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# 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*

***Key Words***: **Waste Expanded polystyrene beads compressive strength, flexural strength, workability.**

## 1. INTRODUCTION:

Many infrastructural upgrades are taking place in the country as a result of rising industrialisation and urbanisation. 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.

### 1.1 Objectives of the study are stated below;

- 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.
- Study of lightweight EPS concrete.

### 1.2 IMPORTANCE OF STUDY:

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

## 2. METHODLOGY

### 2.1 MATERIAL USED:

**a) Cement:**

- The Cement used for this experiment is Sagar Ordinary Portland cement of 53 grade with specific gravity of 3.15.
- OPC 53Grade at SAGAR CEMENT is produced adapted to the Indian standards specification as per IS: 12269-1987
- 53Grade ordinary Portland cement is high strength OPC and can provides copious advantages wherever concrete for special high strength uses is required. The rate of development of strength is higher than 43 grade OPC.

**b) Fine aggregate(VSI sand)**

- Vertical Shaft Impactor (V.S.I.) Sand is also known as Artificial Sand or Crushed Sand. Only sand manufactured by V.S.I. Crusher is cubical and angular in shape. Generally the size of the aggregate lesser than
- Specific gravity of V.S.I sand is 2.63.

**c) Coarse aggregate:**

- Locally available coarse aggregate from quarry was used with specific gravity 2.68 and water absorption of 0.705% and maximum size of 20mm aggregate used.
- Testing is done as per Indian Standard Specification IS: 383-1970.

**d) Water:**

- Water should be free from acids, oils, alkalies, vegetable or other biological impurities.
- Water is used for mixing curing purpose should be clean and portable, fresh and free from any bacteria and desire matter compatible to IS 3025-1964 is used for mixing.

**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.
- It is made up of pre-extended Polystyrene beads. It offers a non-hydroscopic and does not readily absorb moisture from the atmosphere. Expanded polystyrene displays no. of exceptional properties such as lightweight, high strength and structural stability, economy, insulation, aging resistance, recyclability etc.
- Properties of EPS BEADS is as follows.

**TABLE 1**: properties of EPS Beads:

| 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 |

### 2.2 Casting of specimen:

Standard moulds will be used to manufacture test specimens of Cubes 150mm x 150mm x 150mm and beams 700mm x 150mm x 150mm. The samples are ready to be cast. After 24 hours of casting, the samples are remoulded and cured in a water tank for 7 to 28 days. A total of 48 specimens were cast in order to test qualities like compressive and flexural strength.

For varying percentages of partial replacement of Expanded polystyrene beads with coarse aggregate, 24 cube samples of size 150mmx150mmx150mm will be casted. With partial substitution of Expanded polystyrene beads with coarse aggregate, the concrete mixes are 0, 5 %,10 %, and 15%. All cubes will be cast in a single lift and consolidated with the help of a machine vibrator. The cube moulds will be removed after the final setting of the cubes, and the cubes will be maintained in the water tank for curing for 7 to 28 days.

All specimen beams with dimensions of 700mm x 150mm x 150mm will be cast in a single lift with the appropriate compressive strength for the specified mix and consolidated with tamping rods. Wet gunny bags will be used to cover the beams after they have been set. The burlap will be held for a period of three days. The forms will be stripped at the conclusion of the third day, and the beams will be maintained for up to 28 days to cure.

**Fig-1.** Mixing of EPS BEADS in concrete

### 2.3. Testing of specimen:

After 24 hours, the specimens were removed from the mould and water-cured for 7 and 28 days, respectively. The specimens were evaluated for compressive and flexural strength after curing using a compressive testing equipment with a capacity of 200KN, in accordance with Indian standard specification IS: 516-1959. The cube's strength was evaluated after 7 and 28 days. The beam's strength was evaluated after 28 days

## 3. WORKABILITY:

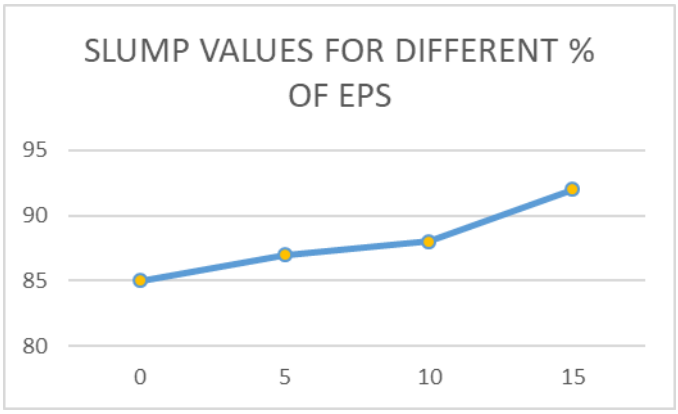
Workability refers to the amount of useful internal work required to fully compress concrete in the field. Both field and laboratory methods are available to measure concrete workability.

