Investigations On Light Weight Cinder Aggregate Concrete With Silica Fume And Fly Ash As Admixtures

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ABSTRACT:

The objective of this project work is to determine the effects of silica fume and fly ash over light weight aggregate concrete with replacing as a normal aggregate by cinder aggregate with different volume percentages of 25,40,60,75 and 100. Experiments were carried out by replacing cement with different percentages of silica fume and fly ash over conventional concrete with light weight aggregate at water-cement ratio of 0.50 and cement replaced by silica fume and fly ash (by weight of cement) were 5,10,15 and 10, 20, 30 percentage respectively. The conventional aggregate concrete mix has been designed for M20 grade concrete using ISI method. In this investigation cubes, cylinders of standard size 150x150x150mm, 150x300mm specimens have been cast and tested for curing periods. In totally 180 specimens have been cast and tested. The unit weight of the cinder concrete is 2220kg/m3. In present work , investigations are being carried out over lightweight aggregate concrete with cinder as lightweight aggregate. Tests are being carried out for ascertious results with respect to strength in compression strength, split tensile strength replacement with partial respectively.

KEYWORDS: **Cinder, Silica fume, Fly ash.**

I. INTRODUCTION

Concrete is most versatile material in building construction. In structural applications, the self-weight of the structure is quite important as it represents a major portion of the load. Replacing partially or entirely the coarse part of normal weight aggregate concrete with low weight aggregates produces lightweight concrete that can reach a reasonably good compressive resistance. The advantage of lightweight concrete is its reduced mass and improved thermal and sound insulation properties, while maintaining adequate strength. The reduced self-weight of LWC will reduce the gravity load and seismic inertial mass leading to reduced member sizes and foundation forces. Aggregates play an important role in concrete and they account for 60 to 75 percent of the total volume of concrete and thus have an influence on the different material properties. In addition to their role as economical filler, aggregates help control the dimensional stability of cement-based materials, which may be considered to consist of a framework of cement paste with relatively large shrinkage movements restrained by the aggregate particles. Aggregates strongly influence concrete's fresh and hardened state properties, mix proportions, and economy. Grading limits and maximum aggregate size are specified since they affect the amount of aggregate used, cement and water requirements, workability of concrete.

Concrete where cement is used as a binding material is called as cement concrete. It is one of the seemingly simple but actually complex materials. Many researchers have tried to modify the properties of conventional concrete to suit the individual needs. The modifications were tried on quality of the concrete making materials. To start with, many additives and admixtures were tried instead of altering the conventional materials used. Though the use of admixtures and additives is being frowned upon by some technologists, there are many, on the contrary, who highly recommend and foster the use and development of admixture as it imparts many desirable characteristics and effects economy in concrete construction.

Also attempts were made to; produce lightweight concrete by using light weight artificial, natural aggregates, air entrained, and sand grading techniques. Here we are using cinder as lightweight aggregate, cinder is waste material obtained from steel manufacturing factory and locally available material and used in certain places where natural aggregates are not available or costly.

REVIEW OF LITERATURE

P.S. Raghuprasad, et.al ., concluded that with the advent of industrial revolution and mass construction in various parts of the world, the pollution levels and the scarcity of materials have reached the peak. The coarse aggregate in the conventional solid concrete blocks were replaced partially with cinder (12 mm) and tested for compressive strength at the age of 3 days, 7 days and 21 days. From the results of investigation, it can be concluded that solid blocks with 15% replacement of coarse aggregate by cinder records more strength that the conventional one.

Owens, P.L. et al., had stated that Light weight aggregate concrete was used for structural purposes since the 20th century. As per this study, the Light weight aggregate concrete is a material with low unit weight and often made with spherical aggregates. The density of structural Light weight aggregate concrete typically ranges from 1400 to 2000 kg/m³ compared with that of about 2400 kg/m³for normal weight aggregate concrete

N. Siva lingaRao, et.al ., concluded that 60 percent replacement of conventional aggregate with cinder by volume along with cement replaced by 10 percent of silica fume by weight, yields the target mean strength of M20 concrete. It is worth to be noted that there is a slight increase in strength and other properties due to extended curing periods and the unit weight of the cinder concrete is varying from 1980Kg/m³ to 2000Kg/m³ with different percentages of cinder. It is also noted that there is a decrease in density after extended curing periods.

