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STUDY OF STRENGTH AND DURABILITY PARAMETERS OF CONCRETE MADE USING RECYLED AGGREGATES

N.THIRUPATHI*1 D.THRIMURTHI NAIK*2
*1Post Graduate Student, Department of Civil Engineering INDIRA INSTITUTE OF TECHNOLOGY AND SCIENCE
2Asst. Professor, Department of Civil Engineering, INDIRA INSTITUTE OF TECHNOLOGY AND SCIENCE

ABSTRACT

In this study, the fine and coarse aggregates were completely replaced by fly ash aggregates in fly ash concrete. A mix design was done for M40 grade of concrete by IS method. Ordinary Portland cement of 43 Grade was selected and fly ash aggregates were prepared by mixing fly ash with cement and water. The properties of fly ash fine aggregates and fly ash coarse aggregates were studied. The aggregate crushing value and aggregate impact value of fly ash coarse aggregates were also studied. The fly ash aggregates proportions of 0% , 10%, 20% , 30 % , 40% , 50% by aggregates weight were tried with a suitable water cement ratio 0.45 to get the fly ash aggregates. The concrete cubes, cylinders and beams were cast with the fly ash aggregates obtained from the above six cement fly ash proportions. Then the compressive strength, split tensile strength and flexural strength and durability were tested and compared with control concrete. This paper briefly presents the compressive strength development of fly ash aggregate concrete at different ages. The split tensile strength and flexural strength of all the concrete mix were also investigated at different days of curing.

Keywords: Fly ash aggregates (FAA), Compressive Strength, Split tensile strength, Flexural strength, etc.

INTRODUCTION

Numerous scientists have been done in the region of fly fiery remains use before. It for the most part focused on supplanting of bond with fly slag however creation of counterfeit totals with fly cinder helps in using substantial volume of fly fiery remains in concrete. In the present situation the world is quite inspired by this part as of late because of this expansive scale usage which additionally diminishes ecological contamination and lessening of common assets. The present trial examination pointed in contemplating workability, quality properties of M40 concrete made with manufactured fly slag totals as supplanting of coarse totals with expansion of super plasticizer.

The natural effects of squashed stone total, extraction are of expanding worry in many parts of the nation. The effects incorporate loss of woodlands, clamor, clean, impacting vibrations and contamination risks impromptu abuse of rocks may prompt avalanches of frail and soak slope inclines. Presently days because of industrialization there is a shortage of power thought India. In India having 85 warm power plants are there for age of power. In every warm plant because of age of power 85 million tones of fly fiery remains coming as leftover per annum. Significant test is finished utilization of fly powder as a total in a development industry. Consequently fly powder can be utilized as a part of making simulated light weight coarse totals. The totals so arranged are known as Fly fiery debris totals.

Standard Portland Cement (OPC) is a result of four key mineralogical stages. These stages are Tricalcium Silicate-C3S (3CaO.SiO2), Dicalcium Silicate - C2S (2CaO.SiO2), Tricalcium Aluminate- C3A (3CaO.Al2 O3) and Tetracalcium alumino-ferrite - C4AF(4CaO. Al2O3 Fe2O3). The setting and solidifying of the OPC happens because of response between these key mixes and water.The reaction between these compounds and water are shown as under:

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2C3S + 6H ⟶ C3S2H3+3CH

Tri calcium silicate water C-S-H gel Calcium hydroxide

2C2S+ 4H ⟶ C3 S2H3 + CH

Di calcium silicate water C-S-H gel Calcium hydroxide

The hydration poles from C3S and C2S are comparative however amount of calcium hydroxide (lime) discharged is higher in C 3S when contrasted with C2S. The response of C3 A with water happens in nearness of sulfate particles provided by disintegration of gypsum exhibit in OPC. This response is quick and is appeared as under:

C3A + 3(CSH 2)+ 26H ⟶ C3A(CS) 3H32

Tri calcium Aluminate gypsum water ettringite

C3A + CSH2 + 10H ⟶ C3ACSH12

Mono sulpho aluminate hydrate.

.MATERIAL

CEMENT: Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most important types of cement are used as a component in the production of mortar in masonry, and of concrete- which is a combination of cement and an aggregate to form a strong building material.

OPC 53 GRADE CEMENT

COARSE AGGREGATE: Crushed stone aggregate of 20mm size is brought from nearby quarry. Aggregates of size more than 20mm size are separated by sieving. Tests are carried in order to find out the Specific gravity = 2.98 Fineness modulus = 7.5.

FINE AGGREGATE: Locally available fresh sand, free from organic matter is used. The result of sieve analysis confirms it to Zone-II (according to IS: 383-1970).The tests conducted and results plotted below. Specific gravity = 2.3, Fineness modulus = 3.06.