Slump cone tests with a w/c ratio of 0.40 for varying percentages of Expanded Polystyrene Beads are used to determine the workability of concrete.

The value gotten for altered percentage mix is as given below.

**Table 2: Slump values for different percentage of mix**

| % of EPS Beads replaced | Slump value (mm) |
|---|---|
| 0 | 85 |
| 10 | 87 |
| 15 | 88 |
| 20 | 92 |




## 4. EXPERIMENTAL METHODLOGY:

### 4.1 Compressive Strength Test:

At 7 and 28 days, compressive strength is measured. 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.

### 4.2 Flexural Strength Test:

All beam specimens must be tested with two point loading to determine their flexural strength. A hydraulic jack and a load cell were used to apply the load. A loading beam was used to transfer the load from the jack to the main specimen. The responses were handled by two roller supports, hence the loading states were two incremental bending point loads. Dial gauge is used to measure the deflection at the web's centre.

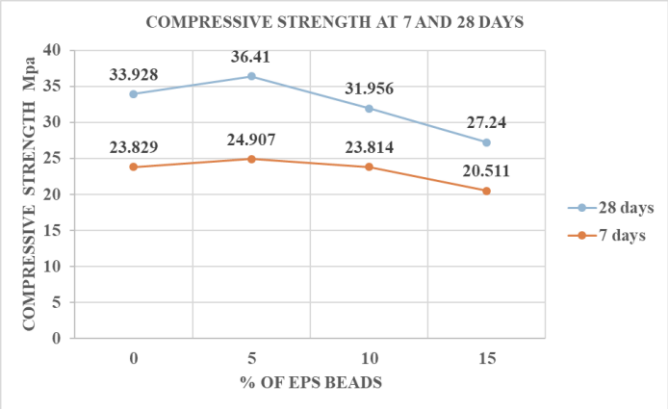
$$F_r = \frac{P \times L}{b \times d^2}$$

## 5. EXPERIMENTAL RESULTS:

5.1 Compressive strength test result:

**Table 4: Compressive Strength at 7 days and 28 days**

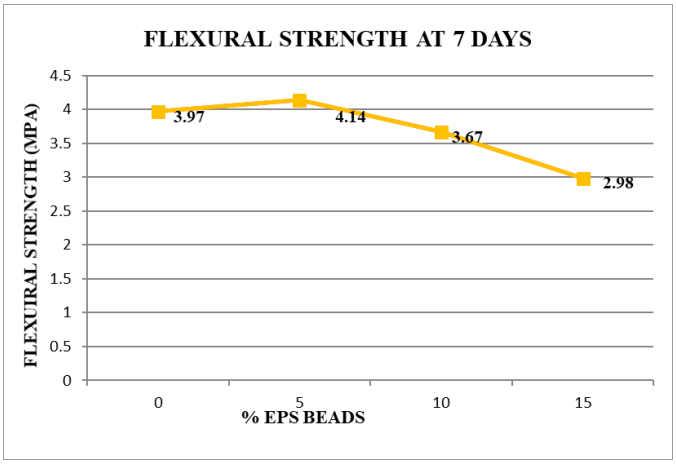
| % of EPS BEADS replacement | Compressive strength at 7 days (N/mm²) | Compressive strength at 28 days(N/mm²) |
|---|---|---|
| 0 | 23.829 | 33.928 |
| 5 | 24.907 | 36.410 |
| 10 | 23.814 | 31.956 |
| 15 | 20.511 | 27.340 |




**5.2 flexural strength test results:**

**Table 5: Flexural Strength at 28 days:**

| %of EPS BEADS replacement | Flexural strength at 28 days(N/mm²) |
|---|---|
| 0 | 6.45 |
| 5 | 6.98 |
| 10 | 6.22 |
| 15 | 5.33 |




## 6. CONCLUSIONS

Based on results and remark 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-priced than conventional concrete.
3. Current study concluded that strength of concrete is attained up to 5% replacement and strength of concrete decreases at 15%.
4. The use of waste EPS BEADS in concrete is possible 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. 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.
7. 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.
8. Flexural strength of concrete increase up to 5% and at 15% flexural strength of concrete decreases.

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