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EXPERIMENTAL INVESTIGATION ON PROPERTIES OF LIGHT WEIGHT CINDER AGGREGATE CONCRETE

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ABSTRACT: Porous lightweight aggregate of low specific gravity is used in this lightweight concrete instead of ordinary concrete. The lightweight aggregate can be natural aggregate such as pumice, scoria and all of those of volcanic origin and the artificial aggregate such as expanded blast-furnace slag, vermiculite and clinker aggregate. The main characteristic of this lightweight aggregate is its high porosity which results in a low specific gravity. In the present investigations of light weight concrete withcinder aggregate used as light weight aggregate and silica fume and fly ash as admixtures were used. The light weight concrete designed as M20 grade to get structural light weight concrete using cinder aggregate. Compressive strength are studied with replacement of cement in different percentages using silica fume and fly ash.

1. INTRODUCTION

Concrete is one of most versatile material used in building construction. In structural applications, the self-weight of the structure is quite important as it represents a major portion of its dead load. Replacing partially or entirely the coarser normal weight aggregate in conventional concrete can be replaced partially or fully with low density aggregates will produces lightweight concrete that can reach a reasonably good compressive resistance. The advantages of lightweight concrete are 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 as well as seismic inertial mass which leads to decreased member sizes as well as forces on foundation can be reduced . Aggregates contribute an important role in concrete volume as they contribute to 60 to 70 percent of the total volume. Thus they have an major influence on the different material properties like density, specific gravity, water absorption etc., Cinder is the material comes under the category light weight aggregate and it is a byproduct of steel, iron manufacturing companies. The surface of cinder aggregate is usually rough and highly porous due to mineral structure. The cinder material visually classified as having 100% crushed face. Cinder aggregates are used for making building blocks for partition walls, for making screeding over flat roofs and for plastering purposes because of its less weight. linear coeff. Of thermal expansion is about 3.8* 10-6 c. Cinder contains large percentage of air, so it is naturally a better material with respect to sound absorption, sound proofing and thermal insulation. Due to its low density it helps in reduction of dead load, increases the progressing of building, and lowers handling costs. The most important characteristic of light weight concrete is the relatively low thermal conductivity. Due to its low specific gravity, the concrete made with it is lighter than natural concrete.

1.1 LIGHT WEIGHT CONCRETE

Lightweight concrete can be defined as a type of concrete which includes an expanding agent in that it expands the volume of the blend while giving extra qualities, for example, nailbility and diminished the dead weight. It is lighter than the customary cement. The principle fortes of lightweight solid are its low thickness and warm conductivity. Its preferences are that there is a lessening of dead load, speedier building rates in development and lower haulage and taking care of expenses.

Lightweight cement keeps up its expansive voids and not framing laitance layers or concrete movies when put on the divider. Be that as it may, adequate water bond proportion is imperative to create satisfactory attachment in the middle of concrete and water. Deficient water can bring about absence of union between particles, subsequently misfortune in quality of cement. In like manner an excessive amount of water can bring about concrete to keep running off total to frame laitance layers, therefore looses quality.

1.2 TYPES OF LIGHT WEIGHT CONCRETE

Lightweight solid can be arranged either by infusing air in its organization or it can be accomplished by precluding the better sizes of the total or notwithstanding supplanting them by an empty, cell or permeable total. Especially, lightweight solid can be classified into three gatherings:

- No-fines concrete
- Lightweight total cement
- Aerated/Foamed cement

1.2.1 No-fines concrete

No-fines solid can be characterized as a lightweight cement made out of bond, water and coarse total. Consistently dispersed voids are framed all through its mass. The fundamental qualities of this kind of lightweight cement is it keeps up its huge voids and not shaping laitance layers or bond film when set on the divider. Figure 1 demonstrates one case of No-fines concrete burden bearing and non-load bearing for outer dividers and segments. The quality of no-fines solid increments as the bond substance is expanded.

Figure 1: No-fines concrete

No-fines concrete normally utilized for both Be that as it may, it is touchy to the water organization. Inadequate water can bring about absence of union between the particles and consequently, resulting misfortune in quality of the cement. In like manner an excessive amount of water can bring about bond film to keep running off the total to frame laitance layers, leaving the majority of the cement lacking in concrete and in this way debilitates the quality.

1.2.2 Lightweight total cement

Permeable lightweight total of low particular gravity is utilized as a part of this lightweight cement rather than standard cement. The lightweight total can be characteristic total, for example, pumice, scoria and those of volcanic beginning and the counterfeit total, for example, extended impact heater slag, vermiculite and clinker total.

