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A STUDY ON MECHANICAL PROPERTIES OF CONCRETE BY REPLACING AGGREGATE WITH EXPANDED POLYSTYRENE BEADS

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ABSTRACT

Artificial light weight aggregate produced from environmental waste like Expanded Polystyrene (EPS), is a workable new source of structural aggregate material. The use of light weight concrete permits greater design flexibility and considerable cost savings, reduced dead load. This paper presents the results of an experimental work on the effects of waste Expanded Polystyrene (EPS) based lightweight aggregate and fly ash in concrete. The natural coarse aggregate were replaced with 0%, 10%, 20%, 30%, 40% and 50% (by volume) of EPS. The ordinary Portland cement was replaced with 30% (by weight) of fly ash. Mechanical properties (compressive, tensile and flexural strength) and mix design of the lightweight concrete will be determined. Compressive strength values of concrete were significantly influenced by the mix ratios and curing period. Increase in the EPS beads content in concrete mixes reduces the compressive, flexural and tensile strength of concrete. The density of concrete was decreased with increasing EPS beads percentages. The density of concrete was decreased from 3.5 % to 23.5 % with addition in the range 10 % - 50 % of EPS beads.

Keywords: *Concrete, Polystyrene Beads etc.*

1. INTRODUCTION

In many countries, due to the increasing cost of raw materials and the continuous reduction of natural resources, the use of waste materials is a potential alternative in the construction industry. Waste materials, when properly processed, have shown to be effective as construction materials and readily meet the design specifications. The continued and expanding extraction of natural aggregate is accompanied by serious environmental problems. Often it leads to irremediable deterioration of rural areas, since quarrying of aggregates alters land topography and causes other potential problems, such as erosion. The artificial aggregates from industrial and post-consumer wastes are not only adding extra aggregate sources, but also reduce environmental pollution. Lightweight concrete can be defined as a type of concrete which includes an expanding agent in it that increases the volume of the mixture while reducing the dead weight. It is lighter than the conventional concrete with a dry density of 300kg/m^3 upto1840kg/m^3. The main specialties of lightweight concrete are its low density and good thermal insulation properties than normal weight concrete. During recent years, a number of materials known as lightweight aggregates have played an increasingly important role in the concrete industry. Lightweight aggregates, used to produce lightweight concretes have valuable in the manufacture of precast concrete. Among lightweight aggregates are expanded slags, expanded clays, shales, and slates, perlite, expanded polystyrene beads and vermiculite. Slag, clay, shale, and slate aggregates are used in structural concrete and for fill and insulating purposes. The marginally higher cost of the lightweight concrete is offset by size reduction of structural elements, less reinforcing steel and reduced volume of concrete, resulting in overall cost reduction.

1.1 NEED OF THE STUDY

Currently millions of tons of waste polystyrene are produced in the world. This will ultimately cause pollution and is harmful to the ecosystem. National and international environmental regulations have also become more inflexible, causing this waste to become increasingly expensive to dispose. Therefore, utilizing waste polystyrene in concrete Production not only solves the problem of disposing this ultra-light (up to 95% air) solid waste but also helps preserve natural resources. The present investigation was taken up, keeping two targets in view, disposal of the polystyrene waste from the point of view of environment and for the replacement of aggregate from the point of view of construction industry.

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1.2 AIM AND OBJECTIVE

In this work, an attempt is made to address the possibility of utilizing Expanded Polystyrene (EPS), a packing material in the form of beads in concrete. This paper presents the results of an experimental work on the effects of waste Expanded Polystyrene (EPS) based lightweight aggregate and fly ash in concrete. The natural coarse aggregate were replaced with 0%, 10%, 20%, 30%, 40% and 50% (by volume) of EPS. The ordinary Portland cement was replaced with 30% (by weight) of fly ash. Mechanical properties (compressive, tensile and flexural strength) and mix design of the light weight concrete will be determined.

1.3 SCOPE OF THE STUDY

Nowadays the use of lightweight concrete is becoming more advantages. This study deals with the preliminary concrete properties such as fresh and hardened concrete properties of the lightweight concrete are compare with Normal Concrete with a grade of M25.

2. MATERIALS

The ingredients of concrete were Expanded Polystyrene beads in the form of spheres, (used for filling bean bags), River sand as fine aggregate, crushed granite stones as coarse aggregate, 53 grade Ordinary Portland Cement conforming to I.S: 8112 , Class F fly ash collected from coal fired thermal power corporation has been used in this investigation and water.

