Experimental Study on Properties of Concrete Using EPS Beeds: A Review

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Abstract

This experimental investigation uses Expanded Polystyrene Beads (EPS Beads) as a partial replacement for coarse aggregate, sand, cement, coarse aggregate, and water as performance indicators for concrete workability and strength. The significance of this alternative stone replacement in reducing EPS waste that is difficult to lapse and avoiding waste of trash that can be transformed to something that may be used in future technological development. In addition to decreasing environmental damage, it also saves money by using the Reduce, Reuse, and Recycle principle.

Keywords : *Recycle, EPS, Porosity,flyash*

I. INTRODUCTION

Many infrastructural upgrades are taking place in the country as a result of rising industrialization and urbanization. As a result of this process, mankind is now faced with the task of resolving the issues that have arisen as a result of this expansion. The issues discussed include a severe scarcity of construction materials and increased garbage dumping. As a result, in order to address the aforementioned issues, waste products should be used as a construction material. The threat of EPS Bead disposal will not be resolved until tangible efforts are taken on the ground. It is feasible to improve the performance of the bituminous mix that is used in road surface. Reduced permanent deformation in the form of rutting and reduced low temperature cracking of pavement surfacing were found in studies using re-cycled plastic, primarily polyethylene, in the fabrication of mixed. The field tests survived the strain and demonstrated that polystyrene wastes used as an addition after proper processing will extend the life of roadways while also addressing environmental concerns.

EPS (expanded polystyrene) is a lightweight cellular plastics material made up ofsmall spherical shaped particles made up of 98 percent air and 2% polystyrene. Its tight cell structure prevents it from absorbing water. Polystyrene is a substance that is not biodegradable. It's a byproduct of the packaging business. It causes disposal issues. Crushed polystyrene granules are a valuable waste disposal solution when used in concrete. Concrete is perhaps the most widely utilized building material on the globe. Lightweight concrete is a form of concrete that contains an expansion agent, which increases the volume of the mixture while also providing extra properties such as durability and lowering the dead weight. It is less dense than regular concrete. The low density and heat conductivity of lightweight concrete are its key characteristics. One of the key advantages is the reduction of dead load, which is followed by faster construction rates and lower transportation and usage costs focus of this study. To achieve enough cohesiveness between water and cement, however, a suitable water cement ratio is required. Insufficient water can lead to a loss of concrete strength due to a lack of particle cohesion. The big voids in lightweight concrete are preserved. The performance of low weight concrete was the sole.

2.LITERATURE REVIEW

2.1 Diksha Menghare Et.Al

They are number of research ,for use of waste in industry most of the related to use the waste in construction are or use of waste in concrete to develop new types of concrete use of waste producing is not only makes it economical but also a very good and attractive solution of disposal problem. Flyash and EPS beads waste is used to produce a new type of concrete by replacing the sand and

aggregate. According to a report in Indian coal is of low grade having ash content of order of 80-45% producing large quantity of fly ash at coal light based thermal power stations in India . flyash waste increase day by day because of its usage in thermal power stations. So it is necessary for coal industries to recycling , reusing and substitution of concrete ingredients. Flyash waste produce fromindustry is durable , hard and highly resistive to biological, chemical and physical degradation forces. Flyash waste powder and EPS beads can be used to produce lighweight concrete . This study summarizes the studies , an flyash waste with EPS beads as a partial replacement of sand and aggregate in cement. Indexed Terms-- Flyash waste,EPS beads, compressive strength, partial replacement of sand and aggregate.

