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A STUDY ON PROPERTIES OF LIGHT WEIGHT AGGREGATE CONCRETE WITH MINERAL ADMIXTURES

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ABSTRACT
In this experimental investigation stands for improving the properties of light weight aggregate concrete of various properties with respect to strength and durability aspects. Especially in this aggressive investigation review states on addition of Cement with mineral admixtures and steel fibers. High performance concrete appears to be better choice for strong and durable structures. Proper introduction of silica fume and metakaolin in concrete improves both the strength and durability characteristics of the concrete. The effects of fibers on workability, density and on various strength properties of high strength concrete M70 of grade concrete have been studied. The Steel fibers content varies from (1% and 1.5%) by volume of cement is used in concrete. For this purpose along with a Control Mix, 24 sets were prepared to study the compressive strength, tensile strength and flexural strength. Each set comprises of 12 cubes, 12 cylinders and 12 beams. All specimens are water cured and tested at the age of 7, 14, 24 and 56 days. Super plasticizer (Master Glenium SKY 233) is to be used to increase workability with the adequate proportions (0.5%, 0.6% 0.7% and 0.8%). Ductility and bond of concrete is to found to increase in steel fibers in the concrete as observed from the Compressive test, Tensile Strength and Flexural Strength tests were performed in the hardened state. In this study optimum percentage steel fibers arrived at the keeping optimum percentage addition of steel fibers constant and replacing granite aggregate with pumice stone by (0% 10%, 20%, 30%, 40% and 50%) by volume, the strength and durability properties of M70 grade of concrete was studied.

KEYWORDS: Silica fume, Metakaolin, Compressive Strength, Split tensile Strength, lightweight aggregate; lightweight concrete.

I. INTRODUCTION

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

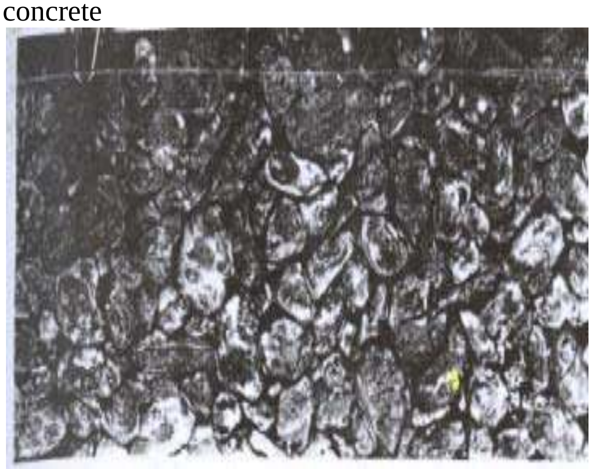

Figure 1: No-fines concrete

No-fines concrete normally utilized for both burden bearing and non-load bearing for outer dividers and segments. The quality of no-fines solid increments as the bond substance is expanded. 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.

No-fines concrete typically utilized for both burden bearing and non-load bearing for outer dividers and segments. The quality of no-fines solid increments as the concrete substance is expanded. In any case, it is delicate to the water arrangement. Deficient water can bring about absence of union between the particles and in this manner, resulting misfortune in quality of the cement. Similarly an excess of water can bring about bond film to keep running off the total to shape laitance layers, leaving the heft of the cement insufficient in concrete and along these lines 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. The fundamental normal for this lightweight total is its high porosity which brings about a low particular gravity.

The lightweight total solid can be partitioned into two sorts as indicated by its application. One is in part compacted lightweight total cement and the other is the basic lightweight total cement.

Somewhat compacted Lightweight total cement

The incompletely compacted lightweight total cement is chiefly utilized for two reasons that is for precast solid squares or boards and cast in-situ rooftops and dividers. The fundamental necessity for this kind of cement is that it ought to have sufficient quality and a low thickness to get the best warm protection and a low drying shrinkage to abstain from splitting.

Auxiliary Light weight concrete

Fundamentally lightweight total cement is completely compacted like that of the ordinary fortified cement of thick total. It can be utilized with steel support as to have a decent bond between the steel and the cement. The cement ought to give satisfactory insurance against the erosion of the steel. The shape and the surface of the total particles and the coarse way of the fine total have a tendency to deliver cruel cement blends. Just the denser assortments of lightweight total are suitable for utilization in auxiliary cement. Figure 2 demonstrates the component of lightweight total cement.

