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STUDY ON MECHANICAL AND DURABILITY PROPERTIES OF SINTERED FLY ASH LIGHT WEIGHT AGGREGATE

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ABSTRACT

The utilization of industrial waste as a construction material is a big leap towards sustainable development. Fly ash is a waste material obtained from thermal power plants during combustion of pulverized coal. The research in relation to the use of sintered fly ash aggregate to produce structural light weight concrete is summarized in this paper. The physical and mechanical properties of the sintered fly ash aggregates were also briefed. The review of literatures shows that the specific of these aggregates was 16–46% less than that of the normal weight aggregates and possess higher water absorption. The fresh, mechanical and durability properties of the concrete produced with sintered fly ash concrete were also summarized. Sintered fly ash aggregate concrete has the 28-day compressive strength in the range of 27–74 MPa, with densities in the range of 1651–2017 kg/m3. The durability properties of the fly ash aggregate concretes indicate that the performance is satisfactory for structural applications. The results indicate that sintered fly ash aggregate concrete is one of the potential materials for the development of structural concrete.

Keywords:Sintered Flyash, Light weight aggregate, light weight concrete, structural concrete.

1. INTRODUCTION

Concrete is the most widely used man-made building material in the world, owing to its versatility and relatively low cost. The main constituent of concrete is aggregate which occupies more than 70% of the concrete mix. The increase in demand for the natural ingredients is met by replacing the building materials with the waste materials obtained from various industries as by-products. To meet the shortage of availability of natural aggregate, artificially manufactured aggregates prepared from certain industrial by-products can be used as alternatives.

Although fly ash has been used in concrete industry for cement replacement,

60% of the fly ash remains unutilized. Hence, fly ash based artificial lightweight aggregates offer potential for large scale utilization in the construction industry.

Fig 1: SFA

1.1. OBJECTIVES

- To provide an alternative for the conventionally used coarse aggregate in concrete to reduce the demand for natural ingredients.
- To effectively use the fly ash generated as a by-product from thermal power plants in the form of sintered fly ash lightweight aggregate.
- To produce the lightweight concrete by using sintered fly ash aggregate.
- To develop M30 grade of concrete.
- To study the basic fresh concrete & mechanical properties is to be compared with control concrete.

1.2. SCOPE

The main scope of the project is to find the feasibility of replacing the conventional coarse aggregate with the sintered fly ash lightweight aggregate in M30concrete. A comparative study has been done between conventional concrete and sintered fly ash aggregate concrete. The destructive tests such as compressive strength test,split tensile test and flexural strength test have been done on conventional concrete, sintered fly ash aggregate concrete. The results of the tests revealed the usefulness of sintered fly ash concrete.

2. LITERATURE REVIEW

Dr. M. VijayaSekhar Reddy et al. (2016) have conducted an experimental investigation in studying the workability, strength properties of lightweight concrete made with artificial fly ash aggregates as replacement of coarse aggregate with addition of superplasticizer. They have found that fly ash aggregates show better results comparable with natural gravel and also have found that it improves the property of concrete as fly ash is a pozzolanic material.

S.Viveka&R.Renuka (2016) has carried out the study of strength characteristics of fly ash aggregate in lightweight concrete. From the experimental study, they have found that the optimum replacement level for fine aggregates is 100% with 30% partial coarse aggregate replacement of fly ash aggregate with conventional coarse aggregate for the economical mix of concrete.

Ashok Kumar Behera et al. (2015) have studied the properties of sintered fly ash aggregate and found that its suitability as a coarse aggregate in production of concrete Masonry units, Hollow & Solid Lightweight concrete blocks as well as Structural Lightweight concretes.

