Experimental Study on Properties of Concrete by Using Expanded Polystyrene Beads (EPS) As a Partial Replacement of Coarse Aggregate

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Abstract— This experimental investigation uses Expanded Polystyrene Beads (EPS Beads) as a partial replacement for coarse aggregate, sand, cement, coarse aggregate, and water as performance indicators for concrete workability and strength. The significance of this alternative stone replacement in reducing EPS waste that is difficult to lapse and avoiding waste of trash that can be transformed to something that may be used in future technological development. In addition to decreasing environmental damage, it also saves money by using the Reduce, Reuse, and Recycle principle. Concrete is the most frequently utilised building material on the planet. I'm using waste product Expanded polystyrene beads to build eco-friendly light weight concrete to solve environmental issues including waste product deposition, recycling, and reuse. The optimum outcome is obtained by using conventional proportionate mixing of EPS beads in concrete in place of aggregate. As the world becomes more environmentally conscious, more attention is being paid to the qualities of waste and finding ways to reuse its valuable component parts as secondary raw materials in other industries. Green construction is becoming a more important global problem and a key approach to conserve biodiversity and limit the amount of waste that ends up in landfills. The effects of replacing coarse aggregate with 0,5 %, 10% and 15% waste EPS Beads in concrete are investigated. To ensure the success of this investigation, coarse aggregate, cement, sand, water, and EPS beads with a diameter of not more than 20mm will be employed. In addition, four trial mixes must be made: 1) ordinary concrete, 2) concrete with addition of original form of EPS Beads. These samples are compared with Ordinary Concrete with VSI Sand.

Keywords: Expanded Polystyrene Beads (EPS), Ordinary Concrete

I. INTRODUCTION

Many infrastructural upgrades are taking place in the country as a result of rising industrialization and urbanization. As a result of this process, mankind is now faced with the task of resolving the issues that have arisen as a result of this expansion. The issues discussed include a severe scarcity of construction materials and increased garbage dumping. As a result, in order to address the aforementioned issues, waste products should be used as a construction material. The threat of EPS Bead disposal will not be resolved until tangible efforts are taken on the ground. It is feasible to improve the performance of the bituminous mix that is used in road surface. Reduced permanent deformation in the form of rutting and reduced low temperature cracking of pavement surfacing were found in studies using re-cycled plastic, primarily polyethylene, in the fabrication of mixed. The field tests survived the strain and demonstrated that polystyrene wastes used as an addition after proper processing will extend the life of roadways while also addressing environmental concerns.

EPS (expanded polystyrene) is a lightweight cellular plastics material made up of small spherical shaped particles made up of 98 percent air and 2% polystyrene. Its tight cell structure prevents it from absorbing water. Polystyrene is a substance that is not biodegradable. It's a byproduct of the packaging business. It causes disposal issues. Crushed polystyrene granules are a valuable waste disposal solution when used in concrete. Concrete is perhaps the most widely utilised building material on the globe. Lightweight concrete is a form of concrete that contains an expansion agent, which increases the volume of the mixture while also providing extra properties such as durability and lowering the dead weight. It is less dense than regular concrete. The low density and heat conductivity of lightweight concrete are its key characteristics. One of the key advantages is the reduction of dead load, which is followed by faster construction rates and lower transportation and usage costs. The big voids in lightweight concrete are preserved. The performance of low weight concrete was the sole focus of this study. To achieve enough cohesiveness between water and cement, however, a suitable water cement ratio is required. Insufficient water can lead to a loss of concrete strength due to a lack of particle cohesion.

A. Objectives of the Project:

- To study the use of waste expanded polystyrene beads (EPS) is relatively a new growth in the world of concrete technology and lot of research must go in before this material is actively used in concrete construction.
- Study the influence of partial replacement to coarse aggregate with expanded polystyrene beads by using V.S.I. sand.
- Find the percentage of expanded polystyrene beads replaced to coarse aggregate that makes the strength of concrete maximum using V.S.I. sand.
- Determine the suitability Expanded polystyrene beads as partial replacement with coarse aggregate in concrete.
- Find the alternative of basic materials which are used in construction from past many years.
- To manage the packaging industry waste and to determine the suitability of Expanded polystyrene beads as partial replacement with coarse aggregate.
- Compare the mechanical properties of expanded polystyrene beads in concrete with control concrete.
- To study the properties of concrete like workability, compressive strength, and Flexural strength with partial replacement of coarse aggregate with expanded polystyrene beads.
- Develop proper mix design.

- Study of lightweight EPS concrete.

B. Significance of the Study:

- To study the properties of concrete like workability, compressive strength, Split tensile strength and Flexural strength test with partial replacement of coarse aggregate with expanded polystyrene beads EPS in concrete to diminish the pressure of exploiting the natural resources.
- To introduce the prospective replacement of coarse aggregate as Expanded polystyrene beads.
- To diminish the pressure of maltreating the natural resources.

II. MATERIAL USED

A. Cement:

Locally obtainable OPC 53Grade cement is used.