2.2 Ben Sabaa and Sri Ravindrarajah

They examined the building properties of expanded polystyrene aggregate (EPS) concrete with somewhat substituting normal coarse aggregate with chemically treated approximate volume of EPS at the stages of 30,50. and 70%. Finally observe that unit weight, compressive strength, drying shrinkage and creep increases by increasing EPS substitution in concrete.Compressive behavior of an idealized EPS lightweight concrete: size effects and failure mode The demand for lightweight concrete in many applications of modern construction is increasing, owing to the advantage that lower density results ina significant benefit in terms of creating much more elegant and economical structures. Lightweight aggregates are broadly classified into two types: natural (pumice, diatomite, volcanic cinders, etc.) and artificial (perlite, clay, sintered fly ash, expanded shale, etc.). Expanded polystyrene (EPS) beads of very smooth and rounded shape are a type of artificial ultra-lightweight aggregate (density of less than 30 kg/m3). They can be incorporated in mortar or cement paste to produce low density concretes required for building applications like cladding panels and load-bearing concrete blocks.

2.3 Miled, K., K. Sab and R. Le Roy

They were explored the Particle size impact of the polystyrene beads on the compressive strength of EPS crete. It was watched that smaller the size of EPS beads, increases the concrete compressive quality. for a similar concrete porosity. Effect of cement and EPS beads ratio on compressive strength and density of lightweight concrete, Expanded polystyrene waste from the packaging industry, in crushed and graded form, can be used as aggregate in concrete mixtures. The polystyrene granules, when coated with an inert hydrophilic chemical, can be added to normal weight concrete mixtures to produce lightweight concrete. Depending upon the amount of expanded polystyrene (density of about 60 kg/m3) aggregate used, lightweight concrete with a wide range of densities from 1000 to 2000 kg/m3 can be obtained for structural and non-structural applications. The coating to the polystyrene aggregate particles is needed to achieve proper dispersion of the granules in the concrete matrix without any segregation. The expanded polystyrene aggregate is a thermoplastic form consisting of gas phase in a polymer matrix. It possesses the property of high compressibility, and can be expected to provide very little restraint to volume changes of the cement paste reducing from due to the applied load as well as the changes in the moisture content.

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2.4 S. The Idawati ismail

Mix design M20 was casted by replacement of cement with EPS BEADS by weight at 0%,5%,10%, 15%. & 20% Cubes, prisms, Cylinders (Cube-150*150*150mm,Prism- 500*100*100mm, Cylinder – 300*150mm) were prepared for testing after seven, and twenty eight days natural process in water served as the control. Results are obtained by the tests like compressive strength, flexure strength and split tensile strength. Even it is compared with the conventional concrete for the difference between them. project reports the results of an experimental investigation into the properties of hardened concrete bricks containing expanded polystyrene beads. The beads are used as part of sandreplacement in the mixes. It was found that polystyrene concrete is very prone to segregation and has low compressive strength.The properties of the bricks are mainly influenced by the content of polystyrene beads inthe mix. The results indicate that polystyrene concrete mix with certain portion of the beads may provide as a suitable alternative material in the construction industry.

2.5 M. Dhivakar Karthick & Bhagavath Ramya

Partial Replacement Of Coarse Aggregates By Expanded Polystyrene Beads In Concrete, Increase in the developmental activities world over, the demand for construction materials is increasing exponentially. This trend will have 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. 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.

2.6 Abdulkadir Kana and Ramazan Demirbodaba

They have done an exploratory examination on the impact of the proportion of eps beads tocement in concrete. By this trial and study they carried out EPS concrete. It has been discovered that the density of EPScrete has been altogether affected by the Portland Cement/EPS proportion. Slump value than the w/c ratio are affected by Higher Densities.This paper presents the results of an experimental study on the effects of using recycled waste expanded polystyrene foam (EPS), as a potential aggregate in lightweight concrete. In this study, waste modified by thermal process EPS foams has been used as aggregate. MEPS were obtained by heat treatment method by keeping waste EPS foams in a hot air oven at 130 º C for15 min. The 28-d compressive strengths of MEPS concreterange were found to improve by satisfying the strength requirement of semi-structural lightweight concrete.

