**IOSR Journal of Engineering (IOSRJEN)** **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Special Issue || Dec. 2019 || PP 07-10
International Conference on Management Practices, Innovations & Research 2019

# Sustainable Construction Using EPS Beads in Light Weight Block

A.S. Moon[1], Dr Arun Patel[2]
[1]*Assistant. Professor, Civil Engineering, SRPCE, RTMNU, Nagpur, Maharashtra, India.*
[2]*Associate. Professor, Civil Engineering, RKDF UNIVERSITY, Bhopal, MP, India.*

***Abstract:*** *EPS or expanded polystyrene is 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. Expanded polystyrene waste in a granular form is used as light weight aggregate to produce light weight non-structural concrete with the unit weight vacillating from 950 kg/m³ to 1350kg/m$^3$.*
*The main objective is to study the properties, such as compressive strength of light weight concrete containing Expanded Polystyrene (EPS) beads. Main Objective is that properties are compared with those of the normal concrete without EPS beads.*
***Keywords:*** *EPS beads, Compressive strength, Light weight concrete etc.*

## I. Introduction

Presently Millions, Trillion of tons EPS waste is produced which is harmful for environment thus better utilize the EPS as a substitute of coarse aggregates. Most polystyrene products are currently not recycled due to the lack of incentive to invest in the compactors and logistical systems required for recycling. Due to low density of polystyrene foam or EPS beads, it is not economical to collect. Usually, if the waste material goes through an initial compaction process. The material changes density from typically 30 kg/m3 to 330 kg/m3 and it becomes a recyclable commodity of high value for production of recycled plastic pellets, insulation sheets and other EPS materials for construction applications; many manufacturers cannot produce sufficient scrap because of collection issues.

## II. Expanded polystyrene (EPS)

Expanded polystyrene (EPS) scrap can be easily added to products such as EPS. Light weight concrete is a mixture of EPS (expandable polystyrene) beads i.e. light weight aggregate and plastic beads and OPC (Ordinary Portland Cement). Light weight concrete can be made in any size and shape as per the requirement. Production can be optimized by the producer. 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. 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, Partition walls, composite flooring system and load bearing concrete blocks. Selection of EPS bead aggregate was made mainly due to its low density, closed cellular structure, hydrophobic and energy absorbing characteristics. The EPS beads added in the mix contributes only to its low density. The oven-dry densities of mortars were reduced by 22 % and 46%, at 40% and 91% by vol. EPS beads addition respectively. At oven-dry density of 800 kg/m3 for insulation, the compressive strength of samples remained 0.8 MPa only. The lowering of strength may be considered due to the inherent weak strength of EPS beads in compression and also the presence of pores and voids in the mix. It was observed that geopolymer concrete had negligible heat release rate, total heat release and effective heat of combustion. The total oxygen required to flash out the samples was 0.6 g only.

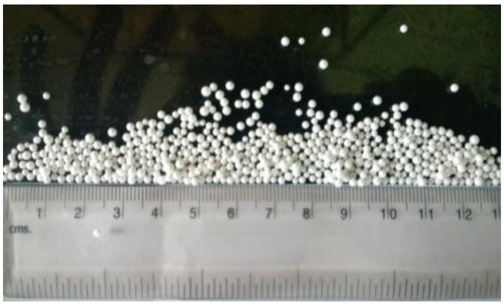

**Fig.** EPS Beads

This indicates that geo-polymer does not contribute to the rate of fire spread. Increasing concentration of EPS beads decreases thermal conductivity of the samples. The thermal conductivity was reduced by 27-50% when EPS beads are added in the geo-polymer mortars to a level of 3% by weight. The mix was cohesive with SBR latex pre-wetted EPS beads. The floating and segregation of EPS beads can be minimized by using low slump of mix and fast setting of geo-polymer with hardener.

The compressive strength and split tensile strength decreased with the increase of EPS bead aggregate. Flammability results indicate that EPS geo-polymer concrete exhibited no support to the growth of fire. The thermal conductivity reduced significantly when EPS beads were added to geopolymer mortar/concrete. Water vapor diffusion resistance (μ) of EPS is around 30–70. ICC-ES (International Code Council Evaluation Service) requires EPS boards used in building construction meet ASTM C578 requirements.

One requirement is the oxygen index of EPS as measured by ASTM D2863 is greater than 24% volume.EPS has an oxygen index of 18% volume; thus, a flame retardant is added to styrene or polystyrene during the formation of EPS. 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 $kg/m^3$) aggregate used, lightweight concrete with a wide range of densities from 1000 to 2000 $kg/m^3$ 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. Expanded polystyrene (EPS) beads of very smooth and rounded shape are a type of artificial ultra-lightweight aggregate (density of less than 30 $kg/m^3$). 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.

## III. Literature Review

**R.Gawale et al. 2016[5]** performed experiments and studied that density, compressive strength of the samples with EPS beads and the samples without EPS beads in the mix design. Admixture Poly-carboxylate ether (PCE) is added in mix design to increase the workability of the concrete. The conclusions were found out to be that strength of light weight concrete using EPS beads is 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.

**Ankur Tayale et al. 2018[6]** performed experiments compared 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 in mix design M25. The cubes were tested 7 days, 14 days and 28 days of curing. Author concluded that the weight of the cube was decreased by 63% when the EPS beads are added by 25%. During heating process, the EPS beads that came in direct contact with the heated surface shrinked leading to formation of voids in the concrete.