B. Fine Aggregate:

Locally available VSI sand is used, with specific gravity 2.63, water absorption 2%

C. Coarse Aggregate:

Locally available coarse aggregate from quarry is used, maximum size 20 mm, with specific gravity 2.68, water absorption of 0.705%

D. Water:

Portable water was used for the experimentation.

E. EPS BEADS:

Expanded polystyrene beads is a lightweight cellular plastic material consisting of 98% air and 2% polystyrene. Expanded Polystyrene (EPS) used in the project was in the form of 'EPS Beads' which is spherical in shape with size varying in between 2mm to 8 mm in diameter.

III. PHYSICAL PROPERTIES OF MATERIAL USED

A. Cement:

Physical properties of cement are as follows:

S. No	Property	Test results
1	Normal consistency	31.5%
2	Specific gravity	3.15
3	Initial setting time	30minutes
4	Final setting time	600minutes

Table 1: Physical properties of Cement

B. Fine Aggregate:

Physical properties of Fine Aggregate are as follows;

S. No	Property	Test results
1	Specific gravity	2.63
2	Fineness Modulus	3.75
3	Grading Zone	II

Table 2: Physical properties of Fine Aggregate

C. Coarse Aggregate:

Physical properties of Fine Aggregate are as follows;

S. No	Property	Test results
1	Size	20mm
2	Specific gravity	2.68
3	Fineness modulus	7.20
4	Total water absorption	0.705%
5	Shape	Angular

Table 3: Physical properties of Coarse Aggregate

D. EPS BEADS:

Physical properties of EPS BEADS are as follows:

Sr. no	Property	Value
1	Specific gravity	0.018
2	Thermal conductivity	Low
3	Bulk density	18kg/m3
4	Water absorption	0.50%
5	Particle shape	Rounded
6	Appearance	White
7	Type	Air cooled
8	Moisture Absorption	Low

Table 4: physical properties of EPS beads

IV. EXPERIMENTAL PROGRAM AND SETUP

The main aim of this experimentation is to study the consequence of partial replacement of Coarse aggregate with EPS Beads On the properties of concrete and check its compressive strength, flexural strength Tensile strength and workability of concrete.

Concrete mix design is done as per IS 10262-2009 for M30.

1) Casting of cubes and beams.
2) Curing of cubes and beams for 7 days and 28 days.
3) Testing of cube in compression testing machine and Beam are tested in flexural testing machine.

Each test result plotted in the Figures or given in the Tables is the mean value of results gained from at least three specimens.

V. MIX DESIGN

Concrete mix design is done as per IS 10262-2009 for M30 grade of concrete. Material quantity essential for 1m^3 volume of work are tabulated in table no.5

S. No	Item	For 1 m^3Concrete	Mix Ratio
1	Cement	375.00 Kg	1
2	Fine aggregate	845.98 Kg	2.25
3	Coarse Aggregate	1097.10 Kg	2.92
4	Water	150.00 Lit.	0.40

Table 5: Material Quantity for 1 m^3

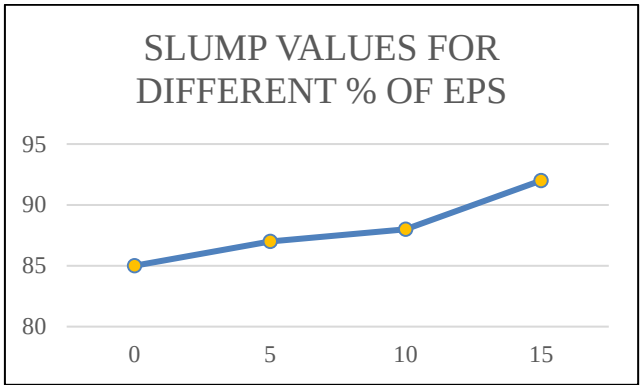
VI. WORKABILITY

The workability of M30 grade of concrete is measured by widely used empirical test i.e. slump test with w/c ratio 0.40 for addition of different percentage EPS BEADS.

Values obtain for different percentage mix is as show in following Table 6

%of coarse aggregate replaced with EPS BEADS	Slump value (mm)
0	85
10	87
15	88
20	92

Table 6: Slump values for different percentage of mix



Graph 1: Slump Value

The results show that as the proportion of Expanded polystyrene beads grows from 0% to 5%, the compressive strength increases, but as the percentage of EPS beads goes higher, the compressive strength decreases. As a result, we can substitute up to 5% of the time.

A. Tensile Strength Test:

We used a formula discovered by researchers for tensile strength tests on beams. After the cubes have been cast for 7 days and 28 days, they are tested in the concrete technology lab using a compressive testing equipment. However, there is a unique approach to insert a cube in a compressive machine: the concrete cubes are placed diagonally in the machine, and a load of KN is applied to its edges after it breaks, and the results are recorded.