2.1CEMENT

TABLE 1 PHYSICAL PROPERTIES OF CEMENT

SL.NO	PROPERTIES	VALUES
1.	Specific gravity of cement	3.10
2.	Fineness of cement	4%
3.	Standard consistency of cement	30%
4.	Initial setting time	35 min
5.	Final setting time	512 min
6.	Compressive strength of cement mortar in 28 days	53.80 Mpa

2.2 FLY ASH

TABLE 2 PROPERTIES OF FLY ASH

S.NO	PROPERTIES	VALUES
1.	Specific gravity of fly ash	2.1
2.	Bulk Density	1100Kg/m^3

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2.3FINE AGGREGATES

TABLE 3 PROPERTIES OF SAND

S.NO	PROPERTIES	VALUES
1.	Specific gravity of sand	2.61
2.	Water absorption	2%
3.	Fineness modulus	3.43
4.	Bulk Density	1650Kg/m^3

2.4 COARSE AGGREGATES

The following tests are carried out on coarse aggregate as per IS: 2386 (Part3) – 1963.

S.NO	PROPERTIES	VALUES
1.	Specific gravity of coarse aggregate	2.75
2.	Water absorption	0.9%
3.	Fineness modulus	4.72
4.	Bulk Density	1599 kg/m^3

2.5 EXPANDED POLYSTYRENE (EPS) BEADS

The ingredients of concrete were Expanded Polystyrene beads in the form of spheres, (used for filling bean bags).The EPS beads has been shown in figure2.

Figure 2. EPS Beads

2.6 WATER

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Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. Portable water is generally considered satisfactory. In the present investigation, tap water was used for both mixing and curing purposes. The pH value of water is 6.5.

3. EXPERIMENTAL INVESTIGATIONS

3.1 MIX DESIGN

Mix design is the process of selecting and determining the relative proportions of materials with the object of producing concrete of certain minimum strength and durability as economically as possible. The main objective is to stipulate the minimum strength and durability. Mix designs are carried out as per Indian Standard Code Method (IS 10262 – 2009) for the test specimen. The mix proportions are made for the M25 grades of concrete.

3.2 MIX PROPORTIONS FOR TRIAL NUMBER

Cement = 462 kg/m^3

Water = 208 kg/m^3

Fine aggregate = 884 kg/m^3

Coarse aggregates = 826 kg/m^3

Water cement ratio = 0.4

This concrete mix proportion is taken as the reference or control mix in the present study. The mix proportion for EPS beads based concrete is obtained by partially replacing coarse aggregate with different dosages of polystyrene beads volumetrically. The quantities of materials for various mixes are obtained by partial replacement (by volume) of coarse aggregates by EPS beads.

MIX NO.	W/C RATIO	SPECIMEN	EPS(%)	FLYASH(	MIXTURE CONSITUENTS Kg/m^3					
					WATER	SAND	CEMEMT	FLYAS	NA	EPS
1	0.4	M25	0	30	208	884	323	139	826	0
2		EPS10	10	30	208	884	323	139	749.9	0.3878
3		EPS20	20	30	208	884	323	139	666.6	0.776
4		EPS30	30	30	208	884	323	139	583.27	1.16
5		EPS40	40	30	208	884	323	139	499.95	1.551
6		EPS50	50	30	208	884	323	139	416.63	1.93

4. RESULTS AND DISCUSSION

4.1 FRESH CONCRETE PROPERTIES

The consistency of lightweight concrete has been measured by conducting a slump test in Concrete laboratory, In order to find the slump values of lightweight concrete with respect to increase percentage of expanded polystyrene beads (EPS). It is indicating that addition of EPS beads increase the workability of concrete. The workability of the concrete mixtures was in-creased with the increasing of EPS beads from 10% to 50%. And that

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refers to absent of the fines and coarse aggregate and also to the shape of spherical (EPS) beads which increase the slipping between the mixture particles. The figure 3 shows the slump values with respect to addition of EPS beads.

