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LIGHT WEIGHT COCRETE BY USING EPS BEADS

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ABSTRACT

We developed a new structural light weight concrete by completely replacing coarse aggregate in concrete by expanded polystyrene (EPS) beads. Expanded polystyrene (EPS) is a lightweight material that has been used in engineering applications since at least the 1950s. Expanded polystyrene waste in a granular form is used as light weight aggregate to produce light weight non-structural concrete with the unit weight varying from 950 kg/m³ to 1350kg/m³. This paper reports the results of an experimental investigation into the engineering properties, such as compressive strength, modulus of elasticity, drying shrinkage and creep, of polystyrene aggregate concrete varying in density. Factors such as water/cement ratio, polystyrene/cement ratio, cement content, maturity, compaction, fire, resistance. At the end of the study, a procedure for designing EPS light weight concrete mixes is outlined.

Keywords: EPS beads, concrete, compression Strength, Replacement.

I.INTRODUCTION

DEFINITION: EPS or expanded polystyrene is a rigid cellular plastic originally invented in Germany in 1950. It has been used in packaging solutions since 1958. It is 98% air but the rest is made from tiny, spherical EPS beads - themselves made only of carbon and hydrogen.

Fig.1 EPS Beads

1.1 Problem Statement

Currently millions of tons of waste polystyrene is produced in the world. This will ultimately cause pollution and is harmful to the ecosystem. National and international environmental regulations have become more inflexible increasingly which have made it expensive to dispose. Therefore using waste polystyrene in concrete

production not only solves the problem of disposing this ultra-light solid waste but also helps preserve natural resources.

1.2 Previous Work

1 B.A. Herki, J.M. Khatib and E.M. Negim School of Technology, University of Wolverhampton, Wolverhampton, UKWorld Applied Sciences Journal 21 (9): 1356-1360, 2013 ISSN 1818-49521

Concretes containing Portland cement, fly ash as the supplementary cementitious material, natural fine aggregate and a novel lightweight material called Stabilized Polystyrene (SPS) aggregate were investigated. This paper presents the results of an experimental work on the effects of waste Expanded Polystyrene (EPS) based light weight aggregate called Stabilized Polystyrene (SPS) and fly ash in concrete. The composite aggregate was formed with 70% waste polystyrene which was shredded to coarse and sand sizes, 10% of a natural material to improve the resistance to segregation of EPS and 20% Portland cement. Nine different Mixtures with water to binder ratio (W/B) of 0.8 with varying SPS content ratios of 0, 60 and 100% as partial replacement of natural fine aggregate by equivalent volume at the fly ash replacement levels of 0, 20 and 40%with Portland cement were prepared and tested. The properties of concrete investigated in this paper were compressive strength and ultrasonic pulse velocity (UPV) at the age of 28-day. The results indicate that there is a decrease in compressive strength and UPV with increasing amounts of SPS and fly ash in concrete.

2 JAY BANKIM SHAH, SAGAR PATEL U.G. Student, Civil Department, Shankersinh Vaghela Bapu Institute of Technology, Unava, Gandhingar-382650. Research Article Impact Factor: 4.226 ISSN: 2319-507X Jay Bankim Shah, IJPRET, 2015; Volume 3 (10): 43-48 IJPRET

Light weight concrete is a mixture of EPS (expandable polystyrene) beads i.e. light weight aggregate and plastic beads and OPC (Ordinary Portland Cement). EPS beads are sufficient enough to meet the requirement of light weight concrete. The cube containing EPS beads does not show enough compressive strength. Light weight concrete made using EPS beads and plastic beads are effectively used in partition walls, panels and other non-load bearing elements of the buildings as they provide required compressive strength. This element shows good thermal insulations and durability. Light weight concrete can be made in any size and shape as per the requirement.

1.3 Purpose

With the rapid development and technological increase, the need of substitutes for aggregate in concrete has increased. Day by day new materials are being used as replacement of aggregates in concrete construction such as expanded glass, expanded polystyrene beads, etc. A result has to be calculated by taking EPS beads and various tests have conducted on it after 7 and 28 days respectively to measure the properties of light weight concrete blocks. Lightweight concretes (LWCs) can be used in various construction fields. EPS beads can be used to produce low density concretes required for building applications like cladding panels, Partion walls, composite flooring system and load bearing concrete blocks.