Figure 2: Lightweight aggregate concrete

1.2.3 Aerated cement

Circulated air through solid does not contain coarse total, and can be viewed as a circulated air through mortar. Regularly, circulated air through cement is made by bringing air or different gas into a concrete slurry and fine sand. In business hone, the sand is supplanted by pummeled fuel fiery debris or different siliceous material, and lime possibly utilized rather than bond.

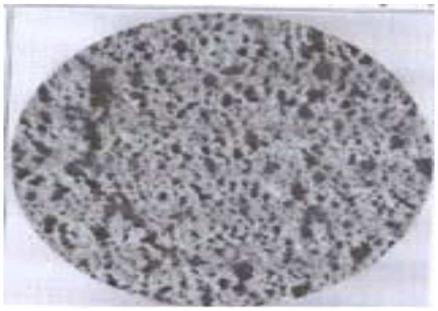

Figure 3: Aerated concrete

1.3 Advantages and disadvantages of lightweight concrete

Table 1 shows the advantages and disadvantages of using lightweight concrete as structure.

Table 1: Types and grading of Lightweight concrete

Type of Lightweight Concrete	Type of Aggregate	Grading of Aggregate (Range of Particle Size)
No- fines Concrete	Natural Aggregate Blast-furnace slag Clinker	Nominal Single-Sized material between 20mm and 10mm BS sieve
Partially Compacted Lightweight Aggregate Concrete	Clinker, Foamed Slag Expanded Clay, Shale, slate, Vermiculite and perlite Sintered Pulverized fuel-ash and pumice	May be of smaller nominal single size of combined coarse and fine (5mm and fines) material to produce a continues but harsh grading to make a porous concrete

Structural Lightweight Aggregate Concrete	Foamed Slag Expanded Clay, Shale, slate and Sintered Pulverized fuel-ash	Continues grading from either 20mm or 14mm down to dust, with an increased fines content (5mm and fines) to produce a workable and dense concrete.
Aerated concrete	Natural fine aggregate Fine lightweight aggregate Raw pulverized-fuel ash Ground slag and burnt shales	The aggregate are generally ground down to finer powder, passing a 75 µm BS sieves, but sometimes fine aggregate (5mm and fines) is also incorporated.

1.4 Application of lightweight concrete

Lightweight cement has been utilized subsequent to the eighteen centuries by the Romans.

The application on 'The Pantheon' where it uses pumice total in the development of cast in-situ cement is the confirmation of its use. In USA and England in the late nineteenth century, clinker was utilized as a part of their development for instance the 'English Museum' and other minimal effort lodging. The lightweight cement was likewise utilized as a part of development amid the First World War. The United States utilized principally for shipbuilding and solid pieces. The frothed impact heater slag and pumice total for square making were presented in England and Sweden around 1930s. These days with the progression of innovation, lightweight cement extends its employments.Case in point, as perlite with its extraordinary protecting qualities. It is broadly utilized as free fill protection as a part of brick work development where it upgrades fire evaluations, lessens clamor transmission, does not spoil and termite safe. It is likewise utilized for vessels, rooftop decks and different applications.

1.5 Objective of the present study

In the present investigations of light weight concrete withcinder aggregate used as light weight aggregate and silica fume and fly ash as admixtures were used. The light weight concrete designed as M20 grade to get structural light weight concrete using cinder aggregate. Compressive strength are studied with replacement of cement in different percentages using silica fume and fly ash.

2. LITERATURE REVIEW

Ganesh Babu. K et al., depicted has the Behavior lightweight stretched polystyrene cement containing silica fume and he concentratedon the Lightweight concrete can be created by supplanting total with lightweight total, either somewhat or completely, contingent on the necessities of thickness and quality, furthermore considered the quality and the sturdiness execution of EPS cements. These blends were planned by utilizing the effectiveness of silica fume at the diverse percentages.

NiyaziUgurKockal et al., portrayed hasstrength and elastic properties of structural lightweight concrete. The study introduces the impact of attributes of four total sorts (two sintered lightweight fly cinder aggregate, normal weight crushed limestone aggregate and cold-bonded lightweight fly ash aggregate)on the quality and flexible properties of solid blends. Distinctive models were likewise utilized as a part of request to foresee the quality and modulus of versatility estimations of cements.

Siva LingaRao.Net al., has studied an investigation has been made to understand the behavior of conventional aggregate concrete in which normal aggregate is replaced with cinder in volume percentages of 20,40,60,80 and 100 and cement is replaced with silica fume in weight percentages of 0,5,8,10,15 and 20.From the study it is reasoned that 60 percent supplanting of ordinary total with ash by volume alongside concrete supplanted by 10 percent of silica smoke by weight yields the objective mean quality. the unit weight of the ash cement is shifting from 1980Kg/m3 to 2000Kg/m3 with distinctive rates of soot.

