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Use of expanded polystyrene beads in manufacturing of light weight concrete

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ABSTRACT

Styrofoam polystyrene was widely used in the food and manufacturing production as packaging tools to absorb vibration during handling and transportation process. Due to light weight characteristics, it has the potential to serve as aggregates replacement of coarse aggregates. This project reports the results of an experimental investigation into the properties of hardened concrete containing expanded polystyrene beads by studying the characteristic strength of concrete. The beads are used as part of aggregate replacement in the mixes. The project includes the study of characteristic properties of EPS concrete with partial replacement of coarse aggregate with an equal volume of expanded polystyrene at levels of 0 %, 5 %, 10 %, 15 %, 20 %, 25 %, and 30 %. Its properties are compared with those of conventional concrete i.e., without EPS beads. The properties of concrete are mainly influenced by the content of polystyrene beads in the mix.

Keywords— *EPS (Expanded Polystrene Beads), Compressive Strength, Density, Workability.*

1. INTRODUCTION

Structural lightweight concrete has an in-place density (unit weight) of 1440 to 1840 kg/m^3. Lightweight concrete is produced by introducing air inside the concrete; either by using gassing and foaming agent or using lightweight aggregates such as natural aggregate (pumice, shale, slate) or industrial by-product (palm oil clinker, sinterized fly ash) or plastic granules (Styrofoam or polymer materials). Lightweight aggregate (clinker, pumice, shale, slate etc.) and chemicals have been used by many researchers for the development of lightweight concrete. Polystyrene is chosen due to its lightweight properties, with good energy absorbing characteristics and good thermal insulator leading mainly to non-structural applications and structural applications.

Increase in the developmental activities world over, the demand for construction materials is increasing exponentially. This trend will have a certainly greater impact on the economic system of any country. India also is aiming at a high developmental rate compared to other nations in Asia. There is heavy demand for the building materials in the domestic market, which is becoming scarce day by day. At this point researchers and engineers who have the foresight to keep the developmental activities abreast and curtail the cost factor should look out for other alternative building materials.

In this work, an attempt is made to address the possibility of utilizing Expanded Polystyrene (EPS), packing material in the form of beads in concrete, which otherwise is posing a threat to waste disposal as well as for waste management. This material is a cause of concern to environmentalists. In this study, it is attempted to partially replace coarse aggregates by means of EPS beads. A general discussion on EPS, its production and its application along with environmental concerns are being discussed.

1.1 Expanded Polystyrene Beads

Expanded Polystyrene (EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are comprised of about 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water. In Beads concrete, expanded polystyrene beads are used in place of coarse aggregate partially. It has good sound and thermal insulation characteristics as well as impact resistance. Polystyrene foam is a non-biodegradable material. It is a waste of material from the packaging industry. It creates a disposal problem. Utilizing crushed polystyrene granules in concrete is a valuable waste disposal method.

Fig. 1: Expanded Polystyrene Beads

There are many advantages to be gained from the use of lightweight concrete. These include lighter loads during construction, reduced self-weight in structures, and increased thermal resistance. Lightweight concrete is generally accepted as concrete having a density of about 1840 kg/m3 or less. The present investigation was taken up, keeping two targets in view, disposal of the polystyrene waste from the point of view of the environment and for the replacement of aggregate from the point of view of the construction industry.

2. PROBLEM STATEMENT

- Study the property, characteristics of Expanded Polystyrene beads.
- Find out the property of available, fine aggregate and coarse aggregate.
- Mix design M 25 grade concrete with available aggregate.
- Percentage replacement of coarse aggregate with Expanded Polystyrene beads by volume.
- Compression strength test of conventional concrete and beads concrete.
- Workability test of conventional concrete and beads concrete.
- The density of conventional concrete and beads concrete.
- Compare the results of beads concrete with conventional concrete mix.
- Find out the area of use of beads concrete with the results.

