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Light Weight Concrete Using Cinder – A Review

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Abstract- The rising demand in the building industry has resulted in an increase in the cost of concrete production. The rising cost of construction materials prompted researchers to develop new low-cost, high-strength construction materials. Aggregates play a significant role in concrete volume, accounting for 60 to 70 percent of overall volume. As a result, they have a significant impact on several material qualities such as density, specific gravity, and water absorption, among others. The coarser normal weight aggregate in traditional concrete can be partially or completely replaced with low density particles, resulting in light weight concrete with strong compressive resistance.

Keywords- Cinder, light weight aggregate, compressive strength, tensile strength, density specimens and Youngs modulus.

I. INTRODUCTION

Except for the use of light weight aggregates or a combination of light weight aggregates and standard aggregates, the composition of light weight concrete is comparable to that of conventional concrete. In some circumstances, low weight materials are used to substitute fine aggregates. When compared to regular conventional concrete, the bond between the cement and particles in light weight concrete is strong. Concrete should have a better strength for structural purposes. Expanded shale, slate, cinder, pumice, and other light weight aggregates are commonly utilised in structural light weight concrete. (1)

It offers numerous advantages, including dead load reduction, good thermal insulation, increased construction progress, and lower handling costs. The use of light-weight concrete for floors and walls results in structural savings. Due to its low thermal conductivity, it also reduces power usage in adverse climatic conditions. Precast and prestressed components now frequently use lightweight concrete. By delivering less dead load, improved seismic structural response, better fire rating, decreased storey height, smaller structural elements, cheaper foundation cost, and less reinforcing steel, light weight concrete provides design freedom and significant cost savings. It is commonly used in other nations such as the United States, the United Kingdom, and Sweden.(2)

1.1 TYPES OF LIGHTWEIGHT CONCRETE -

Lightweight concrete can be made by infusing air into the mix, or by eliminating or substituting the finer aggregate sizes with hollow, cellular, or porous aggregates. Lightweight concrete, in particular, can be divided into three categories:

i) No-fines concrete

ii) Lightweight aggregate concrete

iii) Aerated/Foamed concrete .

A lightweight concrete made up of cement and fine aggregate is known as no-fines concrete. Throughout its mass, uniformly distributed voids form. When placed on the wall, the major characteristics of this type of lightweight concrete are that it retains its big spaces and does not create laitance layers or cement film. For external walls and partitions, it is commonly utilised for both load bearing and non-load bearing applications. As the cement content is raised, the strength of no-fines concrete increases. Insufficient water can result in a lack of cohesiveness between the particles and, as a result, a loss of concrete streng . Similarly, too much water can cause cement film to run off the aggregate, forming laitance

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layers, leaving the concrete deficient in cement and weakening its strength. Instead of standard concrete, porous lightweight aggregate with a low specific gravity is employed in this lightweight Concrete.

Natural aggregates such as pumice, scoria, and other volcanic materials, as well as manmade aggregates such as expanded blast-furnace slag, vermiculite, and clinker aggregate, are examples of lightweight aggregate. This lightweight aggregate's key feature is its high porosity, which leads in a low specific gravity. Depending on the use, lightweight aggregate concrete can be classified into two types. The structural lightweight aggregate concrete and the partially compacted lightweight aggregate concrete are two different types of lightweight aggregate concrete. Precast concrete blocks or panels, as well as cast in-situ roofs and walls, are the two principal applications for partially compacted lightweight aggregate concrete. The key requirements for this type of concrete are enough strength and low density in order to achieve the best thermal insulation and low drying shrinkage in order to minimise cracking. Lightweight aggregate concrete is structurally comparable to dense aggregate reinforced concrete in that it is entirely compacted. It can be used in conjunction with steel reinforcing to ensure a strong binding between steel and concrete. The steel should be well protected from corrosion by the concrete. The coarse nature of the fine aggregate, as well as the form and texture of the aggregate particles, tend to produce harsh concrete mixes.

