Experimental Investigation on Light Weight Concrete by Replacement of Coarse Aggregate using Styrofoam with Adding Flyash

Rajendiran M[1] Dinesh Kumar A[2] Kanmani Prabhu C[3] Richard S J[4] Surendar S[5]
[1]Assistant Professor [2,3,4,5]Student
[1,2,3,4,5]Department of Civil Engineering
[1,2,3,4,5]Loyola Institute of Technology, Chennai, India

Abstract— This study deals about replacement cement and coarse aggregate by Styrofoam (50%) and fly ash (10%). This can reduce the weight of the concrete effectively. The mix design is followed by IS 10262 (2009) (GUIDELINES FOR CONCRETE MIX DESIGN PROPORTIONING). The M25 concrete is used. The 53-grade cement is used. The compression test, split tensile test and flexural strength were going to be done at the interval of 7 days, 14 days and 20 days. The class C fly ash is used since it has both pozzolanic property and Cementous property.
Keywords: Flyash, Coarse Aggregate, Styrofoam

I. INTRODUCTION

Concreate is the most widely used construction material in the world. High strength is novel construction material with improved properties like higher strength, higher constructability, etc., than conventional concrete. But generally concrete is considered as a brittle material, primarily because on its low tensile strength and low tensile strain capacity. Based on the experiments as well theoretical evidence available, it can be conducted that flows low tensile strength of concrete is due to internal flaws and micro cracks present in the concrete. The advantage of using concrete include high compressive strength, good fire resistance, high water resistance, low maintenance, and longer service life. The disadvantages of using concrete include the poor tensile strength of the concrete is measured by the use of reinforcing bars. So the primarily resists compressive stresses and rebar's resist tensile and shear stresses. The longitudinal rebar in the beam resist flexural stresses whereas the stirrups resist shear stresses. In the column, the vertical bars resist compression and buckling stresses.

II. METHODOLOGY

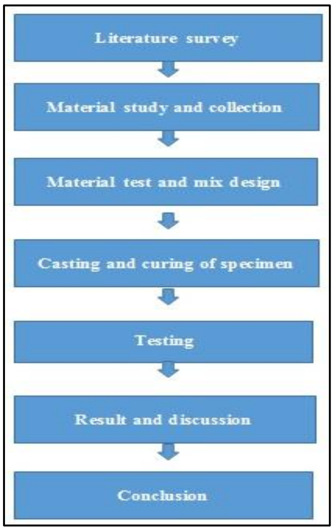

Fig. 1: Methodology

III. PRELIMINARY TESTS

A. *Sieve Analysis: Fine Aggregate*

Weight sample =3kg

Fine modulus of sand = $\frac{\text{Total \% of Cumulative}}{100}$

$= \frac{309.96}{100}$

Fineness modulus of sand = 3.099

Sand conforming to zone II as specified in as specified in IS 383-1970

SI NO	IS Sieve (mm)	Weight retained (kg)	Cumulative weight retained	Cumulative percentage weight retained	Cumulative percentage passing
1	4.75	0.040	40	4	96
2	2.36	0.034	74	7.4	92.6
3	1.18	0.203	277.1	27.71	72.29
4	0.6	0.365	642.5	64.25	35.75
5	0.3	0.248	890.6	89.06	10.94
6	0.15	0.088	978.6	97.86	2.14
7	0.075	0.019	997.6	99.76	0.24
8	Pan	0.002	1000	100	0
					∑=309.96

Table 1: Sieve analysis fine aggregate

B. *Specific Gravity of Fine Aggregate*

Description	Weights	
	Trail 1	Trail 2
Weight of the pycnometer (W1)	645	645
Weight of the pycnometer + Fine aggregate(W2)	845	845
Weight of the pycnometer + Fine aggregate + water (W3)	1627	1630
Weight of the pycnometer + water (w4)	1522	1522

