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Experimental Study on Lightweight Concrete using EPS and Fly Ash

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Abstract: *More people want to use eco-friendly building materials, so there's been a lot of work on making lightweight concrete with different materials. Regular concrete is quite heavy on its own, which adds to the weight that structures have to support. To solve this problem, the current study looks at testing lightweight concrete made with Expanded Polystyrene (EPS) beads and fly ash. Using these materials helps lower the weight of concrete and makes better use of waste products from industries. EPS beads are used instead of some of the usual large stones in concrete, and fly ash is added to help the cement mix work better. EPS is a light material that helps make concrete lighter per unit. Fly ash can help improve the performance of the binding material and enhance certain qualities of concrete when used in the right amounts. The study looks at using EPS and fly ash together to see how they affect the properties of concrete when it's still wet and after it has dried and hardened. The experiment includes six different concrete mixtures, labeled M1 through M6, where each mix has a different amount of EPS replacing the regular material, specifically 0%, 10%, 20%, 30%, 40%, and 50% respectively. Standard cube specimens measuring 150 mm in each side are made and tested at specific curing times. The slump test is done to check how easy it is to work with fresh concrete. Tests for density and water absorption are done to check the weight of the concrete after it has hardened and how much water it can absorb. The compressive strength test is done to check how strong each mix becomes over time. The results from the experiments help look at how replacing EPS affects the performance of concrete. Putting more EPS into the concrete mix is likely to make the concrete lighter, but it might also change how easily it works with tools, how strong it gets when pressed, and how much water it can soak up. So, the study wants to find the right amount of EPS to use that keeps the concrete light but still works well. In summary, this study looks into how EPS and fly ash can be used to make lightweight concrete that works well for different construction uses. The results could help create concrete that uses resources more efficiently, as long as the strength, durability, and other performance standards are met.*

Keywords: Lightweight Concrete, Expanded Polystyrene (EPS) Beads, Fly Ash, Partial Aggregate Replacement, Slump Test, Compressive Strength, Density, Water Absorption, Sustainable Construction, Workability.

I. INTRODUCTION

Concrete is one of the most widely used construction materials in the world due to its high compressive strength, durability, versatility, and suitability for various structural applications. Cement, fine aggregate, coarse aggregate, and water are the primary components of conventional concrete. Making cement gives off carbon dioxide, and taking too many natural materials for construction can use up important resources. So, creating eco-friendly and lighter concrete has become a big focus in the construction field. Lightweight concrete is a type of concrete that is made to make structures lighter by reducing its weight and density. The use of Expanded Polystyrene (EPS) beads as a substitute for

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conventional coarse aggregate can result in lightweight concrete. EPS is a lightweight material that can reduce the overall density of concrete. Increasing the amount of EPS might also affect how well the mixture works, its strength when pressed together, and how much water it can absorb. In recent years, using industrial by-products in concrete has become a key way to make better use of resources and lower the environmental impact. Fly ash, a by-product of coal-based thermal power plants, is widely used as a supplementary cementitious material in concrete. It has materials that act like pozzolana, which can mix with calcium hydroxide when there is water around, helping to improve the qualities of the concrete. Using fly ash in the right amounts can help cut down on cement use and make better use of industrial waste products.

The experiment involves testing the slump to check how easy the fresh concrete is to work with, testing the density to find out the weight of the hardened concrete, testing the compressive strength to see how much weight it can hold, and testing water absorption to understand how much water it can take in. The samples are checked at certain curing times, like 7, 14, and 28 days, whenever it's needed. The results from these tests are compared to see how adding more EPS affects the properties of concrete. The main goal of this study is to create and test light-weight concrete made with EPS and fly ash. It also aims to find the right amount of EPS that can lower the weight while still keeping the concrete strong and lasting. The investigation could help create more efficient materials for construction and encourage the use of lightweight concrete in the right types of buildings..