**Jaydeep Singh et al. 2017[7]** performed experiments with M20 mix design of coarse & fine aggregate in proportions of 0%, 10%, 20%, 30%, 40% and 50% in the water cement ratio of 0.50 was studied with silica fume as a partial replacement of cement. Author concludes that the workability of mixes was observed to increase with increase in percentage replacement of aggregates with polystyrene.

**Suhad M Abd et al. 2016 [8]** studied the workability and the comparison of the compressive strength, density variation in the samples for the 7 days and 28 days. The increase in the EPS content in concrete mixes reduces the compressive strength of concrete. Increase in the EPS content in concrete mixes reduces the density of concrete. Workability increases with increase in EPS beads content.

**M. Divakar Karthick et al. [9]** performed the experiments on the concrete cubes for workability and compressive strength, author also performed the split tensile test. Author concludes that increase in polystyrene volume, increases the voids as compared to the control mix. There is volume decay in the relation of compressive strength and volume fraction of the EPS beads. Author also observed that reduction of the effective cross-section flexural height affected by the EPS size fraction.

**Abhijit Mandlik et al. 2013[10]** performed the experiments concrete mixing with and without the EPS beads the cost effectiveness is also studied by the author , Author also concludes that EPS concrete without any special bonding agent show good workability and could easily be compacted and finished. EPS can be used as a substitute for the coarse aggregate and positive application is performed by the author .EPS beads can be a used as substitute in a non structural member.

**Wenbo shi et Al. 2015[11]** performed experiments and concluded that durability of the EPS concrete was obtained by making comparison between specimen before and after applying cyclic load of 40KN, 50KN, and 60KN for 50000 or 10000 times. Author concluded that hydroxyl-propyl cellulose is mixed in the EPS concrete for improving the workability of the grout and the influence of its mixing ratio on the concrete compressive strength is studied. To increase the compressive strength the polymer emulsion is mixing in the concrete grout which bond other mixtures and relation between mixing ratio and compressive strength is discussed by author.

## IV. Procedure of EPS Light weight blocks

### A. Materials and mix proportions

The materials used in this study were ordinary Portland cement conforming to BS12: 1991, river sand with a fineness modulus of 2.85, crushed granite with a maximum size of 10 mm, available spherical EPS beads. The M20 grade of concrete mix was used in this study.

### B. Properties of EPS Light weight blocks

Property Average value
Density - 13kg/m$^3$
Compressive strength - 0.09MPa
Flexural strength - 0.21MPa
Water absorption - 4%by volume
Specific gravity of cement - 3.15,
Specific Gravity of fine aggregate - 2.40,
Specific Gravity of EPS beads - 0.011,
Fineness modulus of fine aggregate - 3.00,
Bulk Density of Fine Aggregate - 1643 kg/m$^3$.

### C. Mixibility

A technique similar to 'sand-wrapping' was applied on the EPS beads. EPS beads were wetted initially with 30% of the mixing water and then the remaining materials are added. Mixing was continued until a uniform and flowing mixture was obtained. The Cement to EPS ratio was kept 1:1 by volume, the density of hardened concrete reduced 76, 57, 47, and 39%, respectively, when compared to control sample, 1:1 ratio of cement to EPS was selected and since EPS is hydrophobic, it has been reported that water absorption is zero even when the beads are immersed in water continuously for one month.

### D. Casting and Curing

A number of test specimens 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.

## VII. Conclusion

1) Increase in the EPS beads content in concrete reduces the compressive and tensile strength of concrete.
2) All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished.
3) The replacement by using EPS has shown a positive application as an alternate material in building nonstructural members, and it also serves as a solution for EPS disposal.
4) Obtained results suggest that expanded polystyrene concrete has scope for nonstructural applications, like wall panels, partition walls, etc.
5) Due to the circular shape of EPS beads, they also contributed to the workability of the concrete mix.

## References


[1]. IS 383:1970 "Specifications for coarse and fine aggregates from natural sources for concrete", Bureau of Indian Standards, New Delhi.

[2]. IS 456: 2000, "Code of practice for plain and reinforced concrete", Bureau of Indian Standards, New Delhi.

[3]. IS: 10262: 1982, "Recommended guidelines for concrete mix design" Bureau of Indian Standards, New Delhi.

[4]. IS 2386:1963 "Methods of tests for aggregates for concrete", Bureau of Indian Standards, New Delhi.

[5]. Roshan Gawale1, Shubham Mishra. "Light Weight Concrete by using EPS Beads". International Conference on Emerging Trends in Engineering and Management Research (ICETEMR-16), ISBN: 978-81-932074-7-5.

[6]. Ankur Tayal, Gaurav Gupta, Praveen Choudhary. "Lightweight Concrete using Recycled Expanded Polystyrene Beads" International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 05 | May-2018.

[7]. Jaydeep Singh, Sangeeta Dhyani. "Light Weight Concrete using EPS" International Journal Of Research in Technology and Management ISSN 2454-6240, www.ijrtm.com, Volume 3 Issue 3, June 2017

[8]. Suhad M Abd, Dhamya Gh., Maan Hattem1 and Dunya Khalil. "Effective Replacement of Fine Aggregates by Expanded Polystyrene Beads in Concrete", International Journal of Engineering Research and Science and technology. ISSN 2319-5991, www.ijerst.com, Vol. 5, No. 3, August 2016

[9]. M Dhivakar Karthick, S. Bhagavath Ramya. "Experimental study on strength behavior of concrete block with partial replacement of EPS beads", International Journal of Engineering Research & Technology (IJERT). ISSN: 2278-0181, ICITMSEE – 2018, Volume 6, Issue 10.

[10]. Abhijit