Table 2: Specific gravity of fine aggregate

Specific gravity of fine aggregate = (2.35+2.35)/2 = 2.35

C. *Sieve analysis of coarse aggregate*

Weight of sample = 5kg

SI no	IS sieve (mm)	Weight retained (kg)	Cumulative weight retained	Cumulative percentage weight retained	Cumulative percentage retained of passing
1	20	2.604	2.604	52.08	47.92
2	16	0.861	3.465	69.3	30.70
3	12.5	0.943	4.408	88.16	11.84
4	10	0.419	4.827	96.54	3.46

5	4.75	0.0095	4.922	98.4	1.56
6	2.36	0.073	4.995	99.9	0.10
7	0.005	Pan	0.005	100	0

Table 3: Sieve analysis coarse aggregate

Fine modulus of Coarse aggregate= $\frac{\text{Total \% of Cumulative}}{100}$

$= \frac{604.42}{100}$

Nominal size of coarse aggregate = 20 mm

D. Specific Gravity of Coarse Aggregate

Description	Weights(g)	
	Trail 1	Trail 2
Weight of the (w1)	645	645
Weight of the pycnometer + coarse aggregate + water (w3)	845	845
Weight of the pycnometer coarse aggregate + water (w3)	1657	1657
weight of the pycnometer + water(w4)	1532	1532

Table 4: Specific gravity of coarse aggregate

1) Specific gravity of coarse aggregate

$= \frac{w2-w1}{(w2-w1)-(w3-w4)}$

= 2.941

2) Specific gravity of coarse aggregate

$= \frac{w2-w1}{(w2-w1)-(w3-w4)}$

=2.94

E. Specific Gravity of Coarse Styrofoam

Description	Weights(g)	
	Trail 1	Trail 2
Weight of the (w1)	645	645
Weight of the pycnometer + Styrofoam aggregate (w2)	695	845
Weight of the pycnometer styrofoam + water (w3)	1459	1459
weight of the pycnometer + water(w4)	1532	1532

Table 5: Specific gravity of coarse styrofoam

1) Specific gravity of coarse aggregate

$= \frac{w2-w1}{(w2-w1)-(w3-w4)}$ = 2.17

2) Specific gravity of coarse aggregate

$= \frac{w2-w1}{(w2-w1)-(w3-w4)}$ =2.171

3) Specific gravity of Styrofoam

= (2.17+2.171)/2 = 2.17

IV. MIX DESIGN

W\C ratio = 4.5
C: F.A: C.A = 425: 552.5: 1020
Mix ratio 1: 1.3: 2.4

Fig. 2: Flexural test

V. RESULTS AND DISCUSSION

A. Slump Value:

1) Slump Test for Conventional Concrete

SL NO	W/C RATIO IN	SLUMP VALUE IN MM
1	0.40	0
2	0.44	27
3	0.48	48
4	0.52	53
5	0.56	78
6	0.6	92

Table 6: Slump value

2) Slump Test for Specimen 1

S.NO	W/C RATIO IN	SLUMP VALUE IN MM
1	0.40	0
2	0.44	23
3	0.48	49
4	0.52	77
5	0.56	103

Table 7: Slump test for specimen 1

3) Slump Test for Specimen 2

S.No	W/C RATIO IN	SLUMP VALUE IN MM
1	0.40	0
2	0.44	26
3	0.48	53
4	0.52	78
5	0.56	96

Table 8: Slump test for specimen 2

B. *Compressive strength*

1) *Conventional Concrete*

SLNO	CASTING	TESTING	DAYS OF CURING	COMP STRENGTH IN N/mm^2	AVG.COMP IN N/mm^2
1	18/2/2019	4/3/2019	14	21.56	21.6
2	18/2/2019	4/3/2019	14	22.12	
3	18/2/2019	4/3/2019	14	21.4	
4	18/2/2019	18/3/2019	28	25.25	25.18
5	18/2/2019	18/3/2019	28	25.13	
6	18/2/2019	18/3/2019	28	25.17	