1.4 Objectives:

EPS beads can be used to produce low density concretes required for building applications like cladding panels, curtain walls, composite flooring system, and load bearing concrete blocks.

- Excellent thermal insulation capacity.
- Easily controllable protection against the impact of shocks and drops.
- Flexibility of moulding.
- Stable in adverse weather conditions.
- Neutral for the environment and free of CFC.

1.5 Contribution of this paper:

This paper contributes in parametric study of parameter like density, water demand, compressive strength and have been taken in account to establish relation between various parameters. Compressive study of concrete with use of EPS beads as an aggregate. Study of concrete Density with use of EPS beads as an aggregate.

II. METHODOLOGY

To achieve the objective of present investigation, extensive and comprehensive experimental program has been planned. The entire investigation has been classified into various distinct phases of work for through and systematic approach. These phases of work are as follows.

2.1 Introduction of material used:

The materials used for preparing concrete are selected from those by the conventional concrete industry. Materials used for LWC using EPS beads are Crush sand stone, cement, Fly ash, EPS beads and chemical admixtures. LWC can be designed and constructed using a broad range of concreting materials, and that this is essential for LWC to gain popularity.

Cement: The term cement is commonly used to refer to powdered materials which develop strong adhesive qualities when combined with water. These materials are more properly known as hydraulic cements, Portland cement being the most important in construction Cement is a fine grayish powder which, when mixed with water, forms a thick paste. 53 grade Ordinary Portland cement conforming to BIS 12269-1987 is used.

Fly ash: Fly ash or Pulverized fly ash is a residue from the combustion of pulverized coal collected by mechanical separators, from the fuel gases of thermal plants.

Fig 2: Fly ash

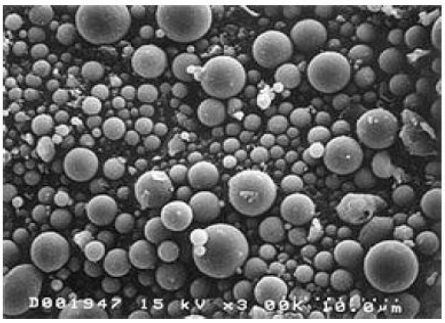

Fig 3: SEM image of Fly ash

The composition varies with type of fuel burnt, load on the boiler and type of separation. The fly ash consists of spherical glassy particles ranging from 1 to 150 micron in diameter and also passes through a 45-micron sieve. The chemical properties of fly ash are mentioned below good concrete quality, aggregates should be hard and strong, free of undesirable impurities, and chemically stable. Soft and porous rock can limit strength and wear

resistance, and sometimes it may also break down during mixing and adversely affect workability by increasing the amount of fines.

Crushed Sand Stone: Concreting sands suitable for LWC are crushed sand, rounded sands and Siliceous sand and calcareous sands can be used. The amount of fines less than 0.125 mm is to be considered as powder. A minimum amount of fines (arising from the binders and the sand) must be achieved to avoid segregation.

Chemical admixture: Polycarboxylate ether (PCE) type is very efficient dispersants for Calcium Aluminate cement. They provide superb workability to the material in the fresh state, and excellent physical properties in the hardened state.

Water: Water is used for mixing and curing as per IS 456:2000. From durability consideration water cement ratio should be restricted as in case of normal concrete and it should preferably be less than 0.4 are tested for their important properties before utilizing them for making concrete.

2.2 Preliminary investigations of materials used:

Cement, Fly ash, Fine aggregate, Crushed Sand Stone are tested for their important properties before utilizing them for making concrete.

