LIGHTWEIGHT CONCRETE USING RECYCLED EXPANDED POLYSTYRENE BEADS

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Abstract - *Demand of lightweight concrete is increasing in the construction industry for the non-structural members. In this paper, coarse aggregates of concrete are replaced by Expanded Polystyrene (EPS) beads to achieve lightweight concrete. The main objective of this experiment was to compare the properties, such as compressive strength and heat insulation, of EPS concrete to the standard concrete cube. The cubes consists of 5%, 10%, 15%, 20%, 25%, and 30% EPS (by vol. of coarse aggregate) for M25 mix design. The cubes were tested at 7d, 14d and 28d of curing. The results obtained were compared with standard concrete sample.*

***Key Words*: Lightweight concrete, Expanded polystyrene, EPS, Styrofoam, Non-Structural, etc.**

1.INTRODUCTION

With increasing construction activities, the demand of raw materials for concrete is at its peak. Since the dead load of concrete is very high because of high density (2400 kg/m^3), thereby load on the structure increases. To reduce this dead load, there is need of lightweight concrete. This lightweight concrete can be used in non-structural members like wall panels, etc to reduce the dead load of structure. The lightweight concrete can be achieved in number of ways like either by introducing gas (or foam) or by replacing the standard aggregates with lighter materials. In this paper, the latter approach is used. The coarse aggregates are replaced by volume by discarded Expanded Polystyrene (EPS) beads.

EPS beads are used for packaging of goods for easy handling and transportation. But the disposal of EPS beads is becoming a problem for the waste disposal department. Since, EPS is lightweight, non-biodegradable, hydrophobic and chemically inert in nature, and also have good thermal and sound insulation; it can be used as a low cost replacement of the coarse aggregates for the light weight concrete. Since, it a waste product from the packaging industry, utilizing it in construction of lightweight concrete will not only reduce the cost but all reduce the burden on waste disposal departments.

Generally, lightweight concrete is accepted as concrete with density less than 1800 kg/m^3. Thereby, in this paper, the EPS concrete is designed for M25 at 5%, 10%, 15%, 20%, 25% and 30% of EPS (by vol. of coarse aggregates). A comparative study between the EPS and standard concrete is done on parameters like compressive strength and thermal insulation.

2.MATERIALS USED AND METHEDOLOGY

2.1 Material used

The materials used in EPS concrete are Cement, Fine aggregate, Coarse aggregates, EPS and water.

2.2 Experimental method

In this experiment, six different sample of EPS concrete was prepared at different percentage of EPS beads (by vol. of coarse aggregates). The concrete was designed for M25 mix design as per the IS 10262: 1982. The cube specimen of size 15x15x15 cm were prepared at 5%, 10%, 15%, 20%, 25% and 30% of EPS (by vol. of coarse aggregates). After 7, 14 and 28 days of curing, they were tested for compressive strength in CTM machine. They were also tested for thermal insulation.

The following the proportions of the material used for M25 concrete design:

Table-1: Quantity of material in 15x15x15 cm cube

	Material used	5%	10%	15%	20%	25%	30%
1	Cement(kg)	1.87	1.87	1.87	1.87	1.87	1.87
2	FA (kg)	2.34	2.34	2.34	2.34	2.34	2.34
3	CA (kg)	3.45	3.17	2.87	2.58	2.30	2.01
	20 mm	2.27	2.08	1.72	1.55	1.38	1.207
	10 mm	1.51	1.39	1.15	1.03	0.92	0.805
4	Water (ml)	711	711	711	711	711	711
5	EPS (g)	3.5	6.41	10.58	14.08	17.6	21.12

3.RESULT

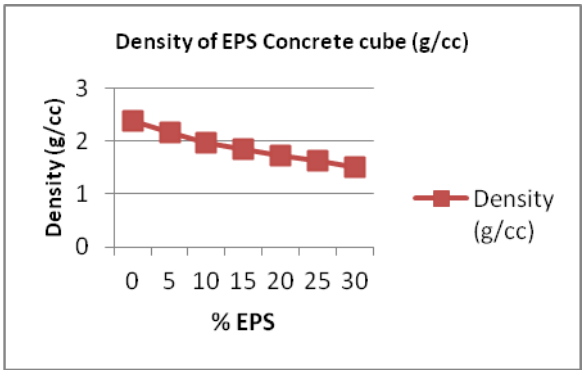
3.1 Density

The density of cube was computed by taking the ratio of the weight of cube to the volume of cube. The weight was measured by weighing machine and the dimension of the cube was known, that is 15x15x15 cm.

Table-2: Density of EPS and Standard concrete

% of EPS	Density (g/cc)
0	2.398
5	2.1745

10	1.9765
15	1.8482
20	1.7309
25	1.6251
30	1.5191

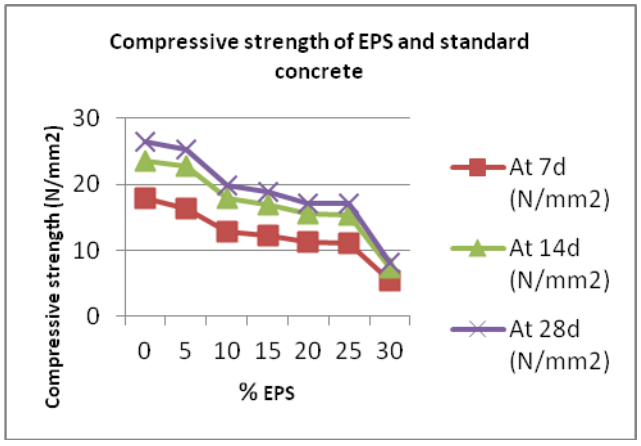


3.2 Compressive Strength

The compressive strength of the cube was tested after 7, 14 and 28 days of curing in CTM machine.

