An Experimental Study of Light Weight Concrete with Expended Polystyrene Beads as Aggregates.

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Abstract - *Compared to ordinary concrete, lightweight concrete is an innovative building material that offers numerous benefits. Its reduced density—which is typically between 10% and 40% lower—leads to improved thermal insulation and energy efficiency. This experimental study investigates the properties of lightweight concrete using expanded polystyrene (EPS) pellets as the aggregate. EPS beads were added to the concrete mix in different proportions to replace traditional coarse aggregates. We evaluated the impact of EPS beads on concrete's density, compressive strength, workability, and thermal conductivity in both its fresh and hardened states. The findings showed that there were significant drops in density (up to 40%) and thermal conductivity (up to 50%) when the number of EPS increased. Compressive strength decreased with increased EPS content, although it remained within permissible limits for structural applications. The study emphasizes the potential of EPS-based lightweight concrete for energy-efficient and sustainable construction, with potential applications in building insulation, foundation systems, and structural elements.*

Key Words: **thermal conductivity, compressive strength, aggregates, expanded polystyrene beads, lightweight concrete, and sustainability.**

1.INTRODUCTION:

Modern infrastructure, buildings, and structures are largely constructed with concrete, a material that has been around for generations. It is a complicated composite material made of cement, water, fine and coarse aggregates, and admixtures. These ingredients work together to create a material that is robust, adaptable, and long-lasting. Because of its special qualities and benefits, concrete is now a crucial part of contemporary building, being utilized for anything from roadways and ornamental elements to high-rise structures and bridges. The high weight, thermal conductivity, and environmental effects of traditional concrete are some of its drawbacks. Using unconventional materials and methods, researchers and engineers have been investigating creative ways to overcome these obstacles, such as creating lightweight concrete.

1.1 Light weight concrete:

Variety of concrete that contains an expanding agent, which adds volume to the mixture and imparts other properties, including ability and reduced dead weight. When poured on the wall, lightweight concrete keeps its vast spaces without creating cement films or laitance layers. The performance of aerated lightweight concrete served as the foundation for this study. For cement and water to cohere sufficiently, though, a suitable water-to-cement ratio is essential. Concrete may become less strong due to a lack of cohesiveness between the particles brought on by insufficient water. Similarly, excessive watering can lead to cement runoff, causing laitance layers to form, which then lose strength.

1.2 Expanded Polystyrene (EPS) and its benefits:

One common ingredient in enhanced concrete aggregate is polystyrene, a light-weight, rigid foam. Blending concrete with EPS blocks or beads creates a unique composite material with unique properties. Reduced density and weight. improved capacity to insulate Increased buoyancy (for maritime applications) enhanced workability and finishability. Potential for reduced material costs.

2. AIM AND OBJECTIVE:

- Examine the potential applications of EPS-based lightweight concrete for building structures, insulation, and infrastructure development.
- Consider the potential cost savings, improved thermal insulation, and reduced environmental effects of using EPS in construction.
- For lightweight concrete with an M30 grade, develop a mix using EPS instead of coarse material. Analyze the variations in lightweight concrete with EPS performance versus conventional concrete.

3. LITRATURE REVIEW:

- **Mohsin Mushtaq Khan, and Anuj Sachar**

  The concrete made of lightweight aggregates which reduce self and density of concrete is called as lightweight concrete. The density of lightweight concrete ranges from 1440 kg/m3 to 1840 kg/m3. It includes expanding agents which increase the volume of concrete thus reducing self-weight of concrete. The minimum strength for structural lightweight concrete should not be less than 17 Mpa. Lightweight concrete reduces the self-weight of concrete by about 25 to 35%. In this study we have used pumice Stone and Thermocol beads as partial replacement for coarse aggregate and fly ash as partial replacement for cement in producing light weight concrete. After the completion of tests on fresh concrete, certain tests were performed on hardened concrete samples which include compressive strength test and flexural strength test. The series of tests on the samples were done and calculated the value of strength that concrete can withstand the loads applied on compression and flexure on cube and beam respectively. Following are the tests done and their results are shown as below