M. A. Caldarone and R. G. Burg et al., Structural lightweight concrete is defined as concrete made with low-density aggregate having an air-dry density of not more than (1850 kg/m³) and a 28-day compressive strength of more than (17.2 MPa). This paper presented the test results of very low-density structural lightweight concrete mixtures developed in the laboratory for the purpose of finding a suitable mixture for use on a historic building rehabilitation project. Mixture parameters included a specified compressive strength of 3000 psi at 28 days and an air-dry density approaching 70 lb/ft3. Various constituent materials, mixture proportions and curing methods were examined. The result of this research exemplifies the feasibility of achieving very low densities with structural concretes.
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Wasserman and Bentur et al., have reported that physical structure of light weight aggregate and its effect on the aggregate-matrix interfacial bond have a marked influence on the compressive strength of concrete.

Suwimol et.al., have studied on Influence of condensed silica fume on the properties of cement-based solid wastes. Influence of condensed silica fume addition as cement replacement material on the properties of cement – based solidification products was investigated.

Thorenfeldt, E reported that et al., Light Weight Aggregate Concrete has a faster hardening factor in the initial setting phase than conventional concrete, normally reaching 80 % of the 28 day strength within 7 days. The strength growth from 28 to 90 days is generally low and decreases with increasing concrete strength level. This is assumed to be a consequence of the strength limiting effect of the light weight aggregate.

As per **Bryan, Dennis. S. P et al.,** Natural lightweight aggregates may be defined as inherently low density natural mineral materials. The primary user is the construction industry where weight reduction equates to cost savings. Principal products in which natural lightweight aggregate is utilized because of its lower density include lightweight Portland cement concrete and lightweight concrete masonry units. In addition, due to location, some natural lightweight aggregates compete with normal weight constructions aggregates for uses such as road base and common backfill material.

Tumidajski and Gong et al., studied the effect of coarse aggregate size on strength and workability properties of concrete by varying the proportions of 37.5 and 19.5 mm stone in the coarse aggregate.

Chen and Liu et al., investigated on high-strength concretes with 10, 15, and 20 mm sizes of crushed limestone as coarse aggregate. The results depicted that the concretes made with 10-16 mm and 16-20 mm fraction aggregates achieve maximal and the lowest compressive strengths respectively.

Alengaram et al., studied the physical and mechanical properties of different sizes of Palm Kernel Shells (PKS) used as lightweight aggregates (LWA) and their influence on mechanical properties of concrete. The flexural and splitting tensile strengths were found respectively 12 and 7% of the compressive strength.

From the brief literature survey conducted in this investigation, it is observed that very little concentration has been paid on the study of normal concrete replacing the conventional coarse aggregate by the cinder aggregate in various proportions and the study of their behavior when subjected to acid attack in various concentrations and extended curing periods .Hence in that direction present study has been taken.

EXPERIMENTAL INVESTIGATION

In the course of investigation normal granite aggregate has been replaced by light weight aggregate (cinder) by different percentages of 0%, 25%, 40%, 60%, 75%, 100% respectively. And cement has been replaced by an admixture Silica fume and Fly ash (by weight of cement) were 5, 10, 15 and 10,20,30 percentages respectively.

MATERIAL PROPERTIES

In the present investigation materials used are Ordinary Portland cement of 53 grade having a specific gravity of 3.11. Locally available river sand passing through IS 4.75mm sieve with specific gravity 2.68. Natural granite aggregate passing through IS 20mm sieve with specific gravity 2.75. Cinder passing through IS 20mm sieve with specific gravity 2.33 is used as aggregate.

PHYSICAL PROPERTIES OF MATERIALS

The strength of concrete is fresh and hardened states is influenced by the physical properties of fine and coarse aggregates. Locally available natural river sand and natural granite aggregates and cinders available from steel industry were used as fine and coarse aggregates respectively. Tests on physical properties like bulk density, specific gravity, water absorption, fineness modulus were conducted for both fine and coarse aggregate respectively in the laboratory. Additionally tests on physical properties like dry unit weight, aggregate impact value and aggregate crushing value were also conducted for both granite and cinder respectively. These results are used for developing suitable mixture proportioning for the investigations. Sand supplied from river handri, and granite stone is procured from a local granite quarry near banaganapally, Kurnool have used. Cinder aggregate supplied from local steel industry near lakshmipuram Kurnool was used .