Bhaskar Desai et al., portray test examination an endeavor is to be made to concentrate on the quality properties of light weight soot total bond solid in distinctive rate extents of 0, 25, 50, 75 and 100 by volume of light weight total solid can be arranged. By utilizing this the properties, for example, compressive quality, split rigidity, modulus of flexibility, thickness and shear stress.

Rathish Kumar P. et al ., has studied the strength and sorptivity attributes of concrete made with cinder based lightweight aggregates. Before this the span of cinder based light weight aggregate was enhanced. The mechanical properties, compressive quality and split tensile strength were learned at the end what's more 28 days for mid-range evaluation concrete with diverse sizes of total. It was noted that with 12.5mm size total and 30% fly ash the mechanical properties were predominant in 20MPa.

3. MATERIAL PROPERTIES AND TESTING PROCEDURE

3.1 Material properties

The materials used in the present investigation are Ordinary Portland cement of 53 grade having a specific gravity of 3.07 with initial and final setting times of 33 minutes and 489 minutes respectively. Locally available river sand passing through IS 4.75mm sieve with specific gravity 2.6 and fineness modulus 4.10 is used. Natural granite aggregate passing through IS 20mm sieve with specific gravity 2.68 and compacted density 1620 Kg/m3 is used. Cinder passing through IS 20mm sieve with specific gravity 2.05 and compacted density 1050 Kg/m3 is used as aggregate. A view of constituent materials is shown in plate. 1 3.1 PROPERTIES OF CINDER: The surface of the cinder is usually rough and highly porous due to mineral structure. No physical testing is usually performed to quantify the angularity of the material, however it is visually classified as having 100% crushed face. The water absorption for cinder is around 1.5%. This significant difference is thought to be the main reason of reduction in strength and durability of concrete made with cinder. Low specific gravity of cinder in comparison with natural aggregate resulted in the concrete made with cinder to be lighter than normal concrete.

3.2 Testing procedure

Test for measuring workability

For checking the consistency of workability standard tests like slump and compaction factor were conducted and with the addition of super plasticizer workability is maintained more or less constant.

Testing of cube for compressive strength

Compression test was done conforming to IS 516:1959. All the concrete specimens were tested in a 200 tones capacity of compression testing machine. Concrete cubes of sizes 150mm x 150mm x 150 mm were tested for crushing strength, crushing strength of concrete was determined by applying load at the rate of 140 kg/sq.cm/minute till the specimens failed. The maximum load applied to the specimens was recorded dividing the failure load by the area of specimens ultimate compressive strength was calculated. The results are tabulated and graphs are plotted which are presented in the next chapter.

Compressive Strength = load/area in N/mm^2

Testing of cylinders for split tensile strength

This test was conducted in a 200 tones capacity of compression testing machine by placing the cylindrical specimen of the concrete horizontal, so that its axis is horizontal between the plates of the testing of specimens. Narrow strips of the packing material i.e., ply wood was placed between the plates and the cylinder, to receive the compressive stress. The load was applied uniformly at a constant rate.

Load at which the specimens failed was recorded and the splitting tensile stress was obtained using the formula based on IS 5816:1970

$F_1 = 2P/\pi DL$

where p = Compressive load on cylinder

L = Length of cylinder

D = Diameter of the cylinder

Plate 4.4 Testing of cube Plate 4.5 Testing of cylinder by split tensile

4. DISCUSSIONS OF TEST RESULTS

4.1. DISCUSSION OF TEST RESULTS

4.1.1 Compressive strength of concrete with replacement of cinder aggregate and silica fume

The compressive strength results with 100% natural aggregate being replaced by 0 % cinder aggregate and with different percentages replacements of cement by silica fume are shown in table 2. The graphical variations of compressive strength versus percentage replacement of cement by silica fume are shown in fig 4.1. Hence, from the above discussions it can be concluded that 40% replacement of natural aggregate by 60% cinder aggregate and cement replacement with 5% silica fume admixture is supposed to be optimum percentage with respect to compressive within the scope of present investigation.