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Figure 2: Lightweight aggregate concrete

The structural light weight concrete is one of the important materials of construction. A concrete which is light in weight and sufficiently strong and to be used in conjunction with steel reinforcement will be a material which is more economical than the conventional concrete. Structural light-weight aggregate is a concrete having 28 days compressive strength larger than 17MPa and 28 days air dried unit weight should not exceeding 1850 kg/m^3. The concrete may consist entirely of light-weight aggregate (all light-weight concrete) or combination of light weight and normal-weight aggregates.

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.

There are two strategies to set up the circulated air through cement. The primary strategy is to infuse the gas into the blending amid its plastic condition by method for a compound response. The second strategy, air is presented either by whipping so as to blend in stable froth or in air, utilizing an air-entraining operators. The principal strategy is typically utilized as a part of precast solid manufacturing plants where the precast units are along these lines autoclaved to deliver cement with a sensible high quality and low drying shrinkage. The second system is principally utilized for as a part of situ concrete, suitable for protection rooftop screeds or funnel slacking. Figure 3 demonstrates the circulated air through cement.

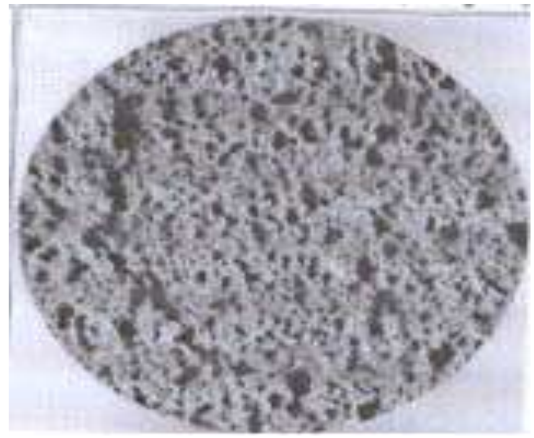

Figure 3: Aerated concrete

The differences between the types of lightweight concrete are very much related to its aggregate grading used in the mixes. Table 1 shows the types and grading of aggregate suitable for the different types of lightweight concrete .

1.3 ADVANTAGES AND DISADVANTAGES OF LIGHTWEIGHT CONCRETE

Table 2 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.

Table 2: Advantages and Disadvantages of Lightweight concrete

Advantages	Disadvantages
1. Rapid and relatively simple Construction 2) Economical in terms of transportation as well as reduction in manpower 3) Significant reduction of overall weight results in saving structural frames, footing or piles 4) Most of lightweight concrete have better nailing and sawing properties than heavier and stronger conventional concrete	1) Very sensitive with water content in the mixtures 2) Difficult to place and finish because of the porosity and angularity of the aggregate. In some mixes the cement mortar may separate the aggregate and float towards the surface 3) Mixing time is longer than conventional concrete to assure proper mixing

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.

II. REVIEW OF LITERATURE

2.0 GENERAL

Light weight concrete is a special type of concrete. One of the weaknesses of the traditional solid is the high self weight of the cement. Thickness of the ordinary solid is in the request of 2200 to 2600 kg/m^3. This overwhelming self weight will make it some degree an uneconomical structural material. Endeavors have been made in the past to diminish the self weight of the cement to build the productivity of the cement as a structural material. The light weight solid is a solid whose thickness shifts from 300 to 1850 kg/m^3.

There are points of interest of having low thickness. It helps for lessening of dead load to build the advancement of building, bring down the haulage and taking care of expenses. The weight of the expanding on the establishment is a paramount variable in configuration, especially on account of feeble soil and tall structures. In surrounded structures, the pillars and sections need to convey heap of the floors and dividers. If the floors and walls are made up of light weight concrete it will results in considerable economy. Another most important characteristic of light weight concrete is its low thermal conductivity. This property improves with decreasing density. The adaption of light weight concrete gives an outlet for industrial waste (silica fume) and dismantled waste (cinder) which otherwise creates problem for disposal.