Aerated concrete is a type of aerated mortar that does not contain coarse material. Aerated concrete is often formed by mixing air or another gas into a cement slurry and fine sand. In commercial usage, pulverised fuel ash or other siliceous material is used instead of sand, and lime is sometimes used instead of cement. The aerated concrete can be prepared in two ways. The first way is to use a chemical process to inject the gas into the mixed while it is still plastic. This technology is commonly employed in precast concrete plants, where precast units are autoclaved to produce concrete with a reasonable high strength and moderate drying shrinkage.In the second procedure, air is introduced by either mixing in stable foam or whipping in air with an air-entraining agent. It's primarily utilised for in-place concrete, such as insulation roof screeds or pipe lagging

.**1.2 CINDER**: Cinder is a light-weight igneous rock that occurs naturally. It's a pyroclastic material that looks like pumice and has many voids with a low density, allowing it to float in water. Cinder comes in a variety of colours, including black, brown, and red, depending on its chemical composition. Scoria is another term for it these days. Volcanic cinders are uncemented, vitric, and include bubble-like cavities known as vesicles that are at least 2.0 mm in diameter (1). Because of the mineral structure, the surface of cinder aggregate is usually rough and porous. Because cinder includes a high percentage of air, it is inherently a stronger sound absorption, sound proofing, and thermal insulation material. Its low density aids in the elimination of dead load, enhances building progress, and reduces handling expenses. The low thermal conductivity of light weight concrete is its most distinguishing feature. The concrete manufactured with it is lighter than natural concrete due to its low specific gravity. (3,4)

1.3 FLY ASH : It is a coal combustion product made up of particulates (fine particles of burned fuel) and flue gases that are discharged from coal-fired boilers. Bottom ash is ash that settles at the bottom of a boiler's combustion chamber (also known as a firebox). Fly ash is often caught by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys in modern coal-fired power plants. It's referred to as coal ash when it's combined with bottom ash scraped from the boiler's bottom.(5) Fly ash contains larger or less reactive particles than Portland cement, and a considerable period of moisturization can last for six months, resulting to greater final strength than concrete without fly ash.

The American Society for Testing and Materials (ASTM) C618 distinguishes between two types of fly ash: Class F and Class C. The amount of calcium, silica, alumina, and iron in the ash are the primary differences between these classes.

Fly ash from Class F is pozzolanic in nature and includes about 7% lime (Cao). Because Class F fly ash has pozzolanic qualities, it needs a cementing agent, such as Portland cement, quicklime, or hydrated lime coupled with water, to react and generate cementitious compounds. A geopolymer can also be formed by mixing a Class F ash with a chemical activator like sodium silicate (water glass).

The hardening and strengthening of Class C fly ash occurs over time. The lime content of Class C fly ash is usually over 20%. (Cao). Unlike Class F fly ash, which requires an activator, self-cementing Class C fly ash does not. In general, Class C fly ashes have higher alkali and sulphate (SO4) concentration.

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Fly ash contains larger or less reactive particles than Portland cement, and a considerable period of moisturization can last for six months, resulting to greater final strength than concrete without fly ash.(8)

II. REVIEW ON LITERATURE

Mr. Anil Kumar R (1), In this work, The strength properties of structural light weight concrete produced by replacing coarse aggregate with light weight aggregates such as Cinder and Leca blended in various percentage proportions 0:100, 10:90, 20:80; 30:70; 40:60, 50:50 and vice versa by volume of concrete are investigated in this study. The mechanical qualities are investigated by casting 33 simple cube specimens with dimensions of 150 x 150 x 150mm in cylindrical moulds with dimensions of 150 x 300mm. The average compressive strength and split tensile strength of M20 grade light weight concrete with 60% Cinder and 40% Leca GGBFS (Ground Granulated Blast Furnace Slag) is used to replace 20% of the cement in the mix, bringing the compressive strength closer to that of conventional aggregate concrete.

