# Experimental Study On Partial Replacement Of Coarse Aggregate By Eps (Expanded Polystyrene) Beads In Concrete Blocks

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**Keywords:**

EPS, Light Weight Concrete, EPScrete, Alternative and Ecological materials, Compressive strength.

**Introduction**:

Expanded Polystyrene beads are also known as EPS beads. EPS is typically used as a single-use packaging material, and once used, it is discarded and disposed of as waste in dump yards. Because EPS is non-biodegradable, it can take decades, if not centuries, to degrade within the soil layers.

The main goal of our project is to consider the possibility of using a single-use packaging waste material for the benefit of mankind, and to use these EPS beads in such a way that, in addition to being beneficial to the environment, it is also cost-effective and economical for use in the construction field.

When coarse aggregate is replaced with EPS beads, our experiments and results show that the dead load of the block can be reduced by up to 41% depending on the ratios and proportions of the replacement.

This reduction in dead load of the blocks will benefit the overall material required for the construction that will support these blocks, resulting in overall cost savings.

We performed destructive tests (such as the Compressive Strength Test, Split Tensile Test, and Flexural Strength Test) and non-destructive tests (such as the Ultrasonic Pulse).

A lightweight concrete with adequate and appreciable strength that can easily replace standard concrete blocks when used as a partition member or panel wall. Because lightweight concrete has adequate and significant insulating properties, it can also be used to thicken floors and roofs. The use of lightweight concrete will not only reduce the dead load of the structure, but will also help to cut and minimise overall construction costs.

**Objectives**:

1. Laboratory evaluation of the performance of expanded polystyrene (Styrofoam) beads in concrete of M25 grade as lightweight coarse aggregate to reduce dead load without significant reduction in compressive strength.

2. To perform tests on workability of fresh concrete (slump cone, vee-bee, compaction factor tests and also the tests on hardened concrete (compression, split tensile and flexural strength tests) along with the non-destructive tests (rebound hammer test, UPV test, etc).

3. To compare the EPS concrete block mass with the mass of the normal concrete block that is used currently in construction and calculate the reduction in their weights, and also to compare their strengths.

4. To determine the strength development of EPS concrete after curing for 7 and 28 days.

**Materials and Methodology:**

**Cement -** OPC53 grade with specific gravity 3.15 was used in this work.

**Coarse aggregates –** Locally sourced aggregates passing through 16mm and retained on 12.5mm IS Sieve with specific gravity 2.65 was used in this work.

**Fine aggregates –** Locally sourced M-sand passing through 4.75mm with specific gravity 2.79 is used in this work.

**Expanded Polystyrene (EPS) Beads –** EPS is a lightweight and completely recyclable material. These are light in weight comprising of fine circular shaped particles. There are numerous benefits to be chosen since the utilization of lightweight concrete. These incorporate smaller loads at construction, increased thermal resistance and decreases self-weight in structures. The current examination was taken up, keeping mainly two focuses, polystyrene waste transfer from the perspective of environment and replace with normal aggregate. In this work, EPS beads retaining on 10mm IS Sieve with specific gravity 0.046 are used.

**Portable water -** Potable fresh water available from local sources was used for mixing and curing as per IS456:2000.

Methodology used for analysing the strength development of concrete is done by casting the specimens and conducting the tests as per their respective code provisions.

1. **Materials collection**- All the required materials were bought and a mix design was developed as per **IS10262:2019).**
2. **Casting and Curing -** Cubes, cylinders, and beams were casted, de-moulded, and placed for curing in both normal concrete and EPS concrete. **(IS456:2000)**

**Testing:**

A. Workability tests on concrete (slump cone test, vee bee consistometer test) are performed to understand the quality of concrete in terms of consistency, cohesiveness, and segregation proneness.
B. Hardened concrete tests such as compressive strength, split-tension, and flexural strength are used to understand the performance of concrete in terms of both strength and durability.
C. Non-destructive tests were performed, including a rebound hammer test and ultrasonic pulse velocity. These tests yield immediate results and are intended to estimate strength and other properties, monitor and assess corrosion, measure crack size and cover, assess grout quality, detect defects, and identify relatively more vulnerable areas in concrete structures.

**Results and Conclusions:**

**Slump Cone Test:**

The workability of both fresh normal concrete and EPS concrete was determined. Fresh concrete was found to be highly workable in all cases. The slump was 110mm for normal concrete and 104-112mm for EPS concrete based on replacement percentages.