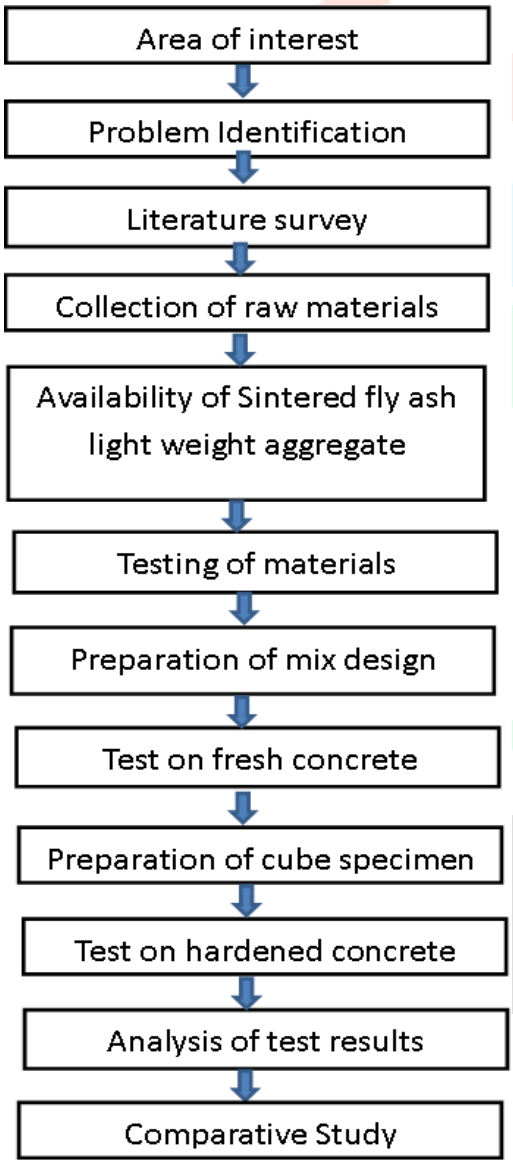

Fig 2: Flow chart

3. METHODOLOGY

The methodology for characteristic study of conventional concrete, sintered fly ash lightweight concrete and latex modified sintered fly ash lightweight concrete.

3.1. CHARACTERISTICS OF MATERIALS

The following laboratory tests were performed to investigate the characteristics of the materials such as cement, sand, gravel and sintered fly ash lightweight aggregate. The test results obtained were used for the mix design of M30 grade concrete as per IS: 20262-1999

Materials Used

- Cement
- Water
- Fine aggregate
- Coarse aggregate
- Super plasticizer
- Sintered fly ash coarse aggregate

4. TEST RESULTS AND ANALYSIS

4.1 COMPRESSIVE STRENGTH TEST FOR CONVENTIONAL CONCRETE

S.No	Day	Specimen	Weight (kg)	Load (kN)	Compressive strength (N/mm²)	Average compressive strength (N/mm²)
1	3rd	1	8.100	370	16.44	14.81
		2	8.125	300	13.33	
		3	8.142	330	14.66	
2	14th	1	8.320	580	25.77	24.58
		2	8.170	530	23.55	
		3	8.245	550	24.44	
3	28th	1	8.330	810	36	36.45
		2	8.401	820	36.44	
		3	8.410	830	36.88	

Table 1: compressive strength test results for m30 conventional concrete

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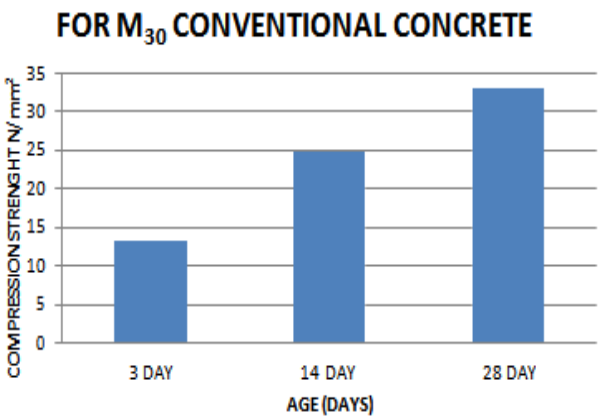

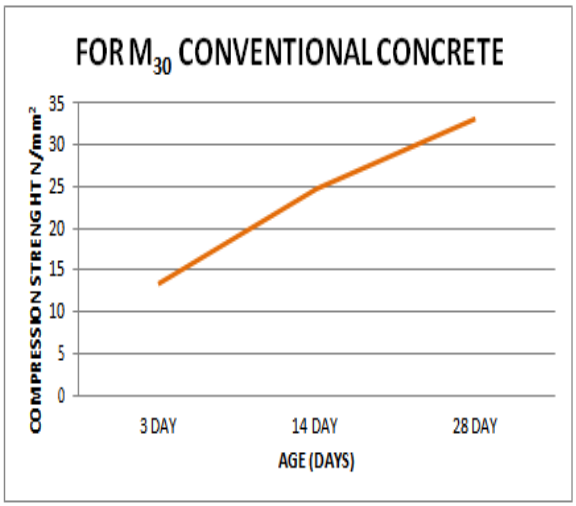

Fig 2: compression strengthfor m30 conventional concrete graph

Fig 3: compression strength testing of conventional concrete

4.2 COMPRESSIVE STRENGTH TEST FOR SFA CONCRETE

Table 2 : compressive strength test results of SFA concrete

S.No	Day	Specimen	Weight (kg)	Load (kN)	Compressive strength (N/mm2)	Average compressive strength (N/mm²)
1	3rd	1	6.49	300	13.33	13.33
		2	6.52	300	13.33	
		3	6.48	300	13.33	
2	14th	1	6.820	560	24.88	24.73
		2	6.720	550	24.44	
		3	6.750	560	24.88	
3	28th	1	6.860	740	32.88	33.10
		2	6.790	750	33.33	
		3	6.890	745	33.11	