3. METHODOLOGY

The present study aims at utilization and the suitability of polystyrene beads as coarse aggregate. A comparative study on strength, workability, density parameters is also done against conventional concrete to study the behavior of the polystyrene aggregate. For this 0 %, 5%, 10%, 15%, 20%, 25% and 30% replacement of coarse aggregate by volume with expanded polystyrene beads is attempted in this work with M 25 mix designed concrete.

In this experimental investigation quantity of cement and sand is same for all compositions samples which are made from partial replacement (5%, 10%, 15%, 20%, 25% and 30%) of coarse aggregate by volume with expanded polystyrene beads. Quantity of cement sand and coarse aggregate is calculated from mix design method for experimental investigation samples are made:

Table 1: Sample of concrete mixes

S. no	Samples	Description
01.	A	0 % Replacement of C.A. by volume
02.	B	5 % Replacement of C.A. by volume
03.	C	10 % Replacement of C.A. by volume
04.	D	15 % Replacement of C.A. by volume
05.	E	20 % Replacement of C.A. by volume
06.	F	25 % Replacement of C.A. by volume
07.	G	30 % Replacement of C.A. by volume

The pattern of testing compressive strength test on concrete cubes are:-

Table 2: Pattern for experiments

S.no.	Sample No.	Specimen no. For 7 days of strength	Specimen no. For 28 days of strength
1.	A	A 1 A 2 A 3	A 4 A 5 A 6
2.	B	B 1 B 2 B 3	B 4 B 5 B 6
3.	C	C 1 C 2 C 3	C 4 C 5 C 6
4.	D	D 1 D 2 D 3	D 4 D 5 D 6
5.	E	E 1 E 2 E 3	E 4 E 5 E 6
6.	F	F 1 F 2 F 3	F 4 F 5 F 6
7.	G	G 1 G 2 G 3	G 4 G 5 G 6

A compression test is carried out on 7 days and 28 days of concrete mix.

4. MIX DESIGN

Mix design is the process of selecting the ingredients in specific quantities for a different type of works. For this project, I was done mix design by INDIAN STANDERD RECOMMENDED METHOD OF CONCRETE MIX DESIGN based on (IS 10262-1982). M 25 grade concrete mix was taken by me. The procedure of mix design is as follows.

4.1 Concrete mix design

(a) Design required:

Characteristic compressive Strength required in the field at 28 days. = 25MPa.

Maximum size of aggregate. = 20mm (angular).

Degree of Workability = 0.80 (compacting factor)

Degree of quality control = Good.

Type of exposure = Moderate.

(b) Test data for materials:

Specific gravity of cement. = 3.15

Specific gravity of coarse aggregate = 2.63

Specific gravity of fine aggregate = 2.62

Water absorption of coarse aggregate = 0.58%

Water absorption for fine aggregate = 1.0%

Free surface moisture for coarse aggregate = Nil

Free moisture for fine aggregate = 1.85%

Conforming zone by sieve analysis of sand = zone-2

(c) Target mean strength = 33.25Mpa.

(d) Selection of water cement ratio = 0.43

(e) Selection of water sand content

Required sand content = 31.6%

Required water content = 186kg/m3

(f) Determination of cement content = 432.56

(g) Determination of coarse and fine aggregate contents (per m3)

Water: 0.43 = 186

Cementitious materials: 1 = 432.6kg

Fine aggregate: 1.26 = 543.68kg

Coarse aggregate: 2.73 = 1181.31kg

(h) Actual quantities required for the mix (per bag)

Cement = 50kg

Fine aggregate = 64kg

Coarse aggregate = 135.76kg

Water = 21.13litres

5. EXPERIMENTAL PROGRAM

To find out the properties of all sample made by replacement of coarce aggregate, compressive strength test, workability test and density test is carried out and compare the value of all sample with conventional concretes properties.