Table 1: Compressive Strength Test results

SAMPLE	7 DAYS	28 DAYS
CUBE 1	18.26	27.56
CUBE 2	21.28	30.96
CUBE 3	17.2	25.8

Table 2 : Flexural Strength Test results

SAMPLE	7 DAYS	28 DAYS
CUBE 1	3.38	5.15
CUBE 2	3.64	5.35

- **Parveen Berwal, Arun Kumar, Ahmad Uzair, Amit Kumar, Abdul Ahad,**

Lightweight concrete keeps up its huge voids and doesn't shape laitance layers or cement pictures when put on the separator. This disquisition was predicated on the prosecution of circulated air through light concrete. In any case, acceptable water cement proportion is imperative to produce satisfactory cohesion between cement and water. shy water can beget need of cohesion between patches, hence mischance in quality of concrete. also, as well important water can beget cement to run off total to make laitance layers, hence debilitates in quality. Hence, this pivotal disquisition report is ready to appear exercises and advance of the light concrete. Centered were on the prosecution of circulated air through lightweight EPS beads concrete similar as compressive quality tests, water assimilation and consistence and supplementary tests and comparisons made with other feathers of light concrete. To determine the workability and consistency of EPS Beads concrete, it is recommended to consult the relevant standards, guidelines, or research papers specific to lightweight concrete incorporating EPS beads. These resources will provide you with detailed information on the appropriate testing methods and acceptance criteria for EPS Beads concrete in your specific application. The addition of polystyrene to a concrete mix generally resulted in increased workability. It was observed that as the percentage of coarse aggregate replaced by polystyrene increased, the workability of the mixes also increased. In other words, higher levels of polystyrene replacement led to higher levels of workability.

Slump test results	SLUMP VALUE
10% replacement	65
20% replacement	68
30% replacement	70
40% replacement	75
50% replacement	81

4. MATERIAL FOR EXPERIMENTS:

4.1 Cement Content: This experiment used cement of grade OPC-53, which has a specific gravity of 3.16 and a cement fineness of 6% Test for Consistency 30%.

4.2 Coarse Aggregate: The aggregate was used in a uniformly graded aggregate grade that was consistent and had a nominal size of 20 mm. It has a 2.98 specific gravity, a 3.44 fineness modulus, and a 0.5% water absorption rate.

4.3 Fine Aggregate: Zone II natural river sand is used for this work. The specific gravity of is 2.44, its fineness modulus is 2.7, its water absorption is 2.2%, and its nominal fine aggregate size is 4.75 mm.

4.3 Water: It is an essential component of concrete and plays a significant role in the mixing, placing, and curing processes, ensuring the strength and longevity of the concrete edifice.

4.4 EPS (Expanded Polystyrene): 0.011 bulk specific gravity Water Absorption: 3.5% by volume Density: 6.88 kg per cub meter and Particle Size: Diameter of 8–10 mm.

5. MIX DESIGN STEPS FOR M-30 GRADE CONCRETE:

As Indian standard recommended method for concrete based on {IS10262-2019}.

(a) Steps for mixed design for concrete:

1. Grade of Concrete = M-30

2. Cement = OPC-53

3. Nominal Size of aggregate = 20 mm

3. Degree of site control condition = Good

4. Condition of Exposure = Severe

5. Workability = 75 mm

6. Method of concrete placing = manual mixing

7. Minimum cement content = 320 kg/m^3

(b) Test result for material:

1. Specific gravity of cement = 3.16

2. Specific gravity of coarse-aggregate = 2.98

3. Specific gravity of fine-aggregate = 2.44

4. Water absorption of coarse-aggregate = 0.5

5. Water absorption for fine-aggregate = 2.2

6. Zone of sand = II

(c) Target mean strength for M-30 grade = 38.25 N/mm^2

(d) Selection of water-cement ratio = 0.45

(e) Selection of water content = 207.567 kg/m^3

(f) Cement content =425.20 kg/m^3

(g) Coarse aggregate (per m^3) = 1124.628 kg

(h) Fine aggregate (per m^3) = 630.235 kg

5. TEST ON CONCRETE:

Workability test of Concrete: for better workability of concrete Consistency of concrete is determine by the slump cone test C:S: A::1:48:2.64 is the mix ratio for conventional concrete, and C:S:A::1:63:3.03 is the mix ratio for expanded polystyrene concrete. The Slump Values of Conventional Concrete 81.25 mm and slump value for EPS concrete is 84mm