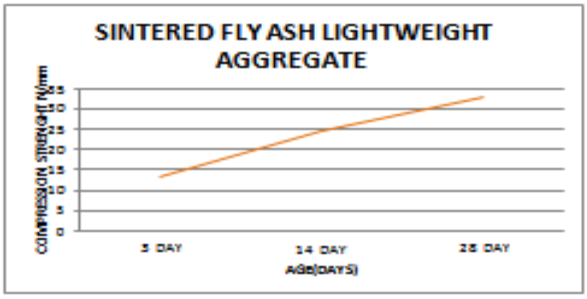

Fig 4: compression strength testing of SFA concrete

4. 3 COMPARISON

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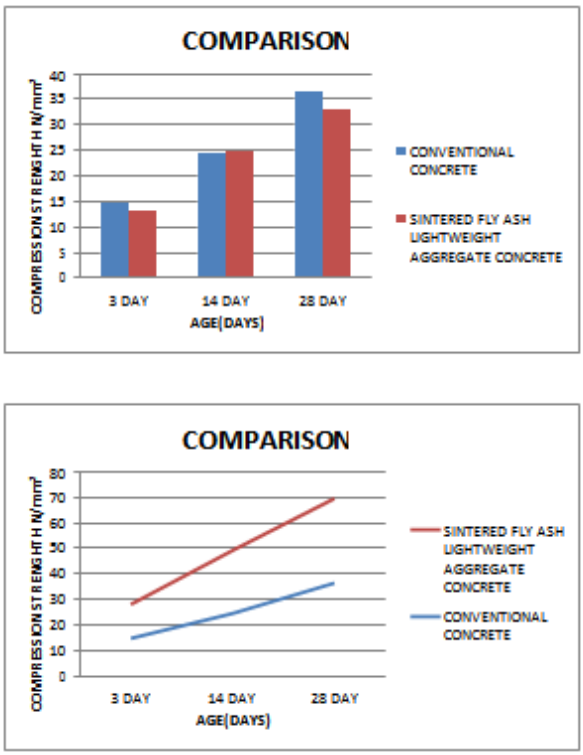

Fig 5: compression strength comparison graph

Fig 6: compression strength test of cubes comparison

5. CONCLUSION

Based on the experimental results obtain from the investigation on sinteredfly ash aggregate, the following conclusions are drawn.Material characterization results of the ingredients are presented below,The specific gravity of the cement was found to be 3.16 and it is in the range of standard specific gravity of the cement. The standard consistency test of cement has a percentage of 30% water contentfor a depth of 33-35mm from the top. The initial setting and final setting time of the ordinary Portland cement is found has 50min and 300min, which is in the range of minimum initial setting time of 30min and maximum final setting time of 600min. The fineness test for the cement obtained 5% of residue weight, which is lesser than range of 10% of ordinary Portland cement weight.

The specific gravity of fine aggregate was found to be 2.16; the range is in between 2.6 to2.8. The fineness modulus of fine aggregate is 2.85; the range of value is medium sand (2.6 to 2.9).The specific gravity of coarse aggregate was found to be2.56; the range is in between 2.4 to 3.0. The fineness modulusof coarse aggregate is determinedto be 7.722; the range of value is in between 6.5 to 8.0. The impact test value of coarse aggregate is determined has 11.2%, which is lesser than 30%, so it can be used for all structural purpose.

The specific gravity of sintered fly ash aggregate was found to be 1.95, the range is very lesser than coarse aggregate and it is because of light weight material. The fineness modulus of sintered flyash aggregate is determined to be6.98; the range of value is in between 6.5 to 8.0. The impact test value of sintered flyash aggregate is 26.85%, which is

lesser than 30%, so it can be used for all structural purpose.

The compression strength of concrete cube at 3-days, the sintered flyash aggregate concrete cube is found has 10% lesser strength than conventional concrete cube and the strength gain for 3-days is 49.36% for the conventional concrete and 44.43% for the sintered flyash aggregate concrete. The compression strength of concrete cube at 14-days, the sintered flyash aggregate concrete cube is found has 0.60% greater strength than conventional concrete cube and the strength gain for 14-days is 81.93% for the conventional concrete and 82.43% for the sintered flyash aggregate concrete. The compression strength of concrete cube at 28-days, the sintered flyash aggregate concrete cube is found has 9.190% lesser strength than conventional concrete cube and the strength gain for 28-days is 121.5% for the conventional concrete and 110.33% for the sintered flyash aggregate concrete.

The split tensile strength of concrete cylinder at 28-days, the sintered flyashaggregate concrete cylinder is found has 0.40% lesser strength than conventional concrete cylinder.

The flexural strength of concrete prism beam at 28-days, the sintered flyash aggregate concrete cylinder is found has 3.57% higher strength than conventional concrete cylinder.

After 100% replacement of coarse aggregate by SFA, the material property of SFA and mechanical testing of SFA concrete can be used as structural concrete (column, beam and slab), since the SFA material is an environmentally friendly and reduce the dependence of natural coarse aggregate and also handle the industrial flyash waste management by using it in construction reduce dumping of flyash.

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