Table 3: Slump test results

S. No.	Samples	Value of slump (mm)
1.	A	35
2.	B	38
3.	C	42
4.	D	44
5.	E	48
6.	F	55
7.	G	60

Fig. 2: Slump measurement of EPS concrete

Table 4: Compressive test results

S no.	Sample designation	7 days N/mm^2	28 days N/mm^2
1.	A	20.08	31.52
2.	B	18.53	28.51
3.	C	15.42	23.83
4.	D	14.25	22.14
5.	E	12.93	18.91
6.	F	11.61	17.95
7.	G	9.35	14.14

Fig. 3: Compressive testing machine

Table 5: Density of concrete cube

S no.	Samples of Concrete cubes	Density of concrete Cube (kg / m^3)
1.	A	2405
2.	B	2311
3.	C	2213
4.	D	2133
5.	E	2044
6.	F	1914
7.	G	1813

6. RESULTS AND DISCUSSION

The present study was undertaken to investigate the workability and compressive strength and density of concrete with partial replacement of coarse aggregate with expanded polystyrene beads by volume. The behavior of all the seven samples is taken as a basic study on the modeled structure.

6.1 Workability

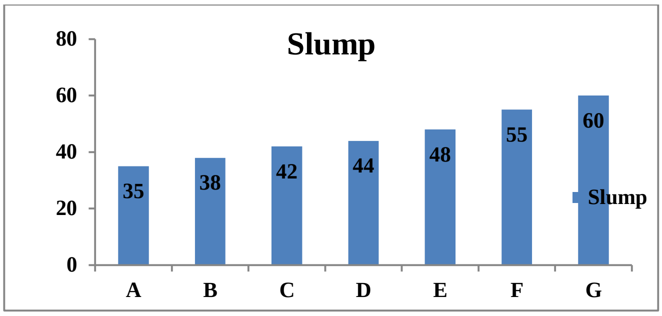

Fig 4: Slump value for w/c ratio 0.43

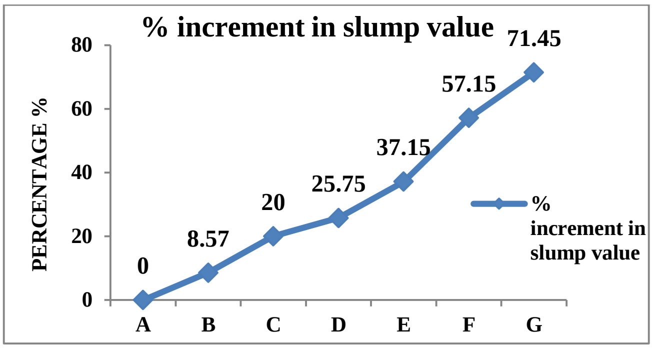

Fig. 5: Percentage increment of workability of EPS concrete from conventional concrete

6.2 Compressive strength

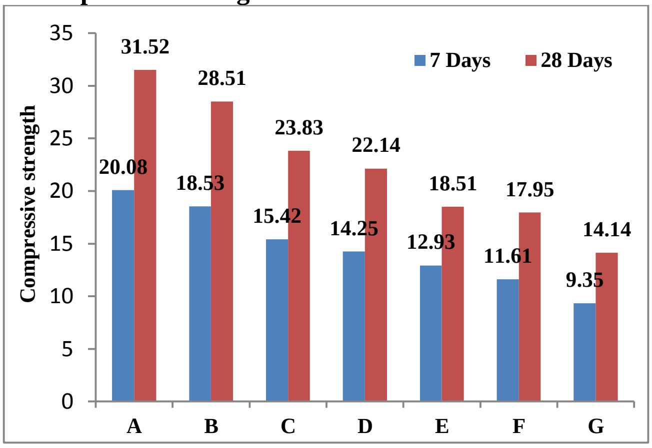

Fig. 6: 7 days and 28 days compressive strength of samples

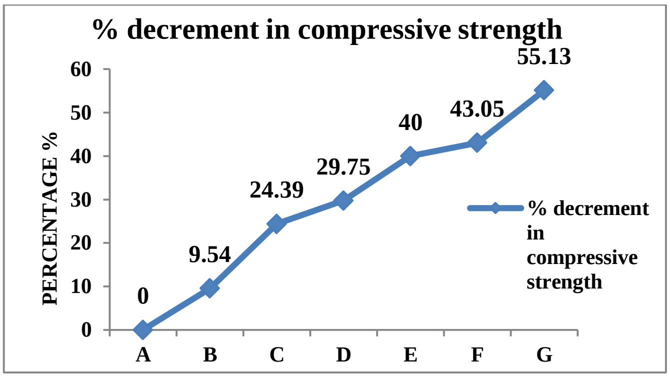

Fig. 7: Percentage decrement of compressive strength of EPS concrete from conventional concrete

