Replacement of Coarse Aggregate with Sintered Fly Ash Aggregates for Making Low Cost Concrete

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Abstract— The present research establishes a relationship of bulged diameter with densification and hydrostatic stress in forming of sintered fly ash. In present study A mix design has been done for M25 Grade of concrete by IS method. Ordinary Portland cement of 43 Grade is selected and sintered fly ash aggregates were prepared by mixing sintered fly ash with cement and water for making low cost concrete. Which is a waste material of coal firing Thermal power plants (TPPs) and its accumulation near power plant.The sintered fly ash is obtained from Gallant group of industries. This industry is located near Sector-23, GIDA Sahjanwa city in Gorakhpur district in Uttar Pradesh state. In this paper author investigate the Compressive Strength and Flexural strength test of the concrete at different ages i.e. 3 days, 7 days, 14 days, 28 days, 56 days and 90 days. Sintered Fly Ash Aggregates is replaced 10%, 20%, 30%, 40% and 50% in the place of Corse aggregate. These theses explain the various utilization of sintered fly ash and its ordinary Portland cement and properties in concretecauses severe pollution problems. Its utilization as a raw material for cube (Brick) making will be a very usefully solution in our economical and environmental aspects.

Keywords: Sintered Fly Ash Aggregates, OPC 43 grade, concrete, sands, strengths

I. INTRODUCTION

India produces approximately more than 110 million tonnes of Coal ash annually. Coal-based thermal power plants all over the world facing serious problems of handling and disposal of the ash produced. The utilization of fly ash is about 30% as various engineering properties requirements that is for low technical applications such as in construction of fills and embankments, backfills, pavement base and sub base course. Sintered Fly ash based artificial lightweight aggregate offer potential for large-scale utilisation in the construction work. Apart from using it in concrete industry as cement replacement, fly ash usages by other related industries have been for cube (Bricks) manufacture, cellular concrete, prefabricated items and road construction. Yet about 75% of fly ash remains unutilised.

The management of coal fly ash produced by coal thermal power station is a major problem in many parts of the word. However, its generation tends to increase every year. Although some coal fly ash is used in a range of applications, particularly as a substitute for cement in concrete. Large amount remain unused and thus required disposal. At present, coal fly ash is used in civil engineering for production of cement, concrete, cube and artificial aggregate. Safe disposal of the ash without adversely affecting the environment and the large storage area required are major concerns.

A. Objective

- To find economical and environmental helpful solution for high cost of concrete.
- To use the replacement of coarse aggregate in concrete.
- Reduce the cost of concrete.
- To decrease the disposal problem of Sintered Fly Ash Aggregates.

II. MATERIALS USED

The following materials were used for preparing the test specimens

- Ordinary Portland cement
- Sintered fly ash aggregates
- Aggregates (Coarse Aggregate)
- Sand (Fine Aggregate)

III. EXPERIMENTAL PROGRAM

A. Properties of Material

The materials used in this experiment were Ordinary Portland Cement (OPC), sand as fine aggregate and sintered fly ash aggregate, Potable water was used for mixing and curing.

1) Cement

Ordinary Portland cement 43 grade in one lot was procured and stored in air light container. The cement used was fresh i.e., used within three month of manufacture .The properties of cement are determined as per the IS 8112–1989 and result are physical property was given below:

Sr. No.	Physical Properties	Test results
1.	Fineness modulus	7.10
2.	Specific Gravity	2.10
3.	Water Absorption (%)	0.15
4.	Consistency	33%
5.	Initial setting time	90 min
6.	Final Setting time	330 min

Table 1: Physical Properties of Cement

2) Fine Aggregate (Sand)

The Fine aggregate use for casting in clean river sand from rapti river and it was clean and dry. It is of size pass through 1.19 mm sieve. Sand conforming to Zone-III was used as the fine aggregate, as per I.S 383-1970. The properties of the fine aggregates are given in following Table.

Sr. No.	Physical Property	Test Result
1.	Fineness modulus	2.42
2.	Specific Gravity	2.67
3.	Bulk Density(gm/cc)	1.54-1.60
4.	Water Absorption (%)	0.74

Table 2: Physical Properties of Fine Aggregates

3) Coarse Aggregates

The coarse aggregate used was broken granite-crushed stone and it was free from clay, weeds, and any other organic matters, they are are non- porous. The water absorption capacity is less than 1%. The size of which pass through 26 mm sieve and retained on 19 mm sieve. The properties of the coarse aggregate are given in following Table 3.