Dr. V. Bhaskar Desai (3) , In this present study The strength properties of light weight cinder aggregate cement concrete in various percentage proportions of 0, 25, 50, 75, and 100 by volume of light weight aggregate concrete are investigated. The ISI method was used to create five different M20 concrete mixes, each having a mix percentage of 1:1.55:3.04 and a water cement ratio of 0.50. The mechanical qualities are investigated by casting and testing roughly 105 samples, which include 15 plain cube specimens measuring 150 x 150 x 150mm, 60 DCN specimens measuring 150x150x150mm, and 30 cylinders measuring 150mm dia. and 300mm height. The cylinder compressive strength, split tensile strength, and young's modulus are found to be decreased continuously with the increase in percentage of cinder . The cinder aggregate is no way inferior to the natural aggregate.

E Hanuman Sai Gupta(4) In this paper, The impact of cinder aggregate and cinder powder on concrete's mechanical characteristics are discussed. The experiments are carried out by substituting varying percentages of cinder aggregate with a water-cement ratio of 0.47 for the granite coarse aggregate. Similarly, cinder powder partially replaces fine aggregate (sand). In traditional M25 grade design mix concrete, a 20 mm nominal size cinder coarse aggregate and cinder powder were employed at various percent replacement levels. Standard-size cubes, cylinders, and beam specimens are casted and evaluated for compression, split, and flexural stress after 28 days. According to the findings of the tests, cinder is one of the best possibilities for coarse and fine aggregates in conventional concrete production in terms of density and workability, though the cost is higher At various replacement levels, strength growth is little. Cinder aggregate concrete with a 40% cinder replacement level had the same target mean strength as conventional concrete. This demonstrates that granite aggregate can be replaced with 40% cinder aggregate to meet the desired mean strength after 28 days.

Sanjana M (5) ,In this study, By partially replacing Natural Course Aggregate with Cinder and completely replacing sand with Fly Ash Granules, an attempt has been made to analyse the conventional concrete and light weight aggregate concrete for M20 Grade. Partial replacement of coarse aggregate with distinct ratios of cinder ranging from 20%, 40%, 60%, and 100% is used to make light weight concrete. The goal of this research is to determine the compression strength, flexural strength, and split tensile strength parameters of light weight aggregate concrete in order to determine the best replacement with the above-mentioned alternatives. According to the findings of this study, a percentage reduction in strength is balanced by a percentage reduction in weight due to the addition of light weight Cinder, resulting in a reduction in total dead weight of the structure, and concrete strength in compression, tension, and flexure decreases as the percentage of Cinder increases. Cinder can replace natural coarse aggregates up to 60% of the time.

Ankit Kumar Agrawal (6) , Fine and coarse aggregates are partially replaced with cinder and cinder powder in this study. The primary benefit of using cinder material is that it lowers costs, reduces trash disposal, and aids in the reduction of dead load. In this study, the mechanical properties of M25 grade concrete were investigated by replacing coarse aggregate with cinder at various percentages, such as 0%, 20%, 40%, 60%, 80%, and 100%, and fine aggregate with cinder powder at 10%, 20%, 30%, 40%, and 50%, with a 28-day curing period. It was determined that the usage of cinder powder had no significant impact on the strength qualities of concrete. With the partial substitution of fine aggregate with cinder powder, the % drop in strength is relatively small. Cinder aggregate concrete with a 40 percent cinder replacement level had the same target mean strength as conventional concrete. This demonstrates that granite aggregate can be replaced with 40% cinder aggregate to meet the specified mean strength after 28 days.

Nagashree B (7) , In this study, It begins with an examination of light weight aggregate concrete made with leca and cinder as coarse aggregates. Both M20 and M30 grade concrete mixtures are designed. Blended aggregates (leca and cinder) replace coarse materials in varied quantities by volume. For both M20 and M30 grade concrete mixes,

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150x150x150mm cubes are cast by adjusting the amounts of leca and cinder. For each proportion, a slump test is performed on fresh concrete. In order to determine the hardened properties of concrete, cubes and cylinders are cast for each mixed proportional %.The experimental results reveal that replacing the coarse aggregate proportion with 40 percent leca and 60 percent cinder aggregates yielded better outcomes in terms of strength, weight, and density.