Ordinary Portland Cement (OPC) grade 53 cement (strength of standard mortar cubes = 55.6 MPa with 30% normal consistency) conforming to IS 12269:1987 was used in the test specimen

The physical properties of fine aggregate (river sand) are indicated in table 1.

The physical properties of coarse aggregate (crushed granite aggregate and cinder aggregate) are indicated in table 2.

TABLE 1: Physical Properties of Fine Aggregates

Property	**Fine aggregate**
	River sand
Bulk density, kg/m3	1650 kg/m3
Specific gravity	2.68
Fineness modulus	2.81
Free surface moisture (%)	2.0
Water absorption (%)	1.0

TABLE 2: Properties of the coarse aggregates

Property	**Coarse aggregate**	
	Granite aggregate	**Cinder aggregate**
Maximum nominal size	20 mm	20 mm
Bulk density (kg/m3)	1800	687.5
Specific gravity	2.75	2.33
Fineness modulus	4.6	2.9
Water absorption	0.5	16

TABLE 3: Concrete mix proportions

Material	**Mixture designation**	
	Granite aggregate for 100% N.A	**Cinder aggregate 100% cinder**
Cement , kg/m3	365.75	365.75
River sand , kg/m3	726.68	694.83
Coarse aggregate , kg/m3	1118.55	906.13
Water-cement ratio	0.5	0.5
Slump , mm	23.2	21.8

CASTING OF SPECIMENS

Concrete Mix has been designed for M20 grade using ISI method of mix design. A constant water cement ratio of 0.50 has been adopted. Cubes (of size 150 x 150 x 150), cylinders (of size 150 x 300), flexure beams (of size 100 x 100 x 500 mm) are cast and tested for curing periods 28 days to know the compressive strength, split tensile strength.

Main constituents of the concrete are fine aggregate, coarse aggregate (granite), cement, water, light weight aggregate (cinder) of 20mm, and Silica fume and Fly ash. Fine aggregate is procured from nearby river, conventional coarse aggregate (20mm) has been procured from local quarry available (machine crushed), and local drinking water is used for mixing and curing.

Cement used is OPC 53 grade. After mixing the weighted materials in a standard way and after completion of trial workability tests, the concrete has been placed in the standard metallic moulds in three layers and has been compacted each time by tamping rod. The concrete in the moulds has been vibrated for 10 to 15 sec using the table vibrator and the surfaces of the specimens have been finished smoothly.

TABLE 4: Casting of specimens

Name of the Mix	**Replacement of Coarse Aggregate by Volume percentage**		**No of specimens cast**
	Natural Aggregate	**Cinder Aggregate**	
C-0	100	0	30
C-25	75	25	30
C-40	60	40	30
C-60	40	60	30
C-75	25	75	30
C-100	0	100	30
		Total	180

DISCUSSION OF TEST RESULTS

Compressive strength of Cinder Aggregate Concrete with Silica Fume Admixture:

Figures 5 shows the variation of compressive strength with percentage of silica fume for 20MPa cinder-based lightweight concretes containing different percentages of silica fume 5%, 10% and 15%. At the age of 28 days the compressive strength obtained for concrete mix with 5%, 10% and 15% silica fume is 28.3 N/mm2, 26.66 N/mm2, 21.40 N/mm2.At all the ages, the compressive strengths of concrete with 15% silica fume have been lesser than the strengths of concretes containing 5%, and 10% silica fume.

Split Tensile Strength Of Cinder Concrete With Silica Fume Admixture:

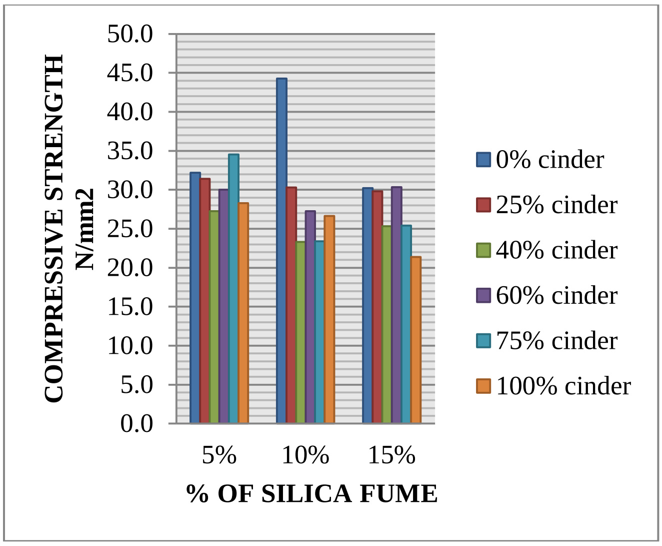
Figures 6 shows the variation of split tensile strength with percentage of silica fume for 20MPa cinder-based lightweight concretes containing different percentages of silica fume 5%, 10% and 15%. At the age of 28 days the compressive strength obtained for concrete mix with 5%, 10% and 15% silica fume is 2.21 N/mm2, 2.12 N/mm2, 2.24 N/mm2.At all the ages, the compressive strengths of concrete with 15% silica fume have been lesser than the strengths of concretes containing 5%, and 10% silica fume.

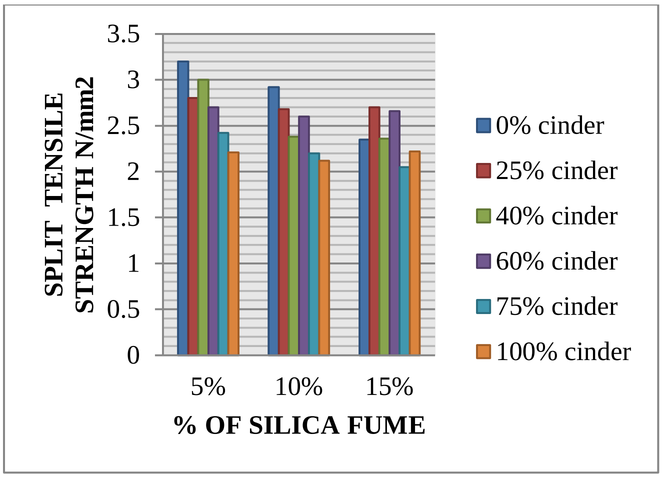
TABLE 5: Compressive strength of 150 mm cubes (average of 3 cubes)

SI. No	**% Cinder**	**Cube Compressive strength N/mm2**		
		5%	**10%**	**15%**
1	0	32.2	44.28	30.2
2	25	31.4	30.3	29.8
3	40	27.3	23.30	25.33
4	60	30.0	27.25	30.33
5	75	34.5	23.4	25.4
6	100	28.3	26.66	21.4

Table 6: Split tensile strength of 150 x300 mm cylinders (average of 3 cylinders)

SI. No	**% Cinder**	**Split Tensile strength N/mm2**		
		5%	**10%**	**15%**
1	0	3.2	2.92	2.34
2	25	2.8	2.68	2.7
3	40	3.0	2.38	2.36
4	60	2.7	2.6	2.66
5	75	2.42	2.2	2.05
6	100	2.21	2.12	2.22





Compressive strength of Cinder Aggregate Concrete with Fly Ash Admixture:

Figure 7 shows the variation of compressive strength for 20MPa cinder-based lightweight concretes containing different percentages of fly ash 10%, 20%, 30%. At the age of 28 days the compressive strength obtained for concrete mix with 10%, 20%, 30% fly ash is 19.40N/mm2, 21.40 N/mm2, 20.04 N/mm2.At all the ages, the compressive strengths of concrete with 10% fly ash have been lesser than the strengths of concretes containing 20%, and 30% fly ash.

Split Tensile strength of Cinder Aggregate Concrete with Fly Ash Admixture:

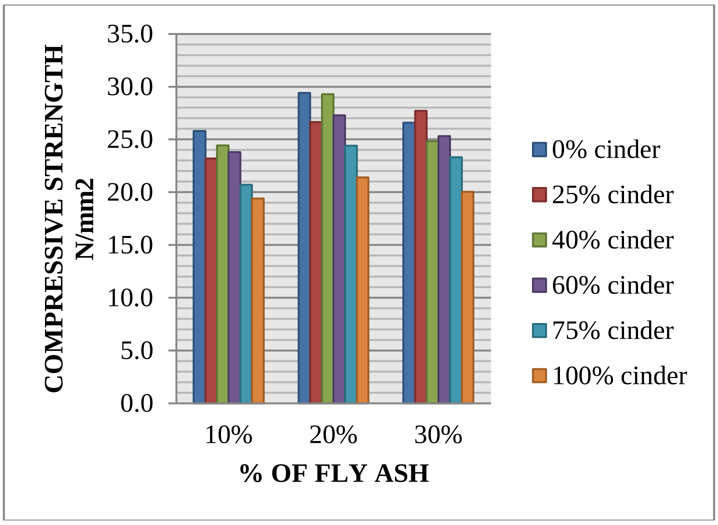
Figures 8 shows the variation of split tensile strength with percentage of fly ash for 20MPa cinder-based lightweight concretes containing different percentages of fly ash 10%, 20%, 30%. At the age of 28 days the compressive strength obtained for concrete mix with 10%, 20%, 30% fly ash is 2.18 N/mm2, 2.22 N/mm2, 2.12 N/mm2.At all the ages, the compressive strengths of concrete with 10% fly ash have been lesser than the strengths of concretes containing 20%, and 30% fly ash.

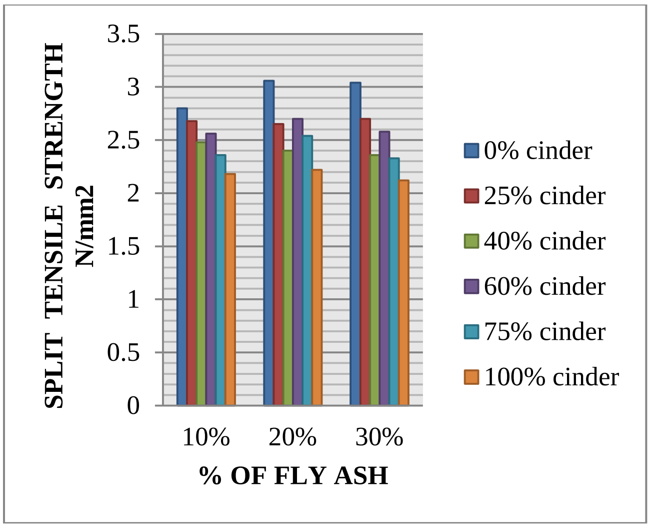
TABLE 7: Compressive strength of 150 mm cubes (average of 3 cubes)

SI. No	% Cinder	Cube Compressive strength N/mm2		
		10%	20%	30%
1	0	25.8	29.4	26.6
2	25	23.2	26.66	27.7
3	40	24.4	29.30	24.84
4	60	23.8	27.3	25.33
5	75	20.7	24.4	23.3
6	100	19.4	21.4	20.4

TABLE 8: Split tensile strength of 150 x300 mm cylinders (average of 3 cylinders)

SI. No	% Cinder	Split Tensile strength N/mm2		
		10%	20%	30%
1	0	2.8	3.06	3.04
2	25	2.68	2.65	2.7
3	40	2.48	2.4	2.36
4	60	2.54	2.7	2.58
5	75	2.36	2.54	2.33
6	100	2.18	2.22	2.12





CUBE COMPRESSIVE STRENGTH TEST AFTER TESTING

CUBE COMPRESSIVE STRENGTH TEST BEFORE TESTING

SPLIT TENSILE STRENGTH TEST BEFORE TESTING

CONCLUSIONS:

1. From the study it is concluded that 5 % silica fume is giving the best results when compare to 10% and 15% silica fume. and also from fly ash 20% is giving best results when compare to 10% and 30%.

2. From the study it may concluded that the usage of light weight cinder aggregate to some extent (60%) and granite aggregate (40%) using admixture as silica fume and fly ash has proved to be quite satisfactory strength when compare to various strengths studied.

3. From the study test results indicate that the quality of cinder is low in comparison with normal aggregate. This is due to its porous in structure.

4. From the study test results indicate that the cube compressive strength is decreased with the increase in percentage of cinder.

5. From the study it is concluded that the split tensile strength is decreased and increased with increase in percentage of cinder.

6. Compressive strength of 5% silica fume concrete is more than the 10% and 15% silica fume concrete at 28 days Similarly tensile strength of 5% silica fume is greater than the 10% and 15% silica fume concrete at 28 days.

7. Compressive strength of 10% fly ash concrete is more than the 20% and 30% fly ash concrete at 28 days Similarly tensile strength of 10% fly ash concrete is greater than the 20% and 30% fly ash concrete at 28 days.

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