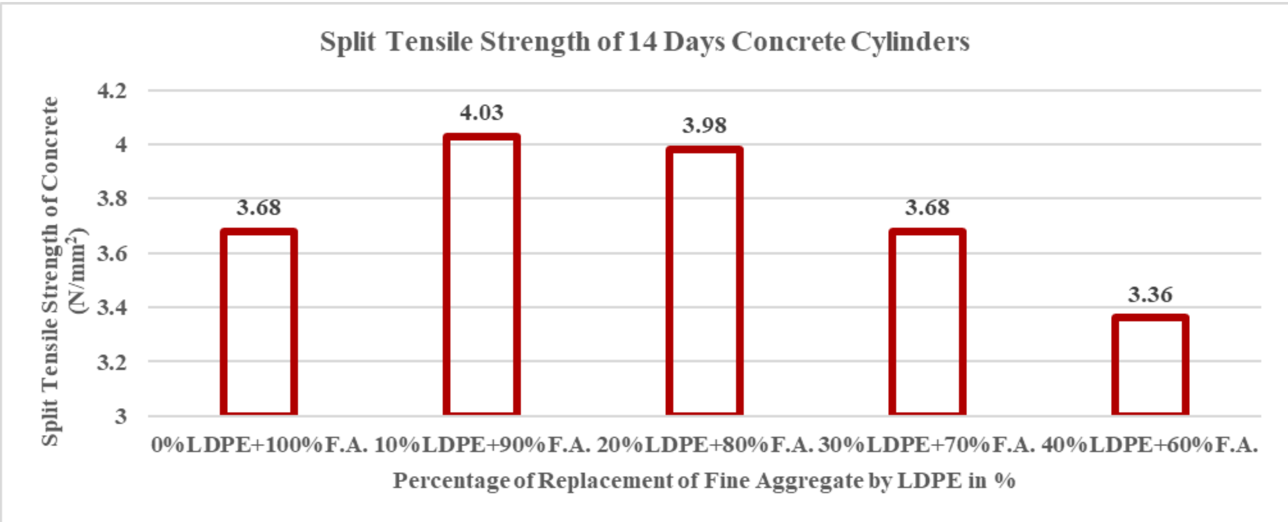

Fig. 13 Split tensile Strength of cylinder after 14 days

At 14 Days, Split Tensile strength is highest in 10% replacement only, compared to all its counterparts.

TABLE VI

SPLIT TENSILE STRENGTH TEST RESULTS AT 28 DAYS

Replacement of Fine aggregate by LDPE	Weight (kg)	Density (kg/m^3)	Average density (kg/m^3)	Failure Load (KN)	Split tensile strength (N/mm^2)	Average Split tensile strength (N/mm^2)
0% LDPE+100% FA	13.95	2632.1	2641.5	329.3	4.65	4.67
	14.01	2643.4		330.12	4.67	
	14.04	2649.0		331.2	4.68	
10% LDPE+90% FA	13.80	2603.7	2602.5	352.0	4.98	5.02
	13.82	2607.5		355.0	5.02	
	13.76	2596.2		359.0	5.08	
20% LDPE+80% FA	13.60	2566.0	2561.6	325.0	4.59	4.62
	13.58	2562.3		328.3	4.64	
	13.55	2556.6		327.5	4.63	
	13.45	2537.7		305.0	4.31	

30% LDPE+70% FA	13.48	2543.4	2540.23	308.2	4.36	4.35
	13.46	2539.6		309.0	4.37	
40% LDPE+60% FA	13.13	2477.4	2469.2	281.3	3.98	3.99
	13.10	2471.7		283.2	4.00	
	13.03	2458.5		283.6	4.01	