6. RESULT AND DISCUSSION:

The sample of concrete were cast in accordance with IS 10086-1982. The cube, cylinder, and beam samples were cured in a water pond for a period of 28 days. At seven and twenty-eight days, the strength metrics of self-compacted concrete were compared to those of conventionally cured concrete.

Fig-3: Casting of Cube.

Fig-2: Casting of Cylinder

Fig-3: Casting of Beam

6.1 TEST OF SAMPLE:

Compressive Strength test: A 150 × 150 × 150 mm concrete cube was cast, and it was tested for seven and twenty-eight days. Compressive Strength is equal to P/A, where A is the cross-sectional area (150 × 150 x 150 mm) and P is the applied load.

Fig-4: Compressive strength test in UTM

TABLE-3: Compressive Strength results of Concrete:

Grade of M30 Concrete with EPS %	**Compressive strength N/mm² at 7 days**
0%	24.00
20%	17.03
30%	16.50
40%	15.45

TABLE-4: Compressive Strength results of EPS Concrete.

Grade of M30 Concrete with EPS %	**Compressive strength N/mm² at 28 days**
0%	52.00
20%	25.02
30%	22.05
40%	19.02

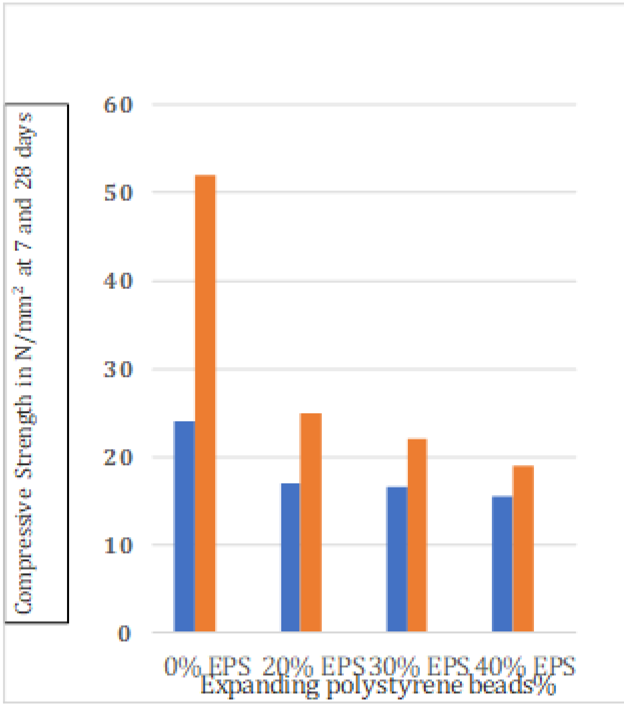

Chart-1: Compressive strength of conventional concrete after 7, and 28-days vs expended polystyrene concrete.

Split tensile strength test: Upon casting, the cylinder underwent testing. Using cylinders that are 150 mm in diameter and 300 mm high, in 7 and 28 days. The formula for split tensile strength is 2P/πDL, where P is the load, D is the cylinder diameter, and L is the cylinder length.