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.

The aftereffects of this study uncovered the accomplishment of assembling high-quality air-entrained lightweight total cements utilizing sintered and frosty reinforced fly powder totals.

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.

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 Lightweight Concrete, while 10 mm size total with a 30% fly powder substitution properties of 30MPa concrete.

P.S. Raghu Prasad et al., has concentrated on the coarse aggregates in the customary robust solid concrete were supplanted in part with Cinder (12mm) and tried for compressive strength at the age of 3days, 7days and 21days. From the aftereffects of the examination, it can be reasoned that strong solid block with 15% substitution of coarse aggregate by cinder records more quality than the traditional one.

III. MATERIALS USED AND THEIR PROPERTIES

3.0 GENERAL

In this chapter deals with the constituents used in preparing the Light weight concretemixtures. The materials include Ordinary Portland cement (OPC), silica fume, fly ash,coarse aggregate fine aggregate, cinder aggregate and water. Details and testing results of each constituent are given below.

3.1 CEMENT

Invention of Portland cement by John Aspidin which is fine gray powder. Among the various kinds cement it is the most commonly used as binding material. It is a mixture of chalk or limestone together with clay.

Apart from OPC, there are several other types of cement, e.g. sulphates resistant cement, colored cement, oil well cement, expansive cement, etc. Ordinary Portland Cement of 53 grade Ultra tech cement brand confirming to IS 12269:1987 standard is used in the present investigation. The cement is tested for its various properties as per IS 4031:1988 and found to be conforming to the requirements as per IS 12269:1987. Various tests conducted on cement to determine its properties.

- Specific gravity of cement
- Normal consistency of cement
- Initial and final setting times of cement
- Compressive strength of cement

Specific gravity	3.14
Normal consistency	30 %
Initial setting time, min	45
Final setting time , min	700
Compressive strength, N/mm2	52

3.2 POZZOLANIC ADMIXTURES IN CONCRETE

Pozzolanas are either normally happening or accessible as waste materials. They for the most part contain silica, which gets to be receptive in the vicinity of free lime accessible in concrete when pozzolanic admixtures are blended with bond. The reactivity fluctuates relying on the kind of pozzolana, its compound arrangement and its fineness. In creating nations like India, pozzolanic materials are chiefly accessible as modern waste by-items, Fly cinder, silica smoke, impact heater slag, stone dustetc., are a percentage of the mechanical squanders and MetaCem is a quality controlled responsive pozzolana, produced using cleansed kaolin which have pozzolanic receptive properties. Broad exploration work has been completed on the utilization of pozzolanas in development materials. Out of the above pozzolanic admixtures, Fly fiery remains can be considered as the one, which is inexhaustibly accessible. Fly fiery remains cement has notable alluring and upgraded properties contrasted with normal plane cement. Silica smoke produced using filtered kaolin is not mechanical waste item, can be prescribed to be utilized alongside bond to determine certain improved properties for solid in extraordinary circumstances.

3.3 **SILICA FUME**

In the refractories world thirty-five prior, nobody was working with silica smoke and few realized what it was. Inside of a couple of years, it was being utilized as an admixture to block. At the point when amountof substantial Alumina block, mullite was framed in the framework of the block on terminating, giving the block great volume quality, quality and synthetic resistance. At the point when utilized as a part of fundamental block, expansive qualities came about atleast at 2700 F, which spoke the truth the farthest point of what could be tried. At the time it was just conclusion that silica smoke would be utilized as a part of block not cast capable. Block were utilized for exceptionally imperative applications; nobody would have plausibility of utilizing thrown capable. Today's headstrong cast capable have gone past having "block like properties" to really out bit of work block in numerous applications. Silica smoke has assumed a greater part in this change.

3.3.1 Physical properties and Chemical composition of Silicafume

Physical properties

- Small piece diameter is about 0.1 micron to 0.2 micron
- Surface area about 30,000 m2/kg
- Density varies from 150 to 700 kg/m3

When its density is about 550 kg/m3 it is suitable for concrete additive.