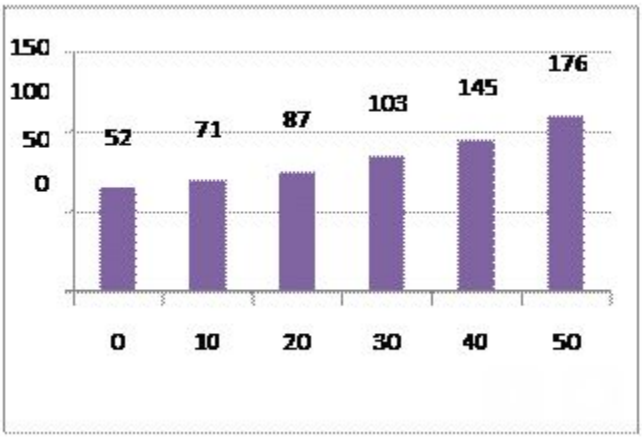

Figure.3 Slump Value of Concrete with EPS

4.2 HARDEND CONCRETE PROPERTIES

Compressive strength is determined primarily by the amount of cement used but is also affected by the ratio of water to cement, as well as proper mixing, placing, and curing.. Here the harden properties of lightweight concrete has been investigated with respect to age of concrete and also effect of EPS beads on concrete.

TABLE 8 COMPRESSIVE STRENGTH TESTS OF CONCRETES CUBES

MIX	COMPRESSIVE STRENGTH (MPa)			WET DENSITY (kg/m^3)	DRY DENSITY (kg/m^3)
	3 DAY	7 DAY	28 DAY		
CC	9.81	22.08	24.53	2465	2575
EPS10	7.01	16.24	18.42	2315	2485
EPS20	5.65	12.51	14.02	2213	2310
EPS30	4.16	9.24	11.5	2122	2202
EPS40	3.6	8.27	9.74	2068	2106
EPS50	2.46	5.6	7.19	1889	1967

The following chart represents the various strength values related to replacement of EPS beads. The replacement of beads increases the slump and decreases the density of fresh concrete.

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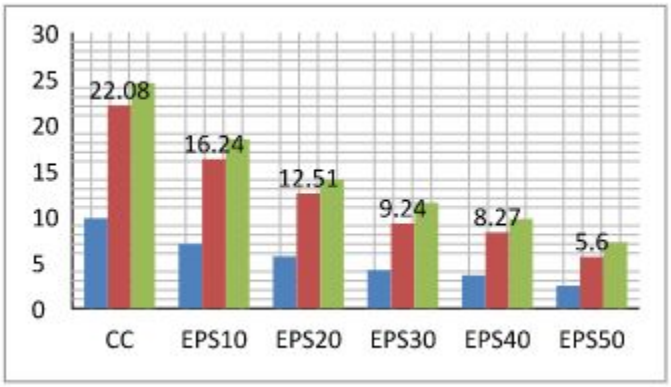

Figure 4. Compressive strength of Concretes with % of EPS

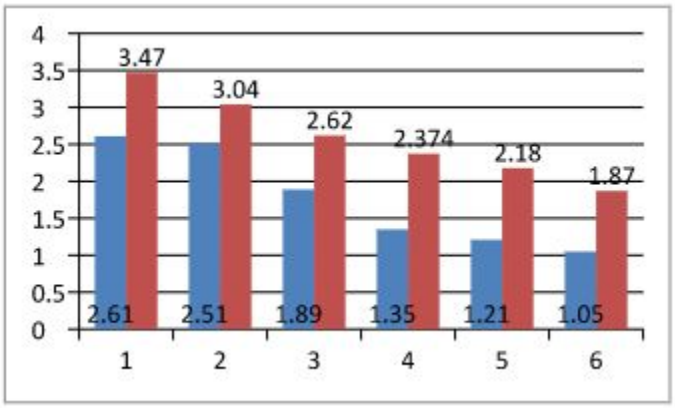

Figure 5. Split Tensile and Flexural Strength of Concretes with % of EPS

5. CONCLUSION

An experimental study was carried out for finding out the slump value, compressive, tensile and flexural strength of concrete prepared by replacing with EPS beads and fly ash. From the study following conclusions are drawn.

- Compressive strength values of concrete were significantly influenced by the mix ratios and curing period. Increase in the EPS beads content in concrete mixes reduces the compressive, flexural and tensile strength of concrete.
- All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished.
- While replacing 10% of EPS beads instead of coarse aggregate in lightweight concrete will have some reduction in strength.
- When the replacement level is 50% the wet density of concrete will become a lightweight concrete.
- Obtained results suggest that expanded polystyrene concrete has scope for nonstructural applications, like wall panels, partition walls, etc.
- The density of concrete was decreased with increasing EPS beads percentages. The density of concrete was decreased from 3.5 % to 23.5

% with addition of EPS beads in the range 10 % - 50 %.

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