2.7 R. R. Bharathi , R. Mullainathan.

Lightweight Concrete Incorporating Waste Expanded Polystyrene Reuse and recycling of wastes materials is considered the best environmental alternative for solving the problem of disposal. One of such waste materials is Expanded Polystyrene (EPS). Polystyrene is a thermoplastic substance and has the potential use in concrete to produce lightweight concrete by replacing normal aggregate in concrete. Properties of Hardened Concrete Containing Treated Expanded Polystyrene Beads, in the first part of the study, the effects of the water to cement ratio on the properties of polystyrene aggregateconcrete having a nominal density of 1300 kg/m3 were studied. The cement content was kept at 400 kg/m3 for the mixes (1-4). The water to cement ratio by weight was varied between 0.35 and 0"60. In the second part of the study, silica fume was used as an addition or replacement material to cement. The silica fume content in the mixes (mixes5 and 6) was kept at 10% of cement weight. The water to cement plus silica fume ratio was kept at 0.40 and the beads content was targeted to 40% by volume.

3. METHODLOGY :

- **Mix Design Methodology For Partial Replacement Of Coarse Aggregate With Expanded Polystyrene Beads (EPS)**

3.1 Stipulations For Proportioning

Table1.Concrete mix design as per IS 10262-2009 for M30 grade of concrete

Characteristic compressive strength	M 30
Nominal size of aggregate	20 mm
Shape of CA	Angular
Workability required at site	100 mm (slump)
Type of exposure(assumed)	Severe (as defined in IS:456)

3.2 Test Data of Material

Table2. Test data of Material

Cement used	OPC 53 GRADE
Specific Gravity of Cement	3.15
Specific gravity of Fine Aggregate(sand)	2.63
Specific gravity of Coarse Aggregate	2.68
Water Absorption of Fine Aggregate	2%
Water Absorption of Coarse Aggregate	0.5%
Chemical Admixture	Super Plasticizer conforming to IS-9103
Free (surface) moisture of Fine Aggregate	Nil
Free (surface) moisture of Coarse Aggregate	Nil
Specific gravity of EPS BEADS	0.018

3.3 Determine the Target Strength for Mix Proportioning

$$f'_{ck} = f_{ck} + (t \times s)$$

Whereas,

f'_{ck} Target average compressive strength at 28days (N/mm^2)

f_{ck} Characteristic compressive strength at 28days(N/mm^2)

t Statistic Constant depending upon accepted proportion of low results (i.e.-1.65)

s Standard deviation (N/mm^2)= 5 (as per table -1 of IS 10262- 2009) (Cl. 3.2.1.2)

3.4 Selection of Water Cement Ratio

From Table -5 of IS-456, maximum water cement ratio = 0.45

Based on experience, adopt water cement ratio as 0.40

0.40 < 0.45 Hence Ok (Take minimum) (IS 456:2000, Table5,Cl-6.1.2, 8.2.4.1 and 9.1.2)

0.41

3.5 Selection of Water Content

From Table-2 (IS-10262-2009) (Cl.-4.2)

Maximum water content for 20 mm aggregate = 186 Kg (for 25 to 50 slump)

Water content = 186 litres

As super plasticizer is used, the water content can be reduced up to 20 percent and above

Based on trials with super plasticizer water content reduction of 20 percent has been achieved

Hence the arrived water content = 186 x 0.8 = 150 litres

3.6 Cement Content

Water content / "w -c ratio" = (150/0.40) = 375.00kg/m^3

Minimum cement Content for severe exposure condition = 320 kg/m^3 (Table 5 of IS 456)

375.0 kg/m^3> 320 kg/m^3, Hence, OK. As per clause 8.2.4.2 of IS: 456

Maximum cement content = 450 kg/m^3, hence ok.