Chemical composition

Contains more than 90% silicon dioxide and other produce arts like carbon, sulphur and oxides of aluminum, iron, calcium, magnesium, sodium and potassium.

sample of Silica fume is shown in Plate 4.8

Table 3 shows that the physical and chemical properties of silica fume

Physical properties	Results
Physical State	Micronized Powder
Odour	Odourless
Appearance	White Colour Powder
Colour	White
Pack Density	0.76 gm/cc
PH of 5% Solution	6.90
Specific Gravity	2.63
Moisture	0.058%
Oil Absorption	55 ml / 100 Gms
Chemical Properties	
Silica (SiO_2)	99.886%
Alumina (Al_2O_3)	0.043%
Ferric Oxide (Fe_2O_3)	0.040%
Titanium Oxide (TiO_2)	0.001%
Calcium Oxide (Cao)	0.001%
Magnesium Oxide (Mgo)	0.000%
Pottasium Oxide (K_2O)	0.001%
Sodium Oxide (Na_2O)	0.003%
Loss On Ignition	0.015%

Chemical composition and classification

Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify rapidly while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 µm to 300 µm. The major consequence of the rapid cooling is that only few minerals will have time to crystallize and that mainly amorphous, quenched glass remains. Nevertheless, some refractory phases in the pulverized coal will not melt (entirely) and remain crystalline. In consequence, fly ash is a heterogeneous material. SiO_2, Al_2O_3, Fe_2O_3 and occasionally CaO are the main chemical components present in fly ashes. The mineralogy of fly ashes is very diverse. The main phases encountered are a glass phase together with quartz mullite and the other oxides hematite, magnetite. Other phase often identified are cristobalite anhydrite free lime percales calcite, halite.

Component	Bituminous	Sub bituminous	Lignite
SiO2 (%)	20-60	40-60	15-45
Al2O3 (%)	5-35	20-30	20-25
Fe2O3 (%)	1040	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

3.5 COARSE AGGREGATE

Conventional Natural Aggregate (Granite) and Light Weight Aggregate (Cinder) are used in the concrete mixes. Machine Crushed granite aggregate conforming to IS 383:1970 consisting 20 mm maximum size of aggregates has been obtained from the local quarry. The Cinder is hand broken to 20 mm size. Both granite and cinder have been tested for Physical and Mechanical Properties such as Specific gravity, Bulk Density, Sieve Analysis.

3.5.1 Specific gravity and water absorption test

The specific gravity of an aggregate is considered to measure the quality or strength of the material. The Specific Gravity test also helps identifying the stone specimen.2 Kg of dry aggregate sample is placed in wire basket and to become completely immersed in water for 24 hours. The sample is consider in water and the buoyant weight is found. The aggregate are then taken out consider after drying the surface. Then the aggregate are dried in oven for 24 hours at a temperature 100 to 110^{0}C, and then the dry weight is found. The specific gravity is calculated by dividing the dry weight of aggregate by weight of equal volume of water.

Water Absorption is expressed as the percent water absorbed in terms of over dried weight of the aggregate.

Specific Gravity of Aggregate

Specific gravity of light weight cinder aggregate is 2.33

Specific gravity of Granite aggregate is 2.75

Water absorption of aggregate

Water absorption of light weight cinder aggregate is 16%

Water absorption of Granite aggregate is 0.5%

3.5.2 Bulk density

The bulk density or unit weight of an aggregate gives significant data's with respect to the shape

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and grading of the aggregate. For a given specific gravity the angular aggregates demonstrate a lower bulk density. The bulk density of aggregate is calculated by filling a container of known volume in a standard way and weighing it. Bulk density indicates how densely the aggregate is placed when filled in a standard way. The bulk density replies on particle size distribution and shape of the particles. One of the early routines of mix design make utilization of this parameter bulk density in proportioning of concrete mix. The higher the bulk density, lower is the void substance to be filled by sand and concrete.

