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"EXPERIMENTAL STUDY ON LIGHT WEIGHT CONCRETE OF GRADE M25 BY PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE WITH FLY ASH AND THERMOCOL"

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ABSTRACT:

The exponential rise in building development and urbanization has resulted in an unprecedented increase in the size and height of buildings. The bulk of buildings in India are made of concrete, which makes them extremely hefty. One of the restrictions on building towering structures is heavy loads. Lowering the weight of structures can also result in a reduction in foundation costs. One of the primary causes of the buildings' increased weight is conventional concrete. Reducing the overall weight of the building can be achieved with great effectiveness by using lightweight concrete. Coarse particles make up a bigger volume of traditional concrete. This study aims to replace traditional coarse aggregates with the extremely lightweight foam known as Styrofoam. Concrete with various We conducted tests on concrete with varying percentages of replacement aggregate. The density and compressive strength parameters exhibit highly positive outcomes.

I. INTRODUCTION:

The most popular and historically significant building material in the world is concrete. It is produced by properly combining cementing materials, water, aggregates, and occasionally admixtures. After being left to cure, the mixture solidifies and becomes concrete. Concrete's properties, including its mix ratio, compaction techniques, and placement, compaction, and curing times, all affect its strength, durability, and other qualities. It is extensively used in the construction industry due to its high compressive strength and low corrosive and weathering effects. Due to its high density, it has poor insulation qualities and weighs more than the live load carried during construction. Numerous aggregates are suitable for use in the production of concrete, according to extensive research in the field of materials for structural application. Among these are pumice, diatomite, Scotia, While artificial aggregates include foamed slag, lightweight expanded clay aggregate, volcanic, rice husk, and sawdust, they also include artificial cinders. In a rotary kiln heated to 1200 degrees Celsius, clay is expanded and vitrified to create lightweight expanded clay aggregate, or LFCA. The concrete gains these new properties: it is self-curing, lightweight, acoustically neutral, and heat resistant. The degree to which lightweight aggregates vary depends on their source and manufacturing process. differences in particle shape and texture. Shapes can be angular or cubic, and textures can range from fine pores to nine large exposed pores. The aggregate's porosity is what allows water to be retained, facilitating internal curing. This combination makes it more workable. Lightweight aggregate concretes are generally used in constructions where the concrete's dead weight accounts for a significant portion of the total load. This reduces the size of the footing beneath the subsurface and does away with the requirement for pricey foundations Concrete is currently the most appropriate and widely used creation fabric. Up until then, this building material underwent extensive development. Concrete is defined as an aggregate of cement, water, and occasionally fantastic plasticizers. The fabric is synthetic. It is initially miles soft, ductile, or fluid, and it may eventually solidify. This building material is recognizable to us as artificial stone. Cement is the component of concrete that is most important. The process used in the production of this raw fabric generates a significant amount of CO2. It is well known that harmful environmental changes are caused by CO2 emissions.

Concrete is currently the most appropriate and commonly used building material. Up until now, this construction material has undergone extensive development. A mixture of cement, water, additives, and occasionally super plasticizers is what is referred to as concrete. It is made of artificial materials. It is soft, ductile, or fluid at first, but it will eventually solidify. This construction material can be thought of as artificial stone. Cement is the component of concrete that matters most. This raw material's production generates a significant amount of CO2. It is commonly known that damaging environmental changes are caused by CO2 emissions. Researchers these days try to reduce CO2 emissions from industry. Using alternative materials to replace a portion of cement is the most efficient way to reduce the CO2 emissions from the cement industry. These substances are known as SCMs, or supplemental cementing materials. Fly ash is a common supplementary cementing material. Since this is usually an industrial by-product, using SCMs reduces the amount of CO2 produced when making cement. Because SCMs have additional benefits, they are being used in concrete technology more and more.

Aggregate, cement, and water are the main ingredients of concrete, a composite building material. Numerous formulations exist, each with unique properties. Typically, the aggregate consists of crushed rocks like granite or limestone in the form of coarse gravel, combined with a fine aggregate like sand. The cement, which is usually Portland cement, along with ten additional cementitious materials like fly ash and slag cement function as a binder for the aggregate.

To obtain a range of qualities, different chemical admixtures are also added. After adding water to the dry composite, it can be shaped—usually by pouring it—and then undergo hydration, a chemical process that solidifies and hardens the material into a strength comparable to that of rock. After the cement and water react, the remaining ingredients are fused together to form a sturdy substance that resembles stone. While its tensile strength is significantly lower, concrete has a relatively high compressive strength. Because of this, is typically reinforced with materials that are resilient to tension (typically steel).

II. LITERATURE REVIEW:

EXPERIMENTAL STUDY ON LIGHT WEIGHT CONCRETE BY PARTIAL REPLACEMENT OF CEMENT AND FINE AGGREGATE WITH FLY ASH AND THERMOCOL.

Nagaswaram Roopa :- K. Supriya

In the present scenario, several buildings are being constructed ranging from ordinary residential buildings to sky-scrap structures. Invariably in all the structures, concrete plays a vital role in construction. Generally concrete is a mixture of cement, fine aggregate (River sand), coarse aggregate, water and type of admixtures used depends upon the situations. Now-a days good sand is extracted and transported from river bed being in a long distance. The extraction of sand has become a serious issue, posing environmental degradation, thereby causing serious threats of flood or diversion of water flow. Never the less the resources are also exhausting very rapidly and economical. To overcome from this crisis, partial replacement of cement with fly ash and fine aggregate with Thermocol can be an economic alternative. This project focuses on investigating the characteristics of M25 grade of concrete with cement partially replace with fly ash 35%, 40% and fine aggregate replace with thermocol 0.2%, 0.3% respectively. The compressive strength of concrete is increases from 33.25 N/mm2 to 35.5 N/mm2 at 35% of fly ash and 0.2% of thermocol replacement; increases from 33.25 N/mm2 to 36.8 N/mm2 at 40% of fly ash and 0.3% of thermocol replacement. Fly ash Fly ash comes primarily from coal-fired, electricity-generating power plants. These power plants grind coal to powder fineness before it is burned.

Fly ash –The mineral residue left over after burning coal is called fly ash, and it is collected for use from the power plant's exhaust gases. Under a microscope, the distinction between Portland cement and fly ash is visible. Because fly ash particles are nearly entirely spherical in shape, they can easily flow and mix into mixtures.

That capability is one of the properties making fly ash a desirable admixture for concrete.

Thermocol - Expanded polystyrene (EPS), also known as Thermocol, is a tough and stiff closed-cell foam. Usually composed of pre-expanded polystyrene beads, it has a white color. It provides a rigid, closed, odorless, and non-hydroscopic cell. Thermocol's inert nature, water resistance, dimensional stability, and lightweight make application possible. Because polystyrene foams are effective thermal insulators, they are frequently used as building materials for structural insulated panel building systems and concrete form insulation. Graphite-infused grey polystyrene foam offers better insulation qualities. They are also utilized for architectural structures that don't support weight, like decorative pillars.Thrown-away polystyrene is resistant to photolysis and takes hundreds of years to biodegrade. Because of its specific gravity, polystyrene foam floats on water and blows in the wind. The health of birds or marine animals may be adversely affected.

1) Box Compression Tester.
2) Peel / Seal / Bond and Adhesion Strength Tester - Digital.
3) Core Compression Tester.
4) Bursting Strength Tester- Digital.
5) Co-efficient of Friction Tester.
6) Bursting Strength Tester Pneumatic - Computerized. Edge Crush Tester / ECT / RCT / FCT.
7) Cobb Sizing Tester.

EXPERIMENTAL STUDIES ON PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH IN CONCRETE ELEMENTS

K.V. Sabarish

Presently large amount of fly ash is generated in thermal power plants as a waste material with an improper impact on environment and humans. Fly ash a waste generated by thermal power plants is as such a big environmental concern. The experimental studies on mortar containing fly ash as a partial replacement of sand by weight as well as by volume were carried out to quantify its utilization. Both the types of pond and bottom fly ash in various ratios were used in preparing cement mortar and their strengths in compression and tension were tested. The use of fly ash in concrete formulations as a supplementary cementations material was tested as an alternative to traditional concrete. The cement has been replaced by fly ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30% & 40% by weight of cement for M-25. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength up to 28 days and split strength for 56 days are taken.

Cement: Ordinary Portland cement (Ultra-Tech Cements of 53 grades) was used having specific gravity: 3.15, 32.5% Consistency and Compressive strength 54 MPa

Fine Aggregate: Natural sand with maximum size of 4.75 mm was used (zone II) with specific gravity 2.6 and fineness modulus 2.63.

Coarse Aggregate: Natural aggregates with maximum size of 40 mm were used with specific gravity of 2.7 and fine modulus 7.51.
LIGHTWEIGHT CONCRETE USING EPS
Abhijit Mandlik1, **Tarun Sarthak Sood**2, **Shekhar Karade**3, **Sangram Naik**4, **AmrutaKulkarni**5
Expanded polystyrene (EPS) geofoam is a lightweight material that has been used in engineering applications since at least the 1950s. Its density is about a hundredth of that of soil. It has good thermal insulation properties with stiffness and compression strength comparable to medium clay. It is utilized in reducing settlement below embankments, sound and vibration damping, reducing lateral pressure on sub-structures, reducing stresses on rigid buried conduits and related applications. Expanded polystyrene waste in a granular form is used as lightweight aggregate to produce lightweight structural concrete with the unit weight varying from 1200 to 2000 kg/m³. The polystyrene aggregate concrete was produced by partially replacing coarse aggregate in the reference (normal weight) concrete mixtures with equal volume of the chemically coated crushed polystyrene granules. This paper reports the results of an experimental investigation into the engineering properties, such as compressive strength, modulus of elasticity, drying shrinkage and creep, of polystyrene aggregate concrete varying in density. The main objectives of this study are the cement contents for the concrete mixtures used were 410 and 540kg/m³.
Lightweight concretes (LWCs) can be used in various construction fields. It can be used for repairing wooden floors of old buildings, carrying walls of low thermal conduction, bridge decks, floating quay, etc. For the first applications, the lightest possible material is used, i.e., usually it has a specific gravity of 0.5, the strength being of less importance.
But for some structural applications, a compressive strength higher than 40 MPa is sometimes necessary, which leads the designer to optimize a material with a specific gravity close to 1.8. In such a case, lightweight aggregates, such as expanded glass or clay, take part in the resistance of the composite. The possibilities offered by new cement-based materials suggest that it is possible to improve the compressive strength versus the specific gravity, or to reach equivalent strength for lower specific gravity. It is proposed to use very lightweight inclusions, like expanded polystyrene (EPS), having a specific gravity of about 0.02 in an ultrahigh strength matrix having a strength higher than 130 MPa. However, the mechanical behaviour of such a material is quite different from that of an ordinary LWC. It is known that the stress distribution within a granular cement-based composite depends on the sizes of the inclusions and on the respective modulus of the matrix and of the inclusions. When the aggregate has a modulus higher than that of the matrix, stress concentrations appear in the vicinity of the aggregates. However, when dealing with very lightweight aggregate, like EPS, having a negligible modulus, the two-phase models are in their limit of applicability. Another way is to refer to models based on porosity, assuming that the concrete is described as a matrix containing voids (EPS spheres).The aim of this report is to achieve a mix design for Lightweight
EPS Concrete with density lesser than 1800kg/m³ and enough high compressive strength so that it can be used in construction purpose.
It has been found from experimental data which shows that the compressive strength depends on the inclusions' size of EPS beads, the smallest the size the highest the performance. Experimental results were fitted to an empirical model. The model took into account the packing density and the EPS diameter. Simulations were made using this model, using a very high performance matrix of 180-MPa compressive strength and weightless inclusions. It appears that new materials can be designed in a domain not yet explored on cement-based materials.
Specific gravity of cement: 3.15
Specific Gravity of fine aggregate: 2.40
Specific Gravity of EPS beads: 0.011
Fineness modulus of fine aggregate: 3.00
Bulk Density of Fine Aggregate: 1643 kg/m3.

III.METHODOLOGY

1. MATERIALS USED FOR MIXING:

1.1 Cement: Regular Portland cement of grade 43, which complies with IS 12269-1987, was utilized. We checked the consistency and freshness of the cement. It turned out to be pure, dry, and lump-free.
1.2 Fine aggregate: Clean waterway sand from Zone II neighborhoods that complied with IS 383-1970 were utilized. 4.75 mm of sieve was used for the sand. It contained no organic impurities, silt, or clay. The aggregate's physical properties, including gradation, bulk modulus, specific gravity, and fineness modulus, were assessed in compliance with IS: 2386-1963.
1.3 Coarse Aggregate: The study's course aggregate consisted of locally accessible crushed stone, obtained from nearby quarries, with a downsize of 20 mm and 10 mm. The physical attributes have been established in accordance with IS: 2386-1963. It was discovered that coarse aggregate had a specific gravity of 2.68. There was a 0.25% water absorption.
1.4 Water: Both mixing and curing concrete could be done with potable water. Therefore, it was determined to be certain that the water met all the criteria for purity and suitability for use in concrete mix. Unwanted organic materials or excessive amounts of inorganic constituents shouldn't be present in mixing water. Clean potable water is used in this project and is cured in accordance with IS: 456-2000.
1.5.5 Thermocol: Thermocol is a tough and rigid closed-cell polystyrene (EPS) Usually white and made of pre-expanded polystyrene beads, polystyrene foam has superior insulation properties and is used for non-weight-bearing architectural structures (such as ornamental pillars). Discarded polystyrene does not biodegrade for hundreds of years and is resistant to photolysis. Polystyrene foam blows in the wind and floats on water due to its specific gravity. It can have serious effects on the health of birds or marine animals. Weight, water resistance, dimensional stability, and inert nature. Polystyrene foams are good thermal insulators and are therefore frequently used as building insulation materials.
1.6 Fly Ash: Fly ash is made up of fine, powdered, glassy, mostly spherical, and amorphous particles. Fly ash has a similar particle size distribution to silt (less than 0.075 mm), a specific gravity of 2.1 to 3.0, and a specific surface area that can range from 170 to 1000 m2/Kg. Fly ash's color can range from tan grey to black, depending on how much unburned carbon is present.
3.1 MIXING PROCEDURE:

3.1.1 Blending A M25 grade (1:1:2) concrete mix was made. To create concrete cubes, 150 x 150 x 150 mm steel molds were used. Different proportions of T&T solution were mixed into the control concrete. For every mix proportion, a total of two cubes were prepared, requiring 3.08 kg of cement, 5.5 kg of sand, and 6.75 kg of coarse aggregate. Every requirement for mixing and filling was taken into account when making the preparation.

3.1.2 Remedying Cubes have been given a full day to set. Cubes were cured in the curing tank for a full day in order to facilitate the hydration process and increase their strength. The use of pure drinking water and curing in accordance with IS:456 2000

3.1.3 The starting and stopping times Fineness is determined in accordance with IS: 4031 - (part 5) - 1988. We have completed the initial setting time for various percentages of T&T solution in cement using the Vicat apparatus.

3.1.4 According to IS: 516-1959, the compressive strength IS code is used to determine fineness. Compressive tests were performed to test the addition of admixtures in various amounts to concrete. Slump cone, ultimate setting time, and initial setting time for control and Thermocol Thinner Concrete [TTC] were measured. Additionally, after 7 and 28 days of curing, the compressive strengths of the control concrete and TTC were tested.

FIG NO 2 : CUBE CASTING

IV.RESULTS AND DISCUSSIONS:

Investigating the properties of M25 grade concrete is the main goal of this project, which replaces some of the fine aggregate (thermocol, 0.2%–0.3%) and fly ash (35–40%) with cement.

FIG NO 3 : CUBE TESTING

SR.NO	SAMPLE	% FLY ASH (IN %)	QUANTITY OF FLY ASH(IN KG)	QUANTITY OF CEMENT (IN KG)
1	NORMAL CONCRETE	0	0	1.55
2	MIX CONCRETE	10	0.14	1.38
		20	0.31	1.25
		30	0.47	1.09
		40	0.62	0.92

Concrete's compressive strength increases with the amount of fly ash added (35%), increasing from 33.25 N/mm2 to 35.5 N/mm2 and with the addition of 0.2% thermocol to 36.8 N/mm2 at the amount of fly ash added (40%).

COMPRESSION STRENGTH VALUE FOR REPLACEMENT OF CEMENT WITH FLY ASH AND FINE AGGREGATE WITH THERMOCOL

SR.NO	MIX		7 DAYS COMPRESSIVE STRENGTH (N/MM^2)	28 DAYS COMPRESSIVE STRENGTH (N/MM^2)
1	NOMINAL MIX		21.61	30.27
2	FLY ASH (IN %)	THERMOCOL (IN %)		
3	10	0.1	22.87	31.14
4		0.2	23.10	31.76
5		0.3	23.35	32.01
6	20	0.1	23.85	32.53
7		0.2	24.15	32.81
8		0.3	24.47	33.11
9	30	0.1	24.70	33.36
10		0.2	24.95	33.61
11		0.3	25.20	33.86
12	40	0.1	25.40	34.06
13		0.2	25.55	34.21
14		0.3	25.70	34.32

RESULTS

COMPRESSION STRENGTH VALUE FOR REPLACEMENT OF CEMENT WITH FLY ASH AND FINE AGGREGATE WITH THERMOCOL.

1. After 28 days of curing, the strength of the concrete at partial fly ash and thermocol replacement (34.33 N/MM2) is higher than that of regular cubes (30.27 N/MM2).
2. After seven days of curing, the strength of the concrete at partial fly ash and thermocol replacement (25.71 N/MM2) is higher than that of regular cubes (21.61 N/MM2).
3. After thermocol and fly ash are replaced, concrete's compression strength increases by up to 13.4%.

V. CONCLUSION

- It is found that, after a 28-day curing period, the strength of the concrete increases when fly ash and thermocol are partially replaced, in comparison to regular cubes.It is made up of 0.3% thermocol and 40% fly ash.
- Studies conducted by various experts demonstrate that partial replacement will increase strength and decrease concrete's density.

- Using fly ash in concrete reduces the need for coal and thermal industry disposal fees and creates more environmentally friendly concrete for building.
- The cost analysis shows that reducing the percentage of cement lowers the cost of concrete.

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