3.7 Volume of Coarse Aggregate and Fine Aggregate Content

For Fine Aggregate Content

$$f_a = 845.98 \text{ kg/m}^3$$

For Coarse Aggregate Content

$$C_a = 1097.10 \text{ kg/m}^3$$

Table3.Material Quantity for 1m^3

Sr. No.	Item	For 1 m^3 Concrete	Mix Ratio
1	Cement	375kg	1
2	Fine Aggregate	845.98 kg	2.25
3	Coarse Aggregate	1097.10 kg	2.92
4	Water	150.00 lit	0.4

- Cube Size = 150mm × 150mm ×150mm
- Volume of 1 cube = 0.15 × 0.15 × 0.15 = 0.003 m^3
- Volume of 6 cube = 6 × 0.0033 = 0.02 m^3

Therefore total quantities required for 6 cubes of 150 × 150 × 150 are as follows

- Cement = 375.00 × 0.02 = 7.50kg
- Water =150 × 0.02 = 3.00litres
- Fine aggregate = 845.98 × 0.02 = 16.93kg
- Coarse aggregate = 1097.10 × 0.02 = 22.00 kg

The total Material required for casting 24 cube of 150mm × 150mm ×150mm size are given in below table

Table5.Required material quantity for casting 6nos of cubes
(total no.of cubes are 24)

Mix Description	**Cement (kg)**	**Sand (kg)**	**Aggregate (kg)**	**Water (litres)**	**EPS BEADS (grams)**
M30					
0%	7.500	16.9300	22.000	3.000	-
05%	7.500	16.9300	21.993	3.000	7.50
10%	7.500	16.9300	21.985	3.000	15.00
15%	7.500	16.9000	21.978	3.000	22.50

Table6.Required material quantity for casting 3nos of beams for every replacement

(total no of beam 24)

Mix Description	**Cement (kg)**	**Sand (kg)**	**Aggregate (kg)**	**Water (litres)**	**EPS BEADS (grams)**
M30					

0%	16.875	38.000	50.000	6.750	----
10%	16.875	38.000	49.983	6.750	17.00
15%	16.875	38.000	49.966	6.750	34.00
20%	16.875	38.000	49.949	6.750	51.00

4. Conclusion

1. It is possible to make concrete by using EPS Beads as partial replacement to coarse aggregate.
2. The replacement by using EPS has shown a positive application as an alternate material in building non structural members such as partition walls wall panels parapet walls etc.
3. All the EPS concrete without any special bonding agent there is increase in workability of concrete and could easily be compacted and finished.
4. Durability of concrete is also better estimated .EPS concrete also serves as a solution for waste EPS disposal.
5. Although the strength of concrete is reduced with increase in EPS beads content ,but its lower unit weight meets the criteria of light weight concrete.

References:

1) IS-10262:2009 for mix design of concrete.
2) IS-456:2000 plain and reinforcement concrete.
3) Abhijit Mandlik, Tarun Sarthak Sood, Shekhar Karade, Sangran Naik, Amruta Kulkarni, (2015), "Lightweight Concrete Using EPS", International Journal of Science and Research, Volume 4 Issue 3, Page: 2007-2010
4) Roshan Gawale , Shubham Mishra , Harshal Sambare , Jidhnesh Kothari, Assistant Prof. Monali Patil. "Light weight cocrete by using eps beads". International Journal of Innovative Research in Science and Engineering Vol. no.2, Issue 03, March 2016.
5) T.Subramani, G.Unni Krishnan, R.Arumugam, A.Godwyn Michael Cornelies, H.Gopu , " Experimental Study Of Quarry Sand And Rice Husk Replacing In Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 5, May 2017 , pp. 312-319 , ISSN 2319 – 4847
6) Aman Mulla, Amol Shelake "Light Weight Expanded Polystyrene Beads Concrete". 19 March 2016.
7) Ankur Tayal, Gaurav Gupta, Pravin Chaudhary, Tarun Tomar, Nikhil Kumar, Sneh Mittal. "Lighteweight concrete using recycled Expanded polystyrene Beads".vol.05 May 2018.
8) P.L. Chowdary, (2015), "Strength Properties of Expanded Polystyrene Beads, Concrete", Journal of Environmental Science, Computer Science and Engineering & Technology JECET, Vol.4.No.3, 734742
9) M.S. Shetty, "Cocrete Technology Theory and Practice", S. Chand and Company LTD. Publication
10) IS 383:1970 "Specifications for coarse and fine aggregates from natural sources for concrete" Bureau of Indian Standards, New Delhi.