For determination of bulk density the aggregates are filled in the container and then they are compacted in a standard way. The weight of the aggregate gives the bulk density calculated in kg/liter or kg/m^3. Knowing the specific gravity of the aggregate in saturated and surface-dry condition, the void ratio can also be calculated.

$$\text{Percentage voids} = \frac{(G_s - y) \times 100}{G_s}$$

Where Gs = specific gravity of the aggregate
and y = Bulk density in kg/liter

3.5.3Aggregate crushing test

Crushing strength of road stones may be decide either on aggregates or on cylindrical specimen cut out of rocks. These two tests are not very different in not only the come near but also in the show of the results. Aggregates used in road construction, should be strong as much as is necessary to resist crushing under traffic wheel loads. If the aggregates are weak, the change of pavement structure is likely to be adversely influence. The strength of coarse aggregates is value by aggregates crushing test. The aggregate crushing value supply a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of pavement, aggregate to have low aggregate crushing value should be preferred.

$$\text{Aggregate crushing value} = \frac{100\,XW3}{W1}$$
$$= \frac{100\,X0.97}{2}$$
$$= 48.5\%$$

3.5.4 Aggregate impact test

Impact test is used to evaluate the toughness of stone or the resistance of aggregate to fracture under repeated impacts.

Aggregate specimen passing 12.5mm sieve and retained on 10mm sieve is replace in the cylindrical measure in 3 layers by tamping each layer by 25 blows. The sample is then move from the measure to the cup in aggregate impact testing machine.

After subjecting the sample to 15 blows by hammer of weight 13.5 to 14 kg, it is sieved on 2.36mm sieve. The aggregate impact value is show as the percentage of the fine formed in terms of total weight of the sample.

$$\text{Aggregate impact value} = \frac{B}{A} \times 100$$

Where B = weight of fraction passing 2.36mm IS sieve
A = weight of oven dried sample

$$= \frac{150}{300} \times 100$$
$$= 50\%$$

Table 3.2 Permissible limits for solids

Sl.No	Parameter	Tested as per code	Permissible limit, Maximum
i)	Organic	IS 3025 (Part 21)	200 mg/l
ii)	Inorganic	IS 3025 (Part 21)	3000 mg/l
iii)	Sulphates (as SO_3)	IS 3025 (Part 24)	400 mg/l
iv)	Chlorides (as Cl)	IS 3025 (Part 32)	2000 mg/l for concrete not containing embedded steel 500 mg/l for R.C.C. work
v)	Suspended matter	IS 3025 (Part 17)	2000 mg/l

IV. EXPERIMENTAL INVESTIGATION

4.1 GENERAL

The mix design has been conducted for M20 concrete making use of ISI method of mix design using normal constituents of concrete. In the course of investigation normal granite aggregate has been replaced by light weight aggregate namely (cinder) in percentages of 0%, 25%, 40%, 60%, 75% and 100%. In the present investigation the OPC cement has been replaced by admixture (silica fume) in three percentages i.e. 5, 10, 15 and admixture (fly ash) in three percentages i.e. 10, 20, 30. For the study of various properties, totally 180 specimens have been cast and tested. Here a constant water cement ratio of 0.50 has been adopted

The experimental part of the investigation has been planned in the following three stages.

Stage 1: Procurement of materials and its testing.

Stage 2: Moulding of specimens and curing.

Stage 3: Testing of specimens.

4.2 STEPS OF EXPERIMENTATION

4.2.1 Procurement of materials and its testing

Materials used in the concrete are fine aggregate, coarse aggregate(granite), light weight aggregate (cinder), cement, water, Silica fume, Fly ash have been procured from various places. Fine aggregate has been procured from Penna River chenur. Coarse aggregate (20mm) has been procured from Kadapa. Local drinking water is used for mixing and curing. Cinder (20mm) has been procured from yerraguntla. The Silica fume is obtained from Astraa chemicals Ltd Chennai.

4.2.2 Cement

Locally available Ultra Tech Ordinary Portland Cement (OPC) of 53 grade of Cement conforming to ISI standards has been procured, and following tests have been carried out according to IS 8112:1989.

The results of following tests are tabulated in table 4.1

- Specific gravity of Cement
- Normal Consistency of Cement
- Initial and Final setting time of Cement
- Compressive Strength of Cement

4.2.3 Fine aggregate

Fine aggregate is locally available natural river sand and is found to be conforming to grading zone-2 of table 4. of IS 383:1970 it has been used as fine aggregate. Following tests have been carried out as per the procedure given in IS 383:1970.