FLY ASH AGGREGATES : The coveted grain measure dispersion of a fake lightweight total is either squashed or by methods for agglomeration process. The pelletization procedure is utilized to make lightweight coarse total; a portion of the parameters should be considered for the effectiveness of the creation of pellet, for example, speed of insurgency of pelletizer circle, dampness substance and edge of pelletizer plate and span of pelletization The diverse sorts of pelletizer machine were utilized to make the pellet, for example, plate or container sort, drum sort, cone sort and blender sort. With circle sort pelletizer the pellet measure conveyance is less demanding to control than drum sort pelletizer. With blender sort pelletizer, the little grains are shaped at first and are in this manner expanded in molecule measure by plate sort pelletization The circle pelletizer measure is 570 mm breadth and side profundity of the plate as 250 mm, it is settled in an adaptable edge with changing the edge of the circle as 35 to 55° and to control for the turn plate in vertically way should shifting velocity as 35 to 55 rpm.

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WATER: Generally potable water should be used. This is to ensure that the water is reasonable free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc

MIX DESIGN AND CALCULATIONS

Mix Design of M40 Grade Concrete

Step 1: Determining the Target Strength for Mix Proportioning

Fck = fck + 1.65 x S

Where, Fck = Target average compressive strength at 28 days Fck = Characteristic compressive strength at 28 days

S = Assumed standard deviation in N/mm2 = 5 (as per table -1 of IS 10262- 2009)

= 40 + 1.65 x 5.0 = 48.25 N/mm^2

We are targeting a slump of 100mm, we need to increase water content by 3% for every 25mm above 50 mm i.e. increase 6% for 100mm slump I.e. Estimated water content for 100 Slump = 186+ (6/100) X 186 = 197litres

Water content = 197 liters.

STEP 4 : Calculation of Cement Content Water-Cement Ratio = 0.45 Water content from Step – 3 i.e. 197 liters

Cement Content

= Water content / "w-c ratio" = (197/0.45) =437.77kgs say 438 kgs From Table 5 of IS 456,

Minimum cement Content for moderate exposure condition = 360 kg/m3 438kg/m3 > 300 kg/m3, hence, OK

As per clause 8.2.4.2 of IS: 456

Maximum cement content = 450 kg/m3, hence ok too.

STEP 5: Proportion of Volume of Coarse Aggregate and Fine aggregate Content

From Table 3 of IS 10262- 2009, Volume of coarse aggregate corresponding to 20 mm size and fine aggregate (Zone I) = 0.60

STEP 6: Estimation of Concrete Mix Calculations

The mix calculations per unit volume of concrete shall be as follows:

1. Volume of concrete = 1 m3

2. Volume of cement = (Mass of cement / Specific gravity of cement) x (1/1000)

   = (438/3.15) x (1/1000) = 0.139 m3

3. Volume of water = (Mass of water / Specific gravity of water) x (1/1000)

   = (197/1) x (1/1000) = 0.197 m3

4. Total Volume of Aggregates = 1- (b+c) =1- (0.139+0.197) = 0.664m3

5. Mass of coarse aggregates = d X Volume of Coarse Aggregate X Specific Gravity of Coarse Aggregate X 1000

   = 0.664 X 0.60 X 2.80 X 1000

   = 1115.52 kgs/m^3 say 1116 kgs/m^3

6. Mass of fine aggregates

= d X Volume of Fine Aggregate X Specific Gravity of

Sl.no	Test	Results	IS code used	Acceptable limit
1	Specific gravity of cement	3.160	IS:2386:1963	3 to 3.2
2	Standard consistency of cement	6mm at 34% w/c	IS:4031:1996	w/c ratio 28%-35%
3	Initial and final setting time	45 mins and 10 hours	IS:4031:1988	Minimum 30mins and should not more than 10 hours
4	Fineness of cement	3.00%	IS:4031:1988	<10%

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fine Aggregate X 1000 = 0.664 X 0.40 X 2.70 X 1000 = 717.12 kgs/m^3 say 718 kg/m^3

STEP-7: Concrete Mix proportions for Trial Number 1

Cement = 438 kg/m3

Water = 197 kg/m3

Fine aggregates = 718 kg/m3

Coarse aggregate = 1116kg/m3 Water-cement ratio = 0.45

Final trial mix for M40 grade concrete is 1:1.64:2.55 at

GRADES OF CONCRETE	CEMENT(OPC53) (kgs/m^3)	Fly ash aggregates	FINE AGGREGATES (kg/m^3)	COARSE AGGREGATES (kg/m^3)	WATER CONTENT (Liters/m)
M40	320 kgs	203.76	499	612	145
Addition of extra 10%	340 kgs	224.136	548.9	673.2	159.5

w/c of 0.45

DESIGN AND CALCULATIONS

MATERIAL PROPERTIES:

CEMENT:

COARSE AGGREGATES :

Sl.no	Test	Results	Is code used	Acceptable limit
1	Fineness modulus	6.5	IS:2386:1963	6.0 to 8.0mm
2	Specific gravity	2.90	IS:2386:1963	2 to 3.1mm
3	Porosity	46.83%	IS:2386:1963	Not greater than 100%
4	Voids ratio	0.8855	IS:2386:1963	Any value
5	Bulk density	1.50g/cc	IS:2386:1963	-
6	Aggregate impact value	37.5	IS:2386:1963	Less than 45%
7	Aggregate crushing value	26.6%	IS:2386:1963	Less than 45%

Sl.no	Test	Result	Is code used	Acceptable limits
1	Fineness modulus	4.305	IS:2386:1963	Not more than 3.2 mm
2	Specific gravity	2.43	IS:2386:1963	2.0 to 3.1
3	Porosity	36.6%	IS:2386:1963	Not greater than 100%
4	Voids ratio	0.577	IS:2386:1963	Any value
5	Bulk density	1.5424	IS:2386:1963	-
6	Bulking of sand	3.0%	IS:2386:1963	Less than 10%

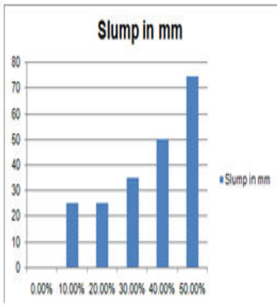
FINE AGGREGATES:

CONCRETE TESTS:

TESTS ON FRESH CONCRETE:

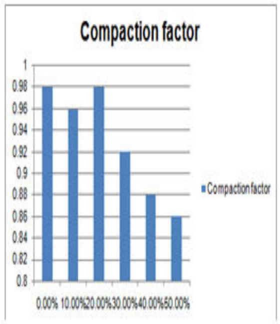
SLUMP CONE TEST

S.no	%Replacement of fly ash aggregates	Slump in mm
1	0.00%	0
2	10.00%	25
3	20.00%	25
4	30.00%	35
5	40.00%	50
6	50.00%	75



COMPACTION FACTOR TEST

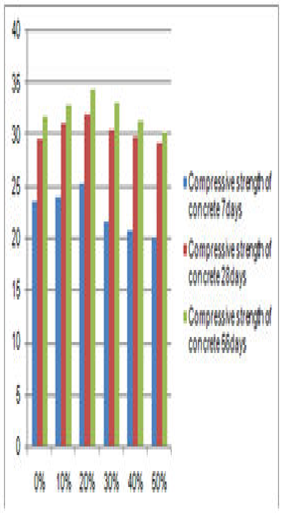
S.no	%Replacement of fly ash aggregates	Compaction factor
1	00.00%	0.98
2	10.00%	0.96
3	20.00%	0.98
4	30.00%	0.92
5	40.00%	0.88
6	50.00%	0.86



TESTS ON HARDENED CONCRETE:

COMPRESSIVE STRENGTH

S.no	%Replacement of fly ash aggregates	Compressive strength of concrete		
		7days	28days	56days
1	00.00	23.49	29.55	31.73
2	10.00	24.01	31.19	32.84
3	20.00	25.34	32.016	34.31
4	30.00	21.72	30.47	33.12
5	40.00	20.66	29.84	31.31
6	50.00	20.16	29.20	30.24



SPLIT TENSILE STRENGTH OF CONCRETE:

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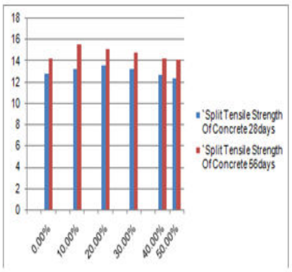
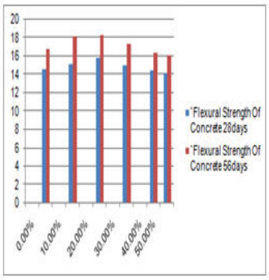
S.no	% Replacement Of fly ash aggregates	`Split Tensile Strength Of Concrete	
		28days	56days
1	00.00%	12.82	14.20
2	10.00%	13.21	15.62
3	20.00%	13.53	15.12
4	30.00%	13.23	14.82
5	40.00%	12.68	14.27
6	50.00%	12.42	14.12



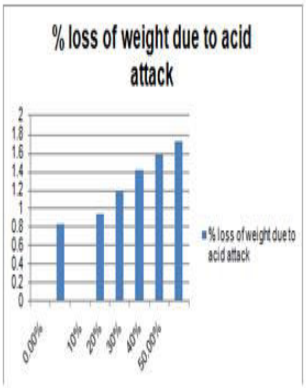
FLEXURAL STRENGTH:

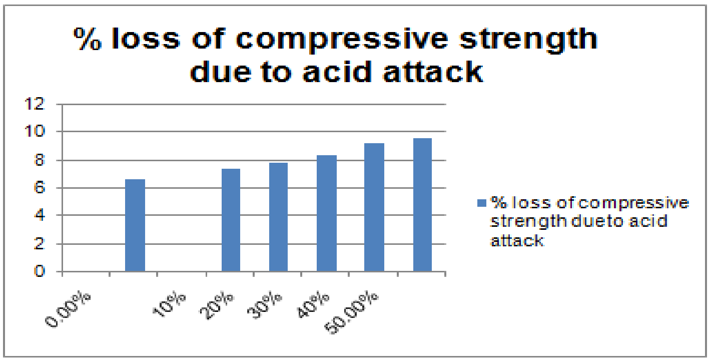
S.no	% Replacement Of fly ash aggregates	`Flexural Strength Of Concrete	
		28days	56days
1	00.00%	14.62	16.84
2	10.00%	15.24	18.20
3	20.00%	15.84	18.40
4	30.00%	15.10	17.40
5	40.00%	14.52	16.48
6	50.00%	14.24	16.20



DURABILITY ACID ATTACK

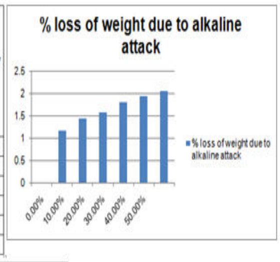
Sl.no	% replacement Of fly ash aggregates	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to acid attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	% loss of compressive strength due to acid attack
1	0.00%	2261	2242	0.840	29.55	27.60	6.60
2	10 %	2340	2318	0.940	31.19	28.88	7.40
3	20%	2351	2323	1.190	32.016	29.52	7.80
4	30%	2234	2202	1.433	30.47	27.91	8.40
5	40%	2394	2356	1.587	29.84	27.10	9.20
6	50.00%	2286	2246	1.749	29.20	26.40	9.60

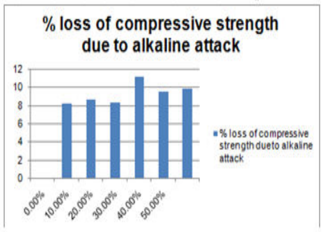




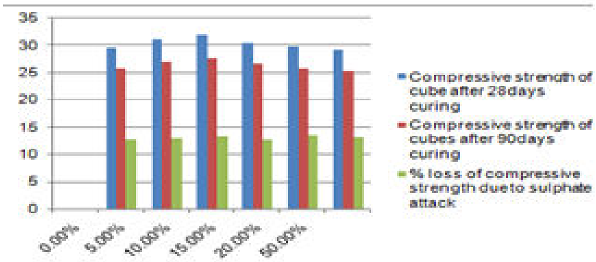
ALKALINE ATTACK:

Sl. No	% replacement fly ash aggregates	Initial weight of cube after 28days curing in grams	Final weight of cubes after 90days curing in grams	% loss of weight due to alkaline attack	Compressive strength of cube after 28days curing	Compressive strength of cubes after 90days curing	% loss of compressive strength due to alkaline attack
1	0.00%	2286	2259	1.181	29.55	27.12	8.223
2	10.00%	2340	2306	1.452	31.19	28.48	8.688
3	20.00%	2280	2244	1.578	32.016	29.32	8.42
4	30.00%	2310	2268	1.818	30.47	27.06	11.191
5	40.00%	2296	2251	1.959	29.84	26.97	9.617
6	50.00%	2324	2276	2.065	29.2	26.32	9.86





SULPHATE ATTACK TEST



CONCLUSION

From the above experimental program the following conclusions were made

- The material properties of the cement, fine aggregates and coarse aggregates are within the acceptable limits as per IS code recommendations so we will use the materials for research.
- Slump cone value for the fly ash aggregate concrete increases with increasing in the percentage of fly ash aggregate so the concrete was not workable.
- Compaction factor value of fly ash aggregate concrete decreases with

increase in the percentage of fly ash aggregate and the maximum values of compaction factor was observed at 20% of fly ash aggregate.

- The compressive strength of concrete is maximum at 20% of fly ash aggregate and is the optimum value for 7days curing, 28days curing, 56days curing,
- Split tensile strength for the cylindrical specimens is maximum at 20% of fly ash aggregate for 28days curing, 56days curing,
- The flexural strength of fly ash aggregate concrete is also maximum at 20% of fly ash aggregate for 28days curing, 56days curing,
- The percentage loss of weight and percentage loss of compressive strength is increases with in increasing the percentages in all cases in durability studies in fly ash aggregate concrete. So, the fly ash aggregate concrete is durable upto 20% replacement.

So the replacement of 20% of fly ash aggregate is generally useful for better strength values in M40 grade of concrete.

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