Sr. No.	Physical Property	Test Result
1.	Maximum Size (mm)	20
2.	Fineness modulus	7.20
3.	Specific Gravity	2.65
4.	Bulk Density(gm/cc)	1.40-1.60
5.	Water Absorption (%)	0.16
6.	Aggregate Crushing Value (%)	15.85
7.	Aggregate Impact Value (%)	12.36
8.	Maximum dry density (kN/m^3)	14.20
9.	Aggregate abrasion value (%)	30.14

Table 3: Physical Properties of Coarse Aggregates

4) Water

Portable water was used for casting all specimens of this investigation. The quality of water was found to satisfy the requirement of IS456-200.

5) Sintered Fly Ash Aggregate

The sintered fly ash aggregate is produced by mixing materials, Then the mix is made into spherical shape and over dried at a temperature of 1100 ºC in muffle furnace. The properties of sintered fly ash aggregates are given in Table 4.

Sr. No.	Properties of Sintered Fly ash Aggregates	Values
1.	Fines modules	6.24
2.	Bulk density(gm/cc)	0.640-0.750
3.	Sizes produced(mm)	4.70-10.0
4.	Water absorption (%)	14.20
5.	Specific gravity	2.02
6.	Maximum dry density (kN/m^3)	7.21
7.	Aggregate crushing strength (%)	18.36
8.	Aggregate impact value (%)	16.12
9.	Aggregate abrasion value (%)	35.32

Table 4: Physical Properties of Sintered Fly ash Aggregates

IV. Results and Discussions

A. Compressive Strength

Compressive strength of the specimen shall be calculated by dividing the maximum compressive load taken by the specimen by its cross-sectional area. Values of compressive strength at different percentage of replacement at different age are given below

Days	0%SFA (N/mm^2)	10%SFA (N/mm^2)	20%SFA (N/mm^2)	30%SFA (N/mm^2)	40%SFA (N/mm^2)	50%SFA (N/mm^2)
3	22.35	25.25	27.52	32.30	30.12	26.24
7	25.56	28.67	32.12	34.67	32.14	28.34
14	28.18	31.98	34.14	36.52	33.25	30.42
28	30.46	33.88	36.10	38.82	34.20	31.18
56	33.87	36.12	39.24	40.66	35.16	32.00
90	36.20	37.98	41.88	43.12	36.86	33.10

Table 5: Compressive Strength of Corse aggregate with sintered fly ash aggregate

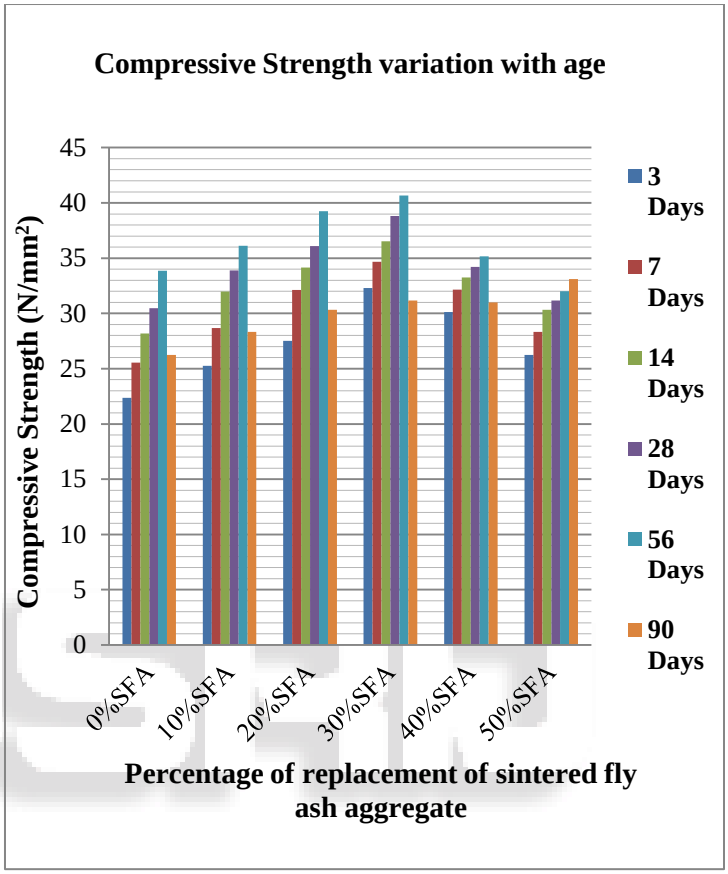

Fig 1: Compressive strength at various ages

B. Flexural Strength

For flexural test beams of 150×150×700 cubic mm size were adopted. The load was applied without shock and was increased until the specimen failed, and the maximum load applied which is on the meter to the prism during the test was recorded. The appearances of the fractured faces of concrete failure were noted. Three-point load method was used to measure the flexural strength of Sintered fly ash aggregate concrete.