- Specific gravity
- Sieve Analysis

4.2.4 Conventional natural aggregate (granite) and light weight aggregate (cinder)

Machine Crushed granite aggregate conforming to IS 383:1970 consisting 20 mm maximum size of aggregates has been obtained from the local quarry. The Cinder are hand broken to 20 mm size. Both granite and cinder have been tested for Physical and Mechanical Properties such as Specific gravity, Bulk Density, Sieve Analysis, Crushing and Impact tests.

4.2.5 water

Locally available water used in the experimental program for mixing and curing.

4.2.6 Mix case considered

Mix design can be characterized as the methodolgy of selecting suitable ingredients of concrete and determining their relative proportions with the objective of producing concrete of certain minimum strength as economically as possible. The design of concrete mix is not a easy task on basis of widely varying properties of constituent materials.

In the present investigation M20 grade of concrete has been considered. The mix design of concrete is taken as per the guidelines given in IS 10262:2009. Mixes were prepared with a replacement of granite aggregate with cinder aggregate in the percentages of 0, 25, 40, 60, 75 and 100 and the replacement of cement by silica fume in percentages of 5, 10, 15 and fly ash in the percentages of 10, 20, 30 by weight of cement. Standard Mix design using conventional aggregate has been given in Appendix-A.

Plate 4.1 Casting of cubes with vibrator

4.2.9 Curing procedure

After the casting of cubes and cylinders, the moulds were kept for air curing for one day and the specimens were removed from the moulds after 24 hours of casting. Marking was done on the specimens to identify the specimens. All the specimens were cured in curing tanks for the desired age i.e. 28 days. The identification of the specimens is as follows.

Plate 4.3 Curing of specimens

Cinder Aggregate	Mix Designation					
0%	CA-0 SF5	CA-0 SF10	CA-0 SF15	CA-0 FA10	CA-0 FA20	CA-0 FA30
25%	CA-25 SF5	CA-25 SF10	CA-25 SF15	CA-25 FA10	CA-25 FA20	CA-25 FA30
40%	CA-40 SF5	CA-40 SF10	CA-40 SF15	CA-40 FA10	CA-40 FA20	CA-40 FA30
60%	CA-60 SF5	CA-60 SF10	CA-60 SF15	CA-60 FA10	CA-60 FA20	CA-60 FA30
75%	CA-75 SF5	CA-75 SF10	CA-75 SF15	CA-75 FA10	CA-75 FA20	CA-75 FA30
100%	CA-100 SF5	CA-100 SF10	CA-100 SF15	CA-100 FA10	CA-100 FA20	CA-100 FA30

4.3 TESTING PROCEDURE

4.3.1 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.

4.3.2 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

4.3.3 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

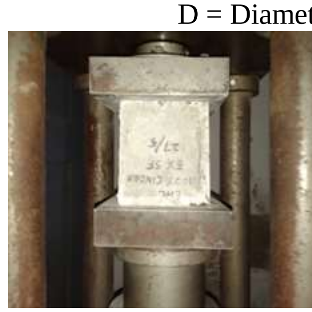

Plate 4.5 Testing of cylinder by split tensile

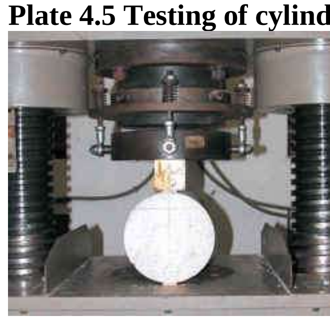

Plate 4.4 Testing of cube

V. DISCUSSIONS OF TEST RESULTS

5.1. DISCUSSION OF TEST RESULTS

5.1.1 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

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 9, September : 2023

replacements of cement by silica fume are shown in table 7. The graphical variations of compressive strength versus percentage replacement of cement by silica fume are shown in fig 5.1. From the above table 7 and fig 5.1 it may be observed that there is an increase in compressive strength for the replacement of cement by silica fume as 5% and for 10% and 15% the strength gets decreased.