Table 9: Compressive strength of conventional concrete 1

2) *SPECIMEN 1*

SLNO	CASTING	TESTING	DAYS OF CURING	COMP STRENGTH IN N/mm^2	AVG.COMP IN N/mm^2
1	19/2/2019	5/3/2019	14	24.4	24.38
2	19/2/2019	5/3/2019	14	23.62	
3	19/2/2019	5/3/2019	14	24.1	
4	19/2/2019	19/3/2019	28	24.7	25.4
5	19/2/2019	19/3/2019	28	25.3	
6	19/2/2019	19/3/2019	28	24.9	

Table 10: Compressive strength of CC specimen 2

3) *SPECIMEN 2*

SLNO	CASTING	TESTING	DAYS OF CURING	COMP STRENGTH IN N/mm^2	AVG.COMP IN N/mm^2
1	20/2/2019	6/3/2019	14	23.9	24.11
2	20/2/2019	6/3/2019	14	23.6	
3	20/2/2019	6/3/2019	14	24.11	
4	20/2/2019	20/3/2019	28	26.9	27.21
5	20/2/2019	20/3/2019	28	25.9	
6	20/2/2019	20/3/2019	28	27.1	

Table 11: Compressive strength of CC specimen 3

C. *Tensile Strength*

1) *Conventional Concrete*

SLNO	CASTING	TESTING	DAYS OF CURING	TENSILE STRENGTH IN N/MM	AVG.COMP IN N/mm^2
1	18/2/2019	4/3/2019	14	5.1	5.27
2	18/2/2019	4/3/2019	14	5.32	
3	18/2/2019	4/3/2019	14	5.24	
4	18/2/2019	18/3/2019	28	6.21	6.46
5	18/2/2019	18/3/2019	28	5.96	
6	18/2/2019	18/3/2019	28	6.43	

Table 12: Tensile strength of conventional concrete 1

2) *SPECIMEN 2*

SL 0NO	CASTING	TESTING	DAYS OF CURING	TENSILE STRENGTH IN N/MM	AVG.COMP IN N/MM
1	19/2/2019	5/3/2019	14	6.61	6.43
2	19/2/2019	5/3/2019	14	5.996	
3	19/2/2019	5/3/2019	14	6.34	
4	19/2/2019	19/3/2019	28	8.1	8.025
5	19/2/2019	19/3/2019	28	7.86	
6	19/2/2019	19/3/2019	28	7.99	

Table 13: Tensile strength of conventional concrete 2

3) *SPEIMEN 3*

SL 0NO	CASTING	TESTING	DAYS OF CURING	TENSILE STRENGTH IN N/MM	AVG.COMP IN N/MM
1	20/2/2019	6/3/2019	14	9.52	9.75
2	20/2/2019	6/3/2019	14	9..65	
3	20/2/2019	6/3/2019	14	9.72	
4	20/2/2019	20/3/2019	28	2.4	2.15
5	20/2/2019	20/3/2019	28	2.15	
6	20/2/2019	20/3/2019	28	1.765	

Table 14: Tensile strength of conventional concrete 3

VI. DISCUSSION

The graph shows the variation of compressive strength of concrete cubes and tensile strength of concrete cylinders for cylinder for 21 and 28 curing days from the date of cast specimen. From this compressive strength and tensile strength increased gradually up to replacement of cement by 10 % fly ash and coarse aggregate by 50 % to 100 %. The compressive strength achieved by replacing the coarse aggregate by Styrofoam.

VII. CONCLUSION

After the entire test been done to determine the strength development of Styrofoam.

Styrofoam, the following conclusions can be drawn from the investigation;

1) The highest compressive strength for Styrofoam series obtained by series 3 that using 10 square mm Styrofoam as coarse aggregate and 10% additions of PFA. By using bigger Styrofoam size and pozzolans will produces denser and stronger concrete. However, the Styrofoam concrete exhibits lower strength at any curing period compared to control concrete.
2) Only Styrofoam series using 20mm without addition of fly ash is not suitable to applied as structural light weight concrete as indicated. Other series produces in the range of 24 – 29 MPa at 28 days. Which is beyond the minimum requirement for structural light weight application, therefore these series are suitable for structural use.
3) The long-term behavior of Styrofoam concrete is about similar to control concrete in any curing period

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