Days	0%SFA (N/mm^2)	10%SFA(N/mm^2)	20% SFA (N/mm^2)	30% SFA (N/mm^2)	40% SFA (N/mm^2)	50% SFA (N/mm^2)
3	2.15	3.40	4.25	5.68	4.86	2.10
7	2.81	4.56	5.95	6.80	5.95	3.51
14	3.10	6.78	7.05	8.13	6.76	4.89
28	3.48	7.28	7.95	9.85	8.04	6.47
56	4.60	8.67	9.24	10.13	9.10	7.96
90	4.95	9.88	9.98	11.16	10.57	8.98

Table 6: Flexural strength at different ages (N/mm^2)

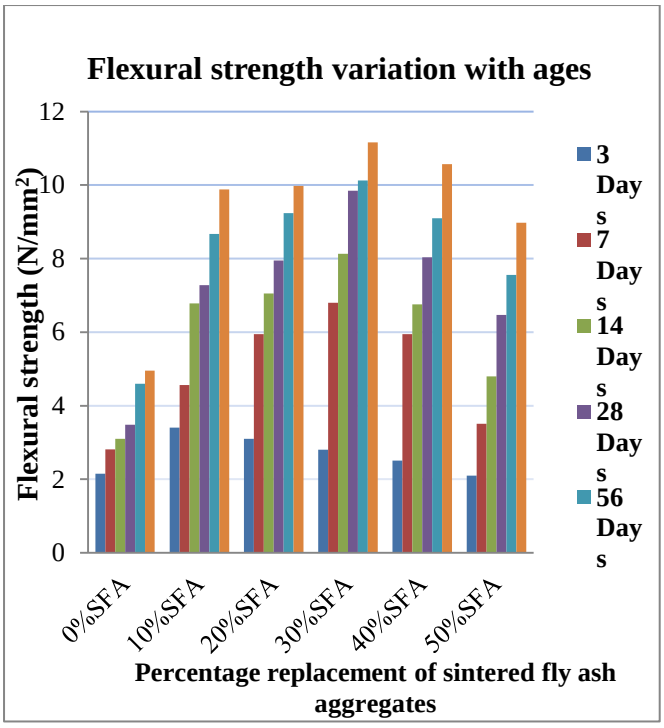

Fig. 2: Flexural strength at various ages

V. CONCLUSION

From above discussion we found that the the maximum compressive strength of 43.12N/mm^2 is found at 30% replacement of Sintered fly ash aggregate in concrete while the minimum strength of 26.24 N/mm^2 is found at 50% replacement of Sintered fly ash aggregate in concrete, At 10 % replacement, increased the value 37.98 N/mm^2 and 30% increased the value 43.12N/mm^2 the highest increased the value. The maximum flexural strength of 11.16 N/mm^2 is found at 30% replacement of Sintered fly ash aggregate in concrete, while the minimum strength of 2.10 N/mm^2 was attained at 50% replacement of Sintered fly ash aggregate in concrete. To increase the speed of construction, enhance green construction environment we can use lightweight concrete. The possibility exists for the partial replacement of coarse aggregate with Sintered fly ash aggregate to produce in thermal power plants waste materials. Sintered fly ash is compatible with the cement. Uses and applications of sintered fly ash as coarse aggregate can reduce the cost of construction Materials and it is useful in environmental protection.