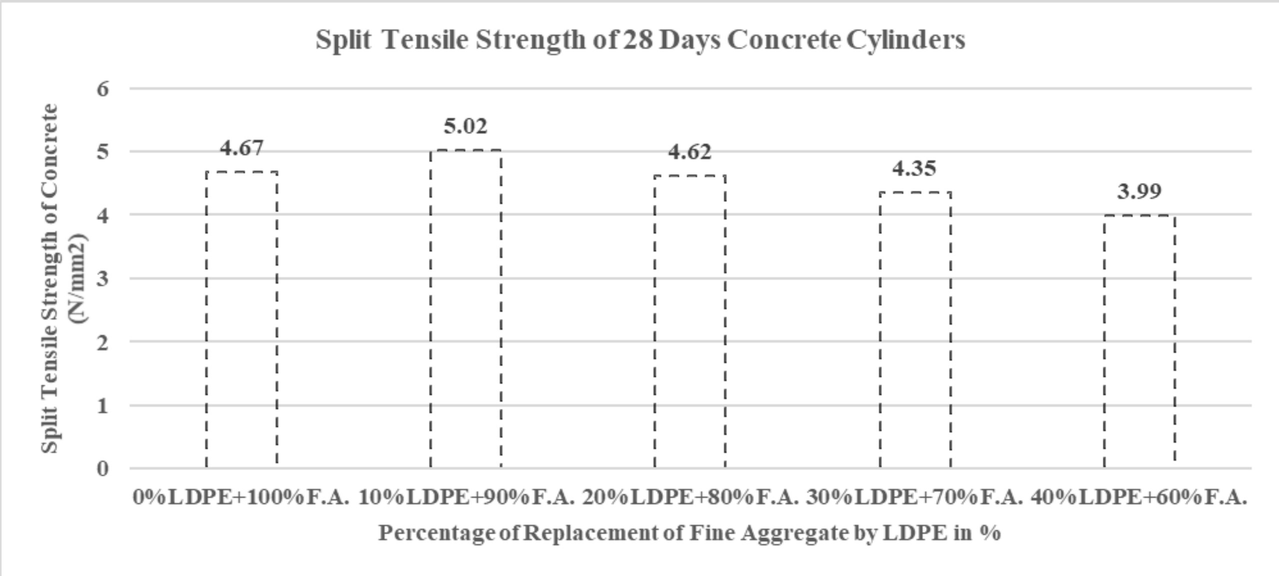

Fig. 14 Split tensile Strength of cylinder after 28 days

At 28 Days, Split Tensile strength is highest in 10% replacement only compared to all its counterparts.

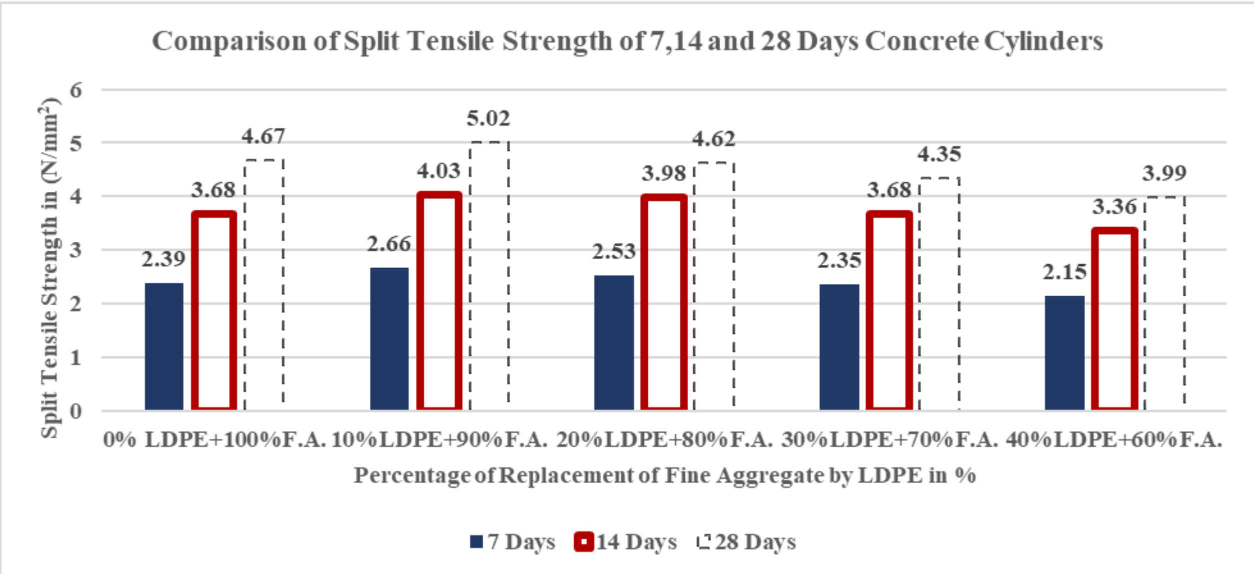

Fig. 15 Comparison for Split tensile Strength of cylinder after 7, 14 and 28 days

The graph indicates the Split Tensile Strength of cylinders after 7, 14 and 28 days. It had been ascertained that, the Split Tensile Strength increased at 10% LDPE + 90% F.A. After substitution, the Split Tensile Strength start decreasing, thus it can be concluded that the Split Tensile Strength is maximum at 10% LDPE +90% FA only.

VI CONCLUSIONS

The Compressive strength is increased by 3.91%, 3.83% and 12.52%, when replaced fine aggregate by 10% LDPE than compared with 100% fine aggregate for 28,14 and 7 Days. The split tensile strength is increased by 7.49% , 9.51% and 11.30% when replaced fine aggregate by 10% LDPE than compared with 100% fine aggregate for 28,14 and 7 Days. In both tests, the values start decreasing when there is a replacement of fine aggregate beyond 10%.

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