6.3 Density

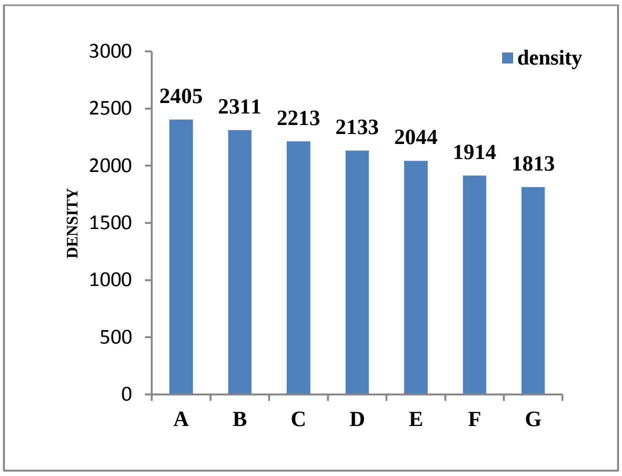

Fig. 8: Density of concrete cube

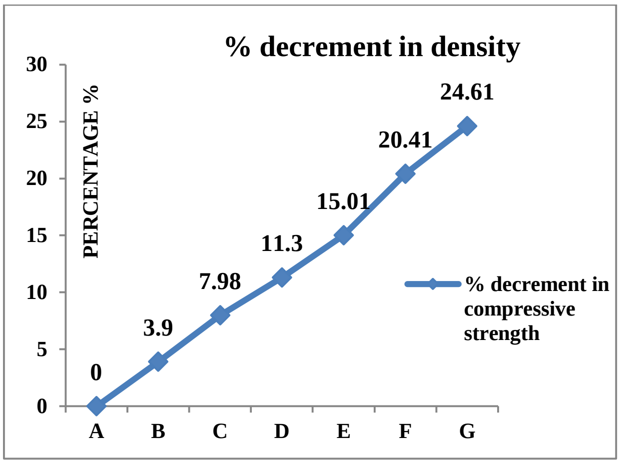

Fig. 9: Percentage decrement in density of EPS concrete from conventional concrete

6. CONCLUSION

In this work, concrete is made by partially replacing coarse aggregate by volume with expanded polystyrene beads. Replacement is done with 5%, 10%, 15%, 20%, 25% and 30%. Concrete is made after this replacement shows a decrement in compressive strength compared to conventional concrete. Expanded polystyrene beads are soft material, it is also one of the main reason behind decrement in compression strength of beads concrete. After replacing the coarce aggregate from beads it shows a decrement in the total weight of concrete or density of concrete, concrete becomes light weight as compared to conventional concrete. In the case of EPS beads as light weight aggregate in concrete, eps beads do not absorb water from concrete, which results that workability of concrete does does not decrease from absorbing water from the coarse aggregate.

Light weight concrete is used in roof slabs and decorative slabs floor it's light weight property is very useful in decreasing the dead weight of the structure. Building blocks and panels can be made for partition and load-bearing walls from beads concrete. Eps concrete is used extensively for roof insulation and for making a slope on flat roofs because it has a good thermal insulating property.

The weight of building on a foundation is an important factor in the design, particularly in the case of weak soil and tall structures. In a framed structure, the beam and column have to carry a load of wall and floor. If these wall and floor are made of light weight concrete blocks it will result in the considerable economy as compared to conventional concrete blocks.

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