**Vee-Bee Consistometer Test:**

The Vee-Bee time for both types of fresh concrete (normal and EPS) was between 2.7 and 2.3-2.5 seconds, respectively. This determines the fresh concrete's semi-fluid nature.

**Compressive Strength Test:**

After 28 days of strength development, the normal cube's average compressive strength was 37.68 MPa.
The average compressive strength of EPS cubes, on the other hand, was found to be 23.45, 21.44, and 18.76 MPa for 40, 45, and 50% replacement of coarse aggregates with EPS beads, respectively.

**Split Tensile Test:**

The average split tensile strength of the normal cylinder after 28 days of strength development was 3.32 MPa.
Similarly, the average split tensile strength for the EPS cylinders were found to be 2.35, 2.11, and 1.87 MPa for 40, 45, and 50% replacement of coarse aggregates with EPS beads respectively.

**Flexural Strength Test:**

The average flexural strength of the normal beam after 28 days of strength development was 7.0 MPa.Similarly, the average flexural strength for the EPS beams were found to be 3.5, 2.75, and 2.5 MPa for 40, 45, and 50% replacement of coarse aggregates with EPS beads respectively.

**Ultrasonic Pulse Velocity Test:**

The pulse velocity in the normal concrete cube was calculated to be 4.7 km per second which determines excellent quality of concrete.

Moreover, the pulse velocities of EPS cubes were 4.3,4.1,4.0 km per second for 40, 45, and 50% replacement of coarse aggregates with EPS beads respectively. These results indicate good quality of concrete.

**Rebound Hammer Test:**

The average rebound number for the normal cube was 27. Hence, the corresponding compressive strength was obtained as 19 MPa.

Also, for 40% EPS-replaced cube, the average rebound number was 20, and hence the compressive strength can be said to be to be 10 MPa.

**Weigh Reduction:**

The weight of the specimen decreases as the replacement percentage of the EPS beads in the concrete increases. When compared to their normal counterparts, the EPS specimens had significantly reduced their dead weight. During the experimental study, participant specimens lost up to 41% of their body weight.

**Conclusion:**

The results and discussions have been completed in order to complete the project and achieve an objective. We discovered that increasing the percentage of EPS beads in concrete, such as 40 percent, 45 percent, and 50 percent, decreased the strength while increasing the weight reduction to make light weight concrete blocks that can be used for a variety of purposes such as partition walls, facades, and so on.

We focused on its ability to reduce dead load while maintaining compressive strength. The findings show that the aggregate density of the concrete matrix influences the properties of structural polystyrene concrete, such as workability and compressive strength and others. Hence, it can be said that lesser the density of the materials used the lesser will be the dead load of the concrete mix.

**Scope for future work:**

Styrofoam, also known as EPS (expanded polystyrene) beads, is a lightweight material that can be used in concrete as a replacement for coarse aggregate. It is easy to shape, and can be formed by hand as well as sculpting and construction tools and can improve insulation properties. This material is used as a partial substitute for coarse aggregates in concrete to achieve lower dead loads, insulation, or both. We used small Styrofoam balls as a lightweight aggregate in the partial replacement of coarse aggregates to produce light-weight concrete blocks that can be used for partition walls, facades, and other applications by reducing dead loads.

Laboratory evaluation of the performance of expanded polystyrene (Styrofoam) beads in concrete of M25 grade as lightweight coarse aggregate, with emphasis on their ability to reduce dead load while maintaining compressive strength. Various tests on fresh and hardened EPScrete were conducted in order to improve its strength. We measured the strength development of EPS concrete after 7 and 28 days of curing. The results of this experiment will be used to create strong, light-weight concrete blocks. To achieve results that are primarily focused on reducing dead load while preserving compressive strength.

Finally, we would like to state that the findings of our project work show that polystyrene waste can be used to make strong and durable light-weight concrete. Polystyrene concrete is best suited for non-load bearing resilient concrete constructions such as partition walls and panel members. We focused on its ability to reduce dead load while maintaining compressive strength. The findings show that the aggregate density of the matrix influences the properties of structural polystyrene concrete, such as workability and compressive strength. As discussed, we have used EPS in place of gravel or jelly that is generally used in construction process. And because regular concrete is a heavy material, if used, it significantly increases the dead weight of the structure. Lightweight concrete not only reduces the dead weight of the structure but also saves on the cost of construction by lowering the materials required for construction and to support that construction.

Hence, we can say that light weight concrete is the material of the future, although not so popularly used today, we can eminently expect that in coming future there will be a great demand of lightweight concrete in general and EPS concrete in particular.