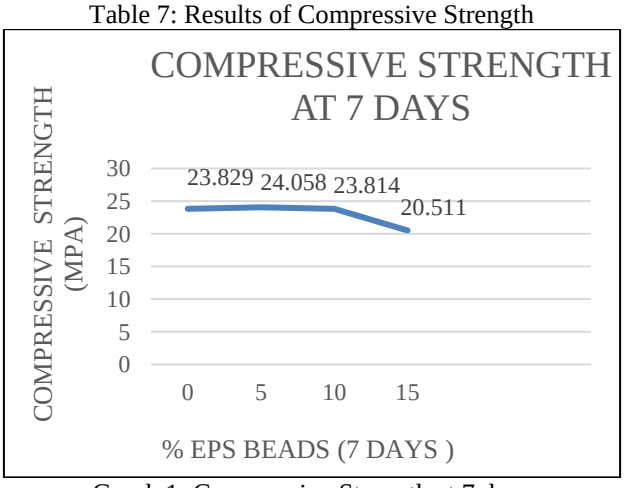
Formula: Stress= 0.5187XP/s^2

VII. EXPERIMENTAL RESULTS

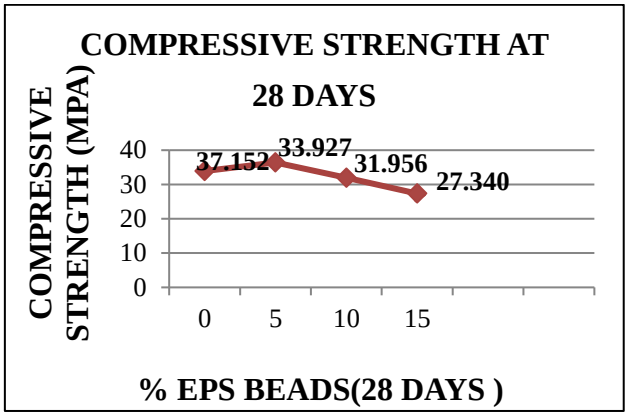
A. Compressive Strength Test:

% of EPS BEADS	Compressive Strength (N/mm^2)	
	7-Days	28-Days
0	23.829	33.928
5	24.907	36.410
10	23.814	31.956
15	20.511	27.340

Table 7: Results of Compressive Strength



Graph 1: Compressive Strength at 7 days

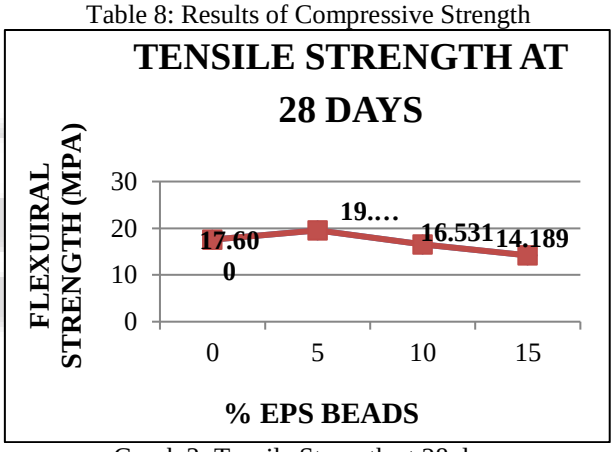


Graph 2: Compressive Strength at 28 days

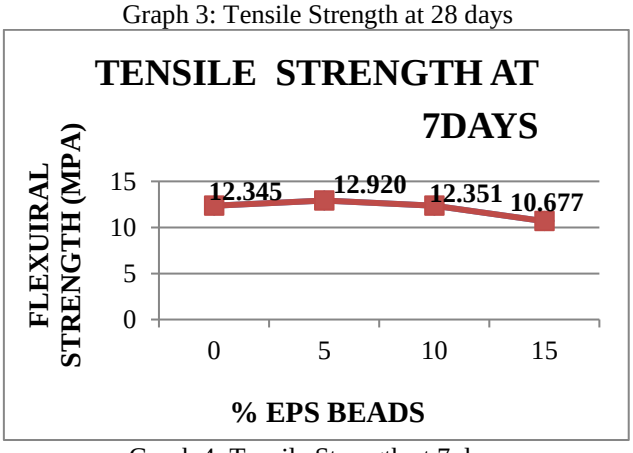
B. Tensile Strength Test:

% of EPS BEADS	Compressive Strength (N/mm^2)	
	7-Days	28-Days
0	12.346	17.600
5	12.920	19.551
10	12.351	16.531
15	10.677	14.189

Table 8: Results of Compressive Strength



Graph 3: Tensile Strength at 28 days



Graph 4: Tensile Strength at 7 days

VIII. CONCLUSION

Based on results and observation made in experimental research study. The following conclusions are drawn.

1) It is observe that with increase in percentage of waste EPS BEADS workability increases.

2) Concrete made by partial replacement of coarse aggregate is low-cost than conventional concrete.
3) Current study concluded that strength of concrete is achieved up to 5% replacement and strength of concrete decreases at 15%.
4) The use of waste EPS BEADS in concrete is feasible to improve its compressive strength, and flexural strength.
5) It is possible to make concrete by using EPS BEADS as partial replacement of coarse aggregate
6) Although the strength of concrete decreases as the number of EPS BEADS increases, the lower unit weight of the concrete fits the criterion for lightweight concrete.
7) The results reveal that all of the EPS Concrete, without the need of a specific bonding agent, has good workability and can be compacted and finished quickly.
8) Tensile strength of concrete increase up to 5% and at 15% flexural strength of concrete decreases

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