Dhanraj A C (8), An experiment was carried out on concrete using another light weight aggregate to partially replace the traditional coarse aggregate. M30 concrete is made by replacing coarse aggregate with cinder in various amounts, such as 0%, 20%, 40%, 60%, 80%, and 100%, then curing it for 7 days and 28 days. Both M30 grade concrete mixes are used to cast 150x150x150mm cubes by altering the quantities of leca and cinder. The results of the investigation show that when the proportion of cinder increases, the cylinder compressive strength, split tensile strength, and young's modulus drop.

Majji Neelima (9), With granite, pumice, and cinder aggregates in proportions of 50%, 75%, and 100%, M30 grade concrete with three mix proportions is considered in this work. This study seeks to determine the compression strength, flexural strength, and split tensile strength parameters of light weight aggregate concrete in order to determine which of the above-mentioned replacements is the most suitable. Using cinder aggregate reduces the unit weight of concrete by 30%, whereas using pumice aggregate reduces it by 34.75 percent. Cinder aggregate concrete's compressive strength is lowered by 4.34 percent, 5.8 percent, and 11.6 percent when compared to natural aggregate concrete. Pumice aggregate concrete's compressive strength is lowered by 0%, 7.25 percent, and 10.14 percent when compared to natural aggregate concrete.Pumice aggregate concrete has shown higher strength results when compared with cinder aggregates. Higher percentages of light weight aggregates had given lesser compression strength.

Pramukh Ganapathy. C (10) , The purpose of this study is to see if cinder can be used as a partial replacement for coarse aggregate in concrete preparation. The purpose of this study is to examine the behaviour of concrete made with Portland Pozzolana Cement (PPC) in an M25 concrete mix with a water-cement ratio of 0.50. Workability-related tests on fresh concrete, such as Slump, Compaction factor, and V-bee test, are used to compare the performance of cinder-replaced concrete with ordinary concrete. Compression, split tensile, and flexural tests on hardened concrete were carried out in accordance with BIS criteria. The concrete using 30% cinder as a partial replacement for coarse aggregate has recorded the closest compressive and flexural strength values, as shown in the above test results.

Dr. N. Venkatesh (11), In this study, concrete was formed by replacing coarse aggregate with cinder in various percentages, such as 20%, 40%, 60%, 80%, and 100%, with curing times of 7 days and 28 days. Also, at levels above cinder replacement, determine the compressive strength of concrete. The ISI approach was used to develop a standard aggregate concrete mix for M20 grade concrete. Cubes of standard dimension 150 x 150 mm specimens were cast and examined after four different curing durations in this study. For each variable, three examples were cast, resulting in a total of 36 specimens being tested. According to the findings, replacing 60% of conventional aggregate with cinder by volume by weight gives the target mean strength.

Veeresh B (12), An experiment was carried out on concrete using another light weight aggregate to partially replace the traditional coarse aggregate. The IS technique was used to create the M20 concrete mix. We manufacture concrete by replacing coarse aggregate with various amounts of cinder, such as 0%, 10%, 20%, 40%, 60%, 80%, and 100%, then curing it for 7 to 28 days. The compressive strength is promising when cinder is used in light weight aggregate instead of natural coarse aggregate. With the addition of cinder aggregate to natural aggregate, the density of concrete is observed to be reduced. With an increase in Cinder content, the compressive strength of concrete is determined to remain within an acceptable range. The compressive, split-tensile, and flexural strengths of concrete are improved by adding mineral and chemical admixtures. Lightweight aggregate is comparable to natural coarse aggregate in terms of strength and can be utilised in building.

III. CONCLUSION

This study was carried out to assess the impact of employing cinder as a partial replacement in concrete composites, as well as to provide guidance on how to use these materials within a certain range. Several tests on the materials used in concrete composites were undertaken, and the results were recorded. We can learn the exact % increase in concrete's compressive and flexural strength, as well as the durability findings, from this investigation. As a result, cinder can be thought of as a high-efficiency replacement material. The results will be proven through an experimental investigation.

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