REFERENCES

[1] VeronikaKalová, "Use of Ignition Layer in Production of Sintered Fly Ash Aggregate" CESB 07 PRAGUE Conference Session W1C: Materials 3.
[2] Saravanan, Sathyapriya, "Study on Sintered Fly Ash Aggregate as Columnar , Inclusions on Soft Clay", International Journal of Combined Research & Development(IJCRD).
[3] Thomas Philips, John J. Dwyer, Jr. and ZbigniewZurecki, "Controlling Properties of Sintered Steel Powder Metal Components Using Atmosphere Composition as a Variable, Air Products and Chemicals".
[4] Wang Qing, Wang Li-jiu, and Ai Hong-mei."Research on soda residue and fly ash high strength ceramist''Journal of Concrete (China), 2000(6), 27-29.
[5] R. Manikandan,& K. Ramamurthy "Physical characteristics of sintered fly ash aggregate containing clay binders" Journal of Material Cycles and Waste Management June 2012, Volume 14, Issue 2, pp 120-131.
[6] S.Lokesh,M.G.Ranjith Kumar, S.Loganathan 'Effective Utilization of High Volume Fly ash with Light Weight Aggregate in Concrete for Construction industry; 2013.
[7] M.S.Shetty(2013).''Concrete Technology'', S. Chand & co Publising Company,pp53-62.
[8] IS 10262-1982 recommended guide lines for concrete mix design.
[9] [9] IS 8112:189, Specification for 43 grades OPC, reaffirmed 1997.
[10] IS 4031:1988,Part 1, Method of Physical Test for Hydraulic Cement, Determination of Fineness by Dry Sieving , reaffirmed 1995.
[11] IS 383:1970, Specification for coarse and fine aggregate from natural sources for concrete (second revision), reaffirmed Feb -1997.
[12] IS 2386:1963,Part 1, Indian Standard Methods of Test for Aggregates for Concrete, Particle Size And Shape reaffirmed 2002.
[13] S.Shanmugasundaram 'Study on Utilization of Fly Ash Aggregates in Concrete'
[14] Kazuhiro Hasezaki, AkifumiNakashita, Gen-yo Kaneko1and Hideaki Kakuda, "Unburned Carbon Behavior in Sintered Coal Fly-Ash Bulk Material by Spark Plasma Sintering, Materials Transactions", Vol. 48, No. 12 (2007) pp. 3062 to 3065 ,Special Issue on Growth of Ecomaterials as a Key to Eco-Society III #2007 The Japan Institute of Metals.
[15] Arvind Kumar and Dilip Kumar "Strength Characteristics of Concrete with Sintered flyash Aggregate" Journal of IJSRD Volume 2, Issue 7, Sept-2014.
[16] Yu-shun Guo et al. (2000)"Comparison of properties of high performance lightweight aggregate and normal lightweight aggregate." Journal of Concrete (China), (6), pp 22-26.
[17] Saravanan, and Sathya priya,(2013) " Study on Sintered Flyash Aggregate as Columnar Inclusion on Soft Clay "(IJCRD) eISSN:2321 , 225X; pISSN:2321-2241 Vol: 1; Issue:5;pp.24-28.
[18] Akshay S. Shelke, et al (2014)" Coconut Shell as Partial Replacement for Coarse Aggregate: Review" International Journal of Civil Engineering Research.ISSN 2278-3652 Volume 5, Number 3 (2014), pp.211-214.
[19] S. Shanmugasundaram at al (2010) "Study on Utilization of Fly Ash Aggregates in Concrete" Modern Applied Science, www.ccsenet.org/mas, Vol. 4, No. 5;pp 44-56.
[20] P.Eswaramoorthi, G.E.Arunkumar (2014)" Fibers Study On Properties of Geopolymerconcrete With Polypropylene"(IRJES) ISSN (Online) 2319-183X, (Print) 2319-1821 Vol; 3, Issue 2, pp.60-75 .

[21] Neetesh Kumar, Dilip Kumar,(2014)" Strength Properties of Coconut Shell as Coarse Aggregate In Concrete" International Journal of Computer & Mathematical Sciences IJCMS ISSN 2347 – 8527 Vol. 3, Issue 5.pp43-52.
[22] Geetha, S., Ramamurthy, K., (2011), "Properties of sintered low calcium bottom ash aggregate with clay binders" Construction and Building Materials, 25, pp2002-2013.
[23] Manikandan, R., Ramamurthy, K., (2008),"Effect of curing method on characteristics of cold bonded fly ash aggregates" Cement & Concrete Composites, 30, pp 848–853.
[24] Wasserman, R., Bentur, A.,(1997),"Effect of lightweight fly ash aggregate microstructure on the strength of concretes", Cement and Concrete Research, Vol. 27 Issue 4, pp 525–537.