The compressive strength results with 25% natural aggregate being replaced by 75% cinder aggregate and with different percentage replacements of cement by silica fume are shown in table 7. The variations of compressive strength versus percentage replacement of cement by silica fume are shown in fig 5.1. From the above table 7 and fig 5.1 it may be observed that there is an increase in compressive strength for replacement of cement by silica fume up to 5% and for 10% and 15 % the strength gets decreased.

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.

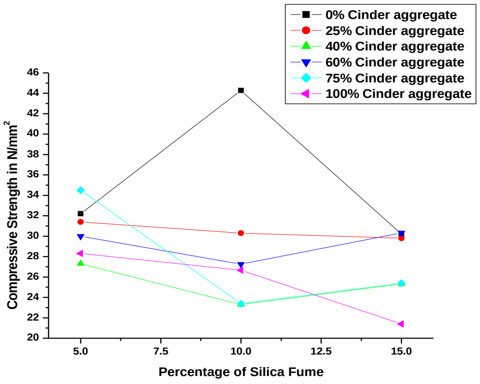

Fig 5.1 Compressive strength with different percentages of cinder aggregate with different percentages of silica fume

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

The compressive strength results with 100% natural aggregate being replaced by 0 % cinder aggregate and with different percentages replacements of cement by fly ash are shown in table 8. The graphical variations of compressive strength versus percentage replacement of cement by fly ash are shown in fig 5.2. From the above table 8 and fig 5.2 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.

The compressive strength results with 0% natural aggregate being replaced by 100% cinder aggregate and with different percentage replacements of cement by fly ash areshown in table 8. The variations of compressive strength versus percentage replacement of cement by fly ash are shown in fig 5.2. From the above table 8 and fig 5.2 it may be observed that there is an increase in compressive strength for replacement of cement by fly ash as 20% and from 10% and 30% the strength gets decreased.

Hence, from the above discussions 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.

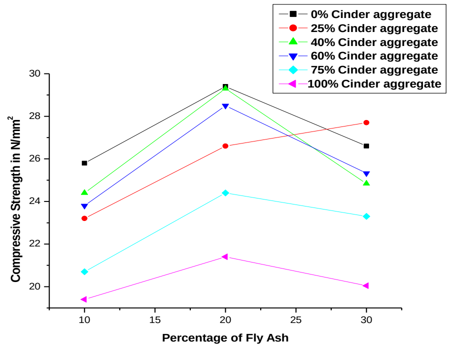

Fig 5.2 Compressive strength with different percentages of cinder aggregate with different percentages of fly ash

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

The split tensile strength results with 100% natural aggregate and with different percentages replacements of cement by silica fume are shown in table 9. The variation of split tensile

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 9, September : 2023

strength versus percentage replacement of cement by silica fume are shown in fig 5.3. From the above table 9 and fig 5.3 it may be observed that there is an increase in split tensile strength for the replacement of cement by silica fume as 5% and from 10% and 15% the strength gets decreased.

The split tensile strength results with 40% natural aggregate being replaced by 60% cinder aggregate and with different percentage replacements of cement by silica fume are shown in table 9. The variations of split tensile strength versus percentage replacement of cement by silica fume are shown in fig 5.3. From the above table 9 and fig 5.3 it may be observed that there is an increase in split tensile strength for replacement of cement by silica fume as 5% and from 10% and 15% the strength gets decreased.

The split tensile strength results with 0% natural aggregate being replaced by 100% cinder aggregate and with different percentage replacements of cement by silica fume are shown in table 9. The variations of split tensile strength versus percentage replacement of cement by silica fume are shown in fig 5.3. From the above table 9 and fig 5.3 it may be observed that there is an increase in split tensile strength for replacement of cement by silica fume as 5% and from 10% and 15% the strength gets decreased.

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 split tensile within the scope of present investigation.