Fig- 5: Split tensile strength test in UTM

TABLE-5: Tensile Strength results of Concrete:

Grade of M30 Concrete with EPS %	Tensile strength N/mm² at 7 days
0%	3.8
20%	3.1
30%	2.4
40%	2.1

TABLE-6: Tensile Strength results of EPS Concrete:

Grade of M30 Concrete with EPS %	Tensile strength N/mm² at 28 days
0%	4.8
20%	3.5
30%	2.9
40%	2.5

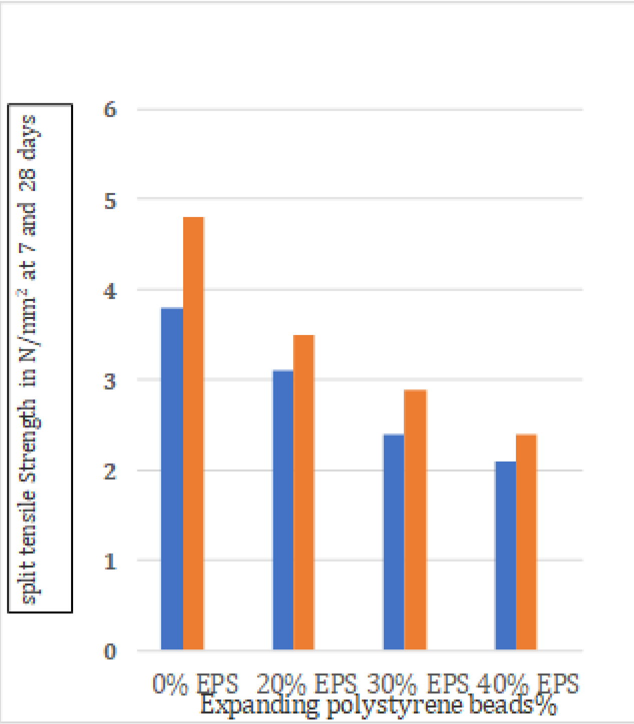

Chart-2: Tensile strength of conventional concrete after 7 and 28-days vs expended polystyrene concrete.

Flexural Strength test: At the age of 7and 28 days, A universal testing equipment applies a 2000 KN force to a 150 x 150 x 700 mm beam specimen to generate bending. f strength is equal to WL/bd.

Fig-6: flexural strength test of concrete in UTM

Table-4: Flexural Strength results of Concrete.

Grade of M30 Concrete with EPS %	Flexural strength N/mm² at 7 days
0%	2.7
20%	2.6
30%	2.9
40%	3.4

Table-5: Flexural Strength results of EPS Concrete.

Grade of M30 Concrete with EPS %	Flexural strength N/mm² at 28 days
0%	3.0
20%	2.9
30%	2.8
40%	3.7

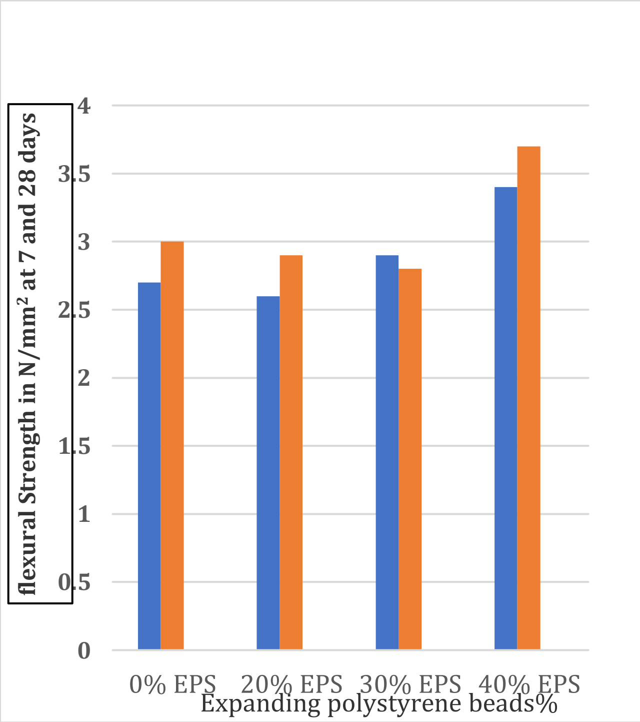

Chart-3: flexural strength OF Conventional concrete after 7 and 28-days vs Expended polystyrene concrete.

7. CONCLUSION:

1. Concrete's density has been lowered without sacrificing the substance's compressive strength.
2. When compared to traditional concrete, the ideal dosage of expanded polystyrene beads results in a 20% reduction in the density of the concrete.

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