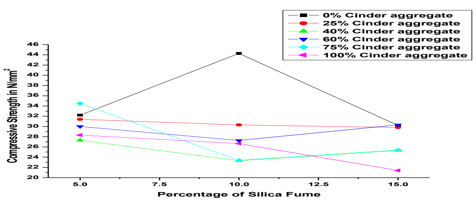

Fig 4.1 Compressive strength with different percentages of cinder aggregate with different percentages of silica fume

Table 2:

S.No.	Mix Designation	Compressive Strength, N/mm^2
1	C A-0 SF5	32.2
2	C A-0 SF10	44.28
3	C A-0 SF15	30.2
4	C A-25 SF5	31.4
5	C A-25 SF10	30.3
6	C A-25 SF15	29.8
7	C A-40 SF5	27.3
8	C A-40 SF10	23.3
9	C A-40 SF15	25.3
10	C A-60 SF5	30.03
11	C A-60 SF10	27.25
12	C A-60 SF15	30.33
13	C A-75 SF5	34.5
14	C A-75 SF10	23.4
15	C A-75 SF15	25.4
16	C A-100 SF5	28.3
17	C A-100 SF10	26.6
18	C A-100 SF15	21.4

4.1.2 Compressive strength of concrete with replacement of cinder aggregate and fly ash

The graphical variations of compressive strength versus percentage replacement of cement by fly ash are shown in fig 4.2. From the below table 3 and fig 4.2 it may be observed that there is an increase in compressive strength for the replacement of cement by fly ash as 20% and from 10% and 30% the strength gets decreased.Hence, it can be concluded that 40% replacement of natural aggregate by 60% cinder aggregate and cement replacement with 20% fly ash admixture is supposed to be optimum percentage with respect to compressive within the scope of present investigation.

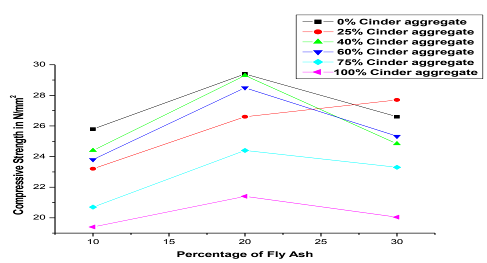

Fig 4.2 Compressive strength with different percentages of cinder aggregate with different percentages of fly ash.

Table 3:

S.No	Mix Designation	Compressive Strength, N/mm^2
1	C A-0 FA10	25.8
2	C A-0 FA20	29.4
3	C A-0 FA30	26.66
4	C A-25 FA10	23.2

5	C A-25 FA20	26.6
6	C A-25 FA30	27.77
7	C A-40 FA10	24.4
8	C A-40 FA20	29.3
9	C A-40 FA30	24.84
10	C A-60 FA10	23.8
11	C A-60 FA20	27.3
12	C A-60 FA30	25.33
13	C A-75 FA10	20.7
14	C A-75 FA20	24.4
15	C A-75 FA30	23.3
16	C A-100 FA10	19.4
17	C A-100 FA20	21.4
18	C A-100 FA30	20.4

4.1.3 Split tensile strength of concrete with replacement of cinder aggregate and silica fume

The variation of split tensile strength versus percentage replacement of cement by silica fume is shown in fig 4.3.

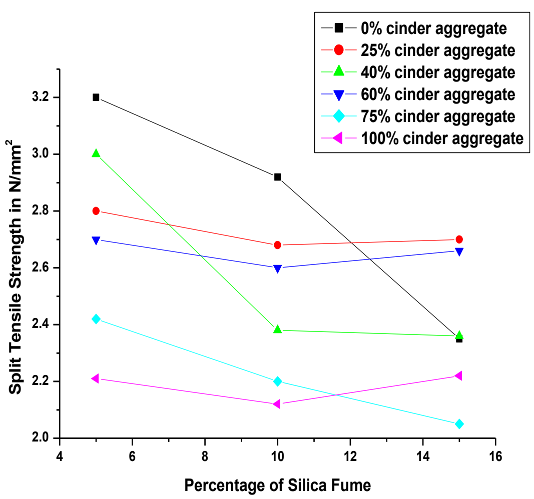

Fig 4.3 Split Tensile strength with different percentages of cinder aggregate with different percentages of fly ash

4.1.4 Split tensile strength of concrete with replacement of cinder aggregate and fly ash

The variation of split tensile strength versus percentage replacement of cement by fly ash are shown in fig 4.4.

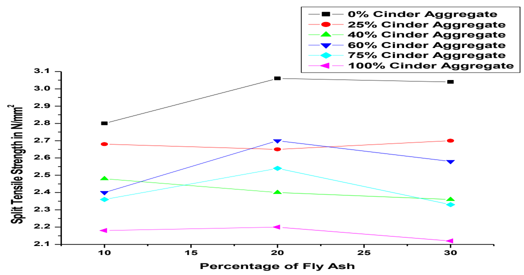

Fig 4.4 Split Tensile strength with different percentages of cinder aggregate with different percentages of fly ash

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. It can be conclude that due to porous nature Cinder aggregate's quality is low in comparison with normal aggregate

4. The results indicate that the compressive strength is decreases with the increase in percentage of cinder.

5. The results indicate that the split tensile strength is decreases 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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