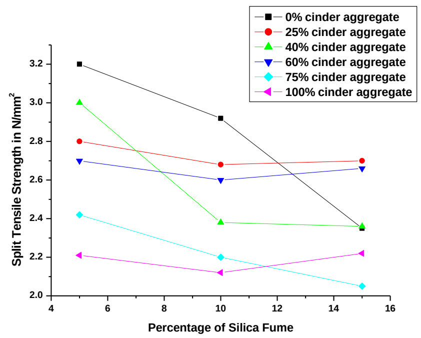

Fig 5.3 Split Tensile strength with different percentages of cinder aggregate with different percentages of fly ash

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

The split tensile strength results with 100% natural aggregate and with different percentages replacements of cement by fly ash are shown in table 10. The variation of split tensile strength versus percentage replacement of cement by fly ash are shown in fig 5.4. From the above table 10 and fig 5.4 it may be observed that there is an increase in split tensile strength for the replacement of cement by fly ash as 20% and from 10% and 30% the strength gets decreased.

The split tensile strength results with 0% natural aggregate being replaced by 100% cinder aggregate and with different percentage replacements of cement by fly ash are shown in table 10. The variations of split tensile strength versus percentage replacement of cement by fly ash are shown in fig 5.4. From the above table 10 and fig 5.4 it may be observed that there is an increase in split tensile strength for replacement of cement by fly ash as 20% and from 10% and 30% the strength gets decreased.

Hence, from the above discussions 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 split tensile within the scope of present investigation.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 9, September : 2023

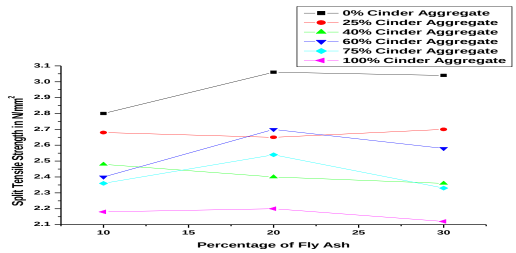

Fig 5.4 Split Tensile strength with different percentages of cinder aggregate with different percentages of fly ash

TABLES

Table 4: Tests Results On Cement

S NO	Name of the test conducted	Results
1	Specific Gravity	3.14
2	Initial Setting Time	45 min
3	Final Setting Time	700 min
4	Soundness Test	2 mm
5	Fineness of Cement	3 %
6	Compressive Strength of Cement 28 days	52 Mpa

Table 5: Sieve Analysis of Fine Aggregate

S NO	Is Sieve Size	Cumulative Weight Retained In (grams)	Weight Retained	Cumulative % Weight Retained (F)	% Passing (100-F)
1	4.75	25	2.5	0.25	99.75
2	2.36	20	2	2.25	97.75
3	1.18	130	13	15.25	84.75
4	0.6	570	57	72.25	27.75
5	0.3	225	22.5	94.75	5.25
6	0.15	15	1.5	96.25	3.75
	PAN	15	1.5		100
		1000		281	

Table 6: Sieve Analysis of Coarse Aggregate

SNO	Is Sieve Size	Cumulative Weight Retained In (grams)	Weight Retained	Cumulative % Weight Retained (F)	% Passing (100-F)
1	80	0	0	0	100
2	63	0	0	0	100
3	50	0	0	0	100
4	40	0	0	0	100
5	31.5	30	0.3	0.2	99.8
6	25	1120	11.2	11.5	88.5
7	20	4170	41.7	53.2	46.8
8	12.5	4360	43.6	96.8	3.2
9	10	220	2.2	99	1
10	6.3	90	0.9	99.9	0.1
11	4.75	10	0.1	100	0
				460.6	

Table 7:Compressive strength of concrete with replacement of cinder aggregate and silica fume

S.No.	Mix Designation	Compressive Strength, N/mm²
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

Table 8:Compressive strength of concrete with replacement of cinder aggregate and fly ash

S.No	Mix Designation	Compressive Strength, N/mm²
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

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 52, Issue 9, September : 2023

PLATES

Plate 4.6 Cinder Aggregate

Plate 4.7 20 mm Cinder

Plate 4.8 A sample of Silica fume

Plate 4.9 Mixing of Silica fume with cement

Plate 4.10 Mixing of cinder with cement

Plate 4.13 Casted cubes and cylinders

Plate 4.14 Crack pattern of cube

Plate 4.15 Crack pattern of cylinder

VI. 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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