Cement: Ultratech 53 Grade Cement will be required for following tests:

- Standard Consistency
- Setting Time

• **Setting Time**	**Limits**	**Test results(minutes)**
• **Initial Setting Time**	**30 Min**	**118**
• **Final Setting Time**	**600 Max**	**166**
• **Compressive strength**		
7 days	**37 Min**	
28 days	**53 Min**	

Table 1: Properties of Cement

Compressive Strength of Crushed Sand Stone: C.S.S will be required for following tests:

- Partial Density
- Particle Absorption
- Bulk Density

Properties of Fine aggregate: Compacted Bulk Density = 1951Kg/m^3

Uncompacted Bulk Density = 1813Kg/m^3

Sieve mm	Limits	Weight retained	% Retained	% Passing
10 mm	100	0	0	100
4.75 mm	90-100	16	3.20	96.80
2.36 mm	60-95	152	30.40	69.60
1.18 mm	30-70	275	55.00	45.00
600 µm	15-34	365	73.00	27.00
300 µm	5-20	411	82.00	17.80
150 µm	0-20	456	91.20	8.80
75 µm	0-15	476	95.20	4.80
PAN	---	500	100%	0%

Table 2: Grading and fines content for C.S.S

Fly Ash: Fly ash of grade P-30 will be required for following tests:

- Fineness test
- Specific gravity

Sr. No	Chemical Composition	Specific value	Test Result (%)
1.	SiO2 + Al2O3 + Fe2O3	70 min	92.9
2.	Sulphuric Anhydride	5 max.	0.84
3.	Loss of ignition	6 max.	1.26
4.	Moisture Content	3 max.	0.21

Table 3: Chemical property of fly ash

Sr. No	Physical Properties	Specific value	Test Result (%)
1.	Residue over sieve	34 max.	25.18
2.	Water requirement	105 max. of control	102.4
3.	Compressive strength at 28 days activity Index Portland Cement	75 min of control (28 days)	---
4.	Soundness by means of autoclave expansion ASTM C 618 %	0.8 max.	---

Table 4: Physical properties of fly ash

2.3 Trial Mix design of concrete mixes with complete replacement of coarse aggregate with EPS beads:

Cube casting is done by trial and error method, the quantities of cement and Fly ash is kept constant. Quantities of Crushed sand stone, EPS, PCE, Air entraining agent and water is changed for getting desired results.

The following table shows the various quantities of material used.

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Trial Mix Design:

Material(kg/m3)	Trial 1	Trial 2	Trial 3
Cement(kg/m3)	250	250	250
Fly ash (kg/m3)	250	250	250
Sand(kg/m3)	375	450	650
Air entraining admixtures	3	2	2
EPS bead(kg/m3)	12	4	4
Water(kg/m3)	185	195	200
Density	950	1150	1350
Strength	2.5	3.49	6.61

2.5 Testing Program of LWC:

In order to study the behavior of lightweight concrete, concrete testing was done to determine the material and structural properties of lightweight concrete and how will these properties differ according to a different type of mixture and its composition. When the concrete has hardened it can be subjected to a wide range of tests to prove its ability to perform as planned or to discover its characteristics. For new concrete this usually involves casting specimens from fresh concrete and testing them for various properties as the concrete matures.

COMPRESSIVE STRENGTH CALCULATION:

1) Note the maximum failure load in KN=F

2) Note the area of cube =A

Derived the compressive strength from following formula in N/mm^2

Cube strength Fc = (F x 1000)/A

DENSITY CALCULATION:

Taking the density of water as $1000kg/m^3$, calculate the volume V of the specimen (in m^3) from :-

V =(Ma - Mw)/1000 , Density (saturated) = Ma/V

M_a = Mass in air

Mw = Mass in water

III. CONCLUSION

1. Initial finding have shown that the lightweight concrete using EPS beads has a desirable strength to be an alternative construction material for the construction of partition wall, foot path, parapet wall, bed concrete.

2. The strength of light weight concrete using EPS beads are low for lower density mixture. This resulted in increment of voids throughout the sample caused by the Air entraining admixture. Thus the decrease in compressive strength of the concrete.

3. The increase in CSS and decrease in EPS beads causes increase in compressive strength and density of concrete and wise versa.

4. The quantity of fly ash, cement and PCE is kept constant.

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