Table-3: Compressive strength of EPS and standard concrete

% of EPS	At 7d (N/mm²)	At 14d (N/mm²)	At 28d (N/mm²)
0	17.83	23.54	26.4
5	16.37	22.67	25.18
10	12.84	17.78	19.75
15	12.19	16.88	18.75
20	11.16	15.453	17.17
25	11.11	15.381	17.09
30	5.33	7.38	8.2



3.3 Thermal Insulation Test

Thermal Insulation test of the specimen was done at 14d of curing.

Table-4: Temperature at 5 min of heating

	0%	5%	10%	15%	20%	25%	30%
Bottom	211	187.5	163.2	149.5	132	124	106
5 cm	71.9	70.3	68.2	64	62	52	46
10 cm	48.7	38.2	36	35.1	34.9	33	32.1
15 cm	42	36.1	35.3	34.2	32.7	31.8	29
Plate	250	250	250	250	250	250	250

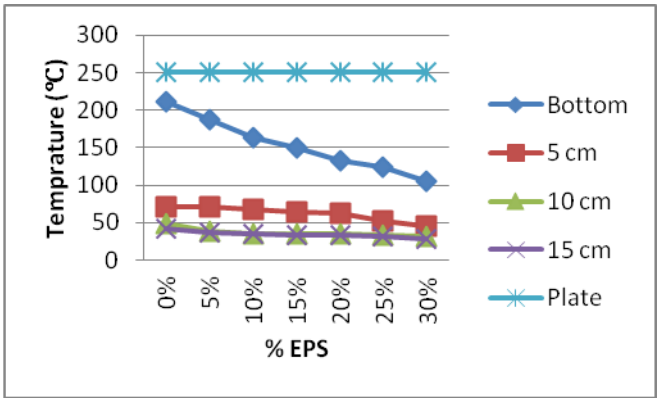


Table-5: Temperature at 10 min of heating

	0%	5%	10%	15%	20%	25%	30%
Bottom	231	190	168	153	148	137	126
5 cm	73	72.1	69.3	65.8	63.7	53.2	48.2
10 cm	51.9	40.1	37.2	36.8	35	34.2	33.2
15 cm	47	35.8	35.6	34.7	33.5	32.1	29.4
Plate	250	250	250	250	250	250	250

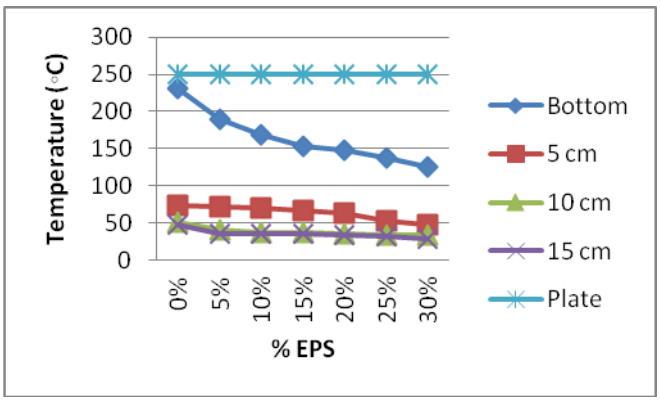
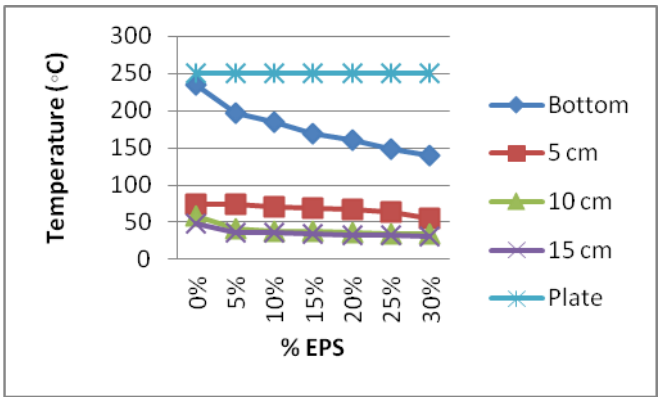


Table-6: Temperature at 15 min of heating

	0%	5%	10%	15%	20%	25%	30%
Bottom	235	196	184	169	161	148	139
5 cm	74.6	73.8	70.2	68.5	66.7	63	54.3
10 cm	58	41	38	37.9	36.3	34.9	33.8
15 cm	49	36	35.8	34.9	33.5	32.3	30.7
Plate	250	250	250	250	250	250	250



4. CONCLUSIONS

1. 25% of the aggregates were replaced by EPS beads, the reduction in weight for a standard concrete cube is about 2.61kg (67.73%).

2. At 25% replacement, the compressive strength obtained was 17.09 N/mm2, which is 64.73% of the conventional concrete block.

3. At 25% replacement, only 32.15% of the heat transferred along the length of the cube.

4. During heating process, the EPS beads that came in direct contact with the heated surface shrinked leading to formation of voids in the concrete.

5. Due to the circular shape of EPS beads, they also contributed to the workability of the concrete mix.

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