II. OBJECTIVE

To investigate the potential of EPS beads as a concrete additive substitute for conventional coarse aggregate. To look into how fly ash can be used as an extra material to help make concrete lighter. To evaluate the workability of fresh concrete by conducting the slump test. To find out the density of concrete that has different amounts of EPS substituted in it. compressive strength of concrete at different curing ages.7,14,28 days. determine the water absorption characteristics of the hardened concrete mixes. To look at how adding more EPS affects the physical and mechanical characteristics of concrete. The goal is to check how well each type of concrete mix works and find out the best amount of EPS to use, based on the test results. To look into making concrete that is lighter and uses fewer resources for use in appropriate construction projects.

III. METHODOLOGY

EPS beads and fly ash are utilized to investigate the hardened and fresh features of lightweight concrete in the current study. The process starts by looking at existing research to learn about the features and uses of lightweight concrete. The constituents are composed of cement, fine aggregate, coarse aggregate, water, EPS beads, and fly ash. The preparation of the concrete mixtures is preceded by examining the physical properties of the materials. Six different mixtures, labeled M1 through M6, are made with varying amounts of EPS bead replacement: 0%, 10%, 20%, 30%, 40%, and 50% respectively. The mix proportions for the concrete are decided according to the mix design method that is used. The different materials are carefully measured and combined to create a consistent concrete mix. EPS beads and fly ash are added based on the required mix proportions. The slump test is used to check how easy it is to work with fresh concrete. After the concrete is mixed, it is poured into molds that are shaped like cubes and each side is 150 millimeters long. The concrete is then pressed firmly to make sure it is packed properly. After the initial setup, the specimens are removed from their molds and kept in proper conditions to cure for 7, 14, and 28 days. Density, water absorption, and compressive strength tests are administered to the hardened concrete specimens. The purpose of these tests is to evaluate the impact of replacing EPS bead with other materials on the physical and mechanical properties of concrete. The results from the experiments are written down and then looked at together for all six mixtures. The differences in how easily the material works with, how dense it is, how much water it absorbs, and how strong it is under pressure are studied to see how adding more EPS affects these properties. The results help determine how well EPS beads and fly ash can be used to make lightweight concrete that is good for sustainable construction projects.

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IV. LITERATURE REVIEW

1. Babu et al. In 2006, a study looked at how the size of EPS particles affects the strength of lightweight concrete and how moisture moves through it. The study showed that the size of the particles affects how well concrete works.
2. Miled et al. In 2007, a study looked at how the size of EPS particles affects the compressive strength and showed why this is important for designing lightweight concrete.
3. Sayadi et al. In 2016, research was done on how EPS particles affect the density, compressive strength, thermal conductivity, and fire resistance of concrete.
4. Kan and Demirboga (2009) studied using recycled EPS as a lightweight material in concrete and found that it can help make concrete lighter.
5. Chen and Fang in 2009 looked at fibre-reinforced EPS concrete and found that using the right amount of fibre can make the particles more stable and improve some of the material's performance features.

V. MATERIALS USED

1. Expanded Polystyrene (EPS) Beads
2. FlyAsh
3. Fine Aggregate
4. Coarse Aggregate
5. Water

VI. PREPARATION OF MATERIALS

The materials used in this experiment are Ordinary Portland Cement (OPC), manufactured sand (M-sand), coarse aggregate, Expanded Polystyrene (EPS) beads, fly ash, and water. The materials were chosen because they work well for making lightweight concrete and can help with building in a more sustainable way. The physical characteristics of the individual materials were checked before making the concrete mixtures. The primary bonding material was Ordinary Portland Cement, and the fine aggregate was composed of M-sand. Crushed angular granite stones, each no bigger than 20 mm, were used as the regular coarse aggregate. Fly ash, which is a by-product from burning coal in industry, was used as a partial substitute for cement, with a fixed replacement rate of 10%. The EPS beads, which are about 3 to 6 millimeters in size, were used as a partial substitute for regular coarse aggregate to make the concrete lighter. Before combining them, the EPS beads were inspected to make sure they were clean and didn't have any unwanted impurities. The cement, fine aggregate, coarse aggregate, and fly ash were measured based on the required mix proportions. The EPS beads were weighed based on the chosen replacement levels of 0%, 10%, 20%, 30%, 40%, and 50%. The water amount was kept at 0.708 litres for each batch, just like it's shown in the mix proportion table. All the different materials were then combined thoroughly to create a fairly even concrete mix, making sure the lightweight EPS beads stayed well mixed and didn't separate. Six different concrete mixtures, labeled M1 through M6, were made for the experiment. For each batch, the amount of cement was kept at 1.275 kg, fly ash at 0.142 kg, and fine aggregate at 2.303 kg. The amount of coarse aggregate was changed based on how much EPS was used instead of the regular material. It went down from 4.075 kg in the normal mix to about 2.038 kg in the mix where 50% of the material was replaced with EPS. The prepared mixtures were then used to make standard concrete cube samples that were 150 mm in length, width, and height. These samples were left to cure for the set time and then tested to check how well the concrete worked, how dense it was, how much water it absorbed, and how strong it was under pressure.

VII. NUMBER OF TEST TAKEN

1. Specific Gravity Test
2. Sieve Analysis Test
3. Slump Test
4. Compressive Strength Test

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5. Water Absorption Test
6. Density Test

1. SPECIFIC GRAVITY TEST:

S. No.	Material	Specific Gravity
1	Cement	3.12
2	Fine Aggregate (M-sand)	2.67
3	Fly Ash	2.35
4	EPS Beads	0.011
5	Coarse Aggregate	2.78

$$G = Wm/Ww$$
$$= 2.67$$

2. SIEVE ANALYSIS TEST:

TABLE 1. SIEVE ANALYSIS OF FINE AGGREGATE (M-SAND)

Assumed total sample weight = 1000 g.

Sieve size (mm)	Weight retained (g)	% Retained	Cumulative % retained	% Passing
4.75	0	0	0	100
2.36	51	5.1	5.1	94.9
1.18	119	11.9	17.0	83.0
0.600	252	25.2	42.2	57.8
0.300	298	29.8	72.0	28.0
0.150	221	22.1	94.1	5.9
0.075	39	3.9	98.0	2.0
Pan	20	2.0	100.0	0
Total	1000	100	—	—

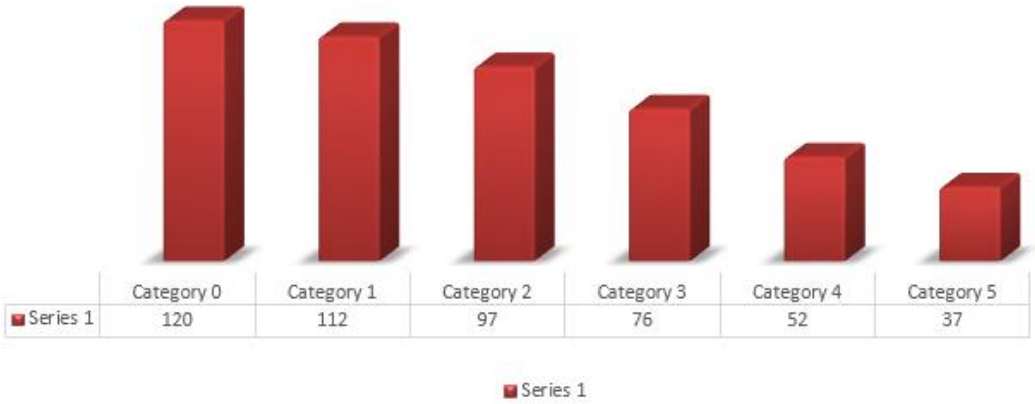
TABLE 2. SIEVE ANALYSIS OF COARSE AGGREGATE

Assumed total sample weight = 2000 g.

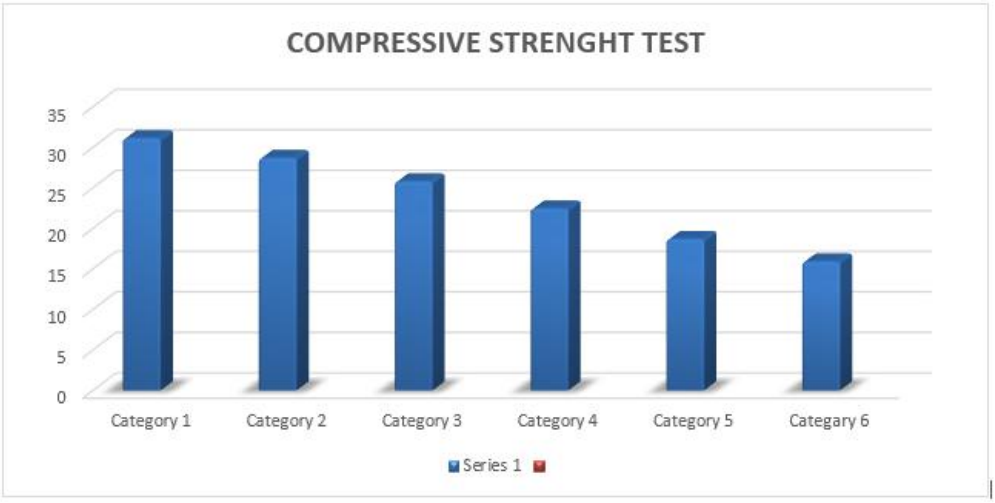
Sieve size (mm)	Weight retained (g)	% Retained	Cumulative % retained	% Passing
20.0	0	0	0	100
16.0	298	14.9	14.9	85.1
12.5	602	30.1	45.0	55.0
10.0	704	35.2	80.2	19.8
4.75	346	17.3	97.5	2.5
2.36	26	1.3	98.8	1.2
Pan	24	1.2	100	0.0
Total	2000	100	—	—

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TEST 3: SLUMP TEST



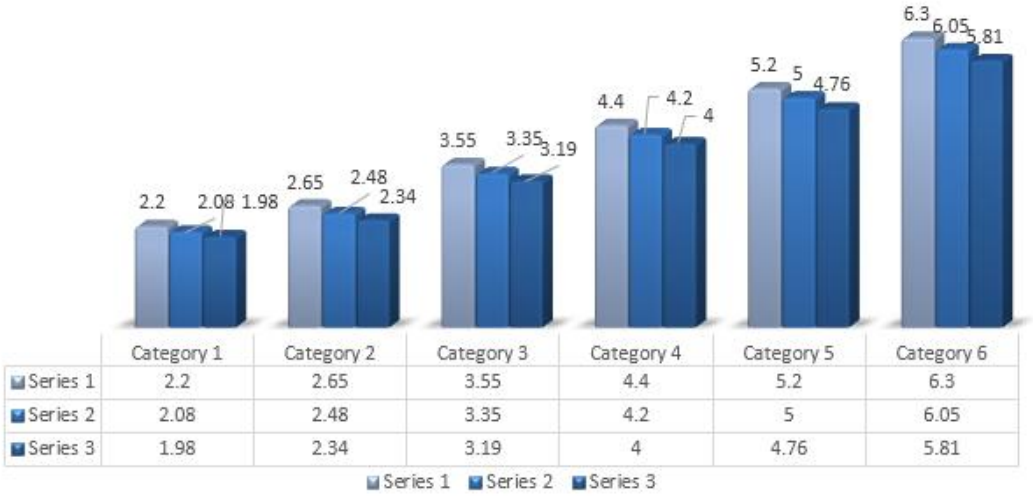
TEST 4: COMPRESSIVE STRENGTH TEST

TABLE 3: COMPRESSIVE STRENGTH TEST TABLE

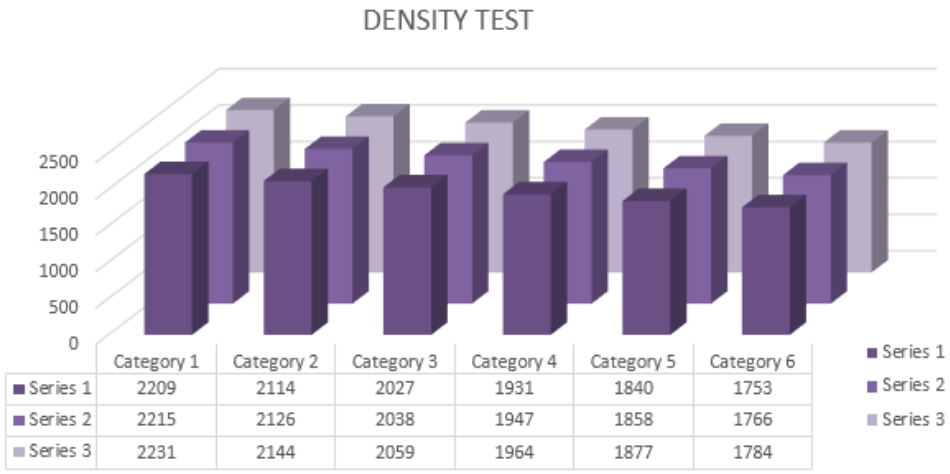
MIX	EPS REPLACEMENT	CUBE SIZE (MM)	FAILURE LOAD (KN)	AREA (MM^2)	COMPRESSIVE STRENGTH (MPA)
M1	0%	150×150×150	700	22500	31.11
M2	10%	150×150×150	645	22500	28.67
M3	20%	150×150×150	580	22500	25.78
M4	30%	150×150×150	505	22500	22.44
M5	40%	150×150×150	420	22500	18.67
M6	50%	150×150×150	358	22500	15.91

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TEST 4: WATER ABSORPTION TEST



TEST:5 DENSITY TEST

TABLE 4: COMPARISON AND DISCUSSION OF RESULTS:

Property	0% EPS	10% EPS	20% EPS	30% PWS	40% EPS	50% EPS	Best result
Slump value	120	103	86	69	53	37	M1(highest)
Compressive strength, 28 days	31.11	28.67	25.78	22.44	18.67	15.91	M1(highest)
Water absorption,28days	1.98%	2.34%	3.19%	4.00%	4.76%	5.81%	M1(lowest)
Density	2231 kg/m³	2144 kg/m³	2059 kg/m³	1964 kg/m³	1877 kg/m³	1784 kg/m³	M6(lowest)

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VIII. CONCLUSION

1. The project called "Experimental Study on Lightweight Concrete Using EPS and Fly Ash" looks into whether it's possible to use Expanded Polystyrene beads and fly ash in making concrete. The study looks at the characteristics of fresh and hardened concrete, such as how easily it can be mixed and poured, how strong it becomes, how much water it absorbs, and how heavy it is.
2. The experiment looks at how regular concrete mix performs compared to other mixes that have added EPS and fly ash in specific amounts. The outcomes are utilized to evaluate the impact of these elements on the physical and mechanical features of concrete.
3. The right use of the lightweight concrete made depends on how dense it is, how strong it is under compression, how much water it absorbs, and what it's meant to be used for. The final decision about the best mix should be based on tested lab results and the right standards.
4. This study lays the groundwork for more research on using EPS and fly ash in making lightweight concrete and explores how these materials can be used in construction projects.

IX. ACKNOWLEDGMENT

we want to thank our respected principal and the head of the civil engineering department for giving us the chance and the resources needed to complete our project titled "Experimental investigation on lightweight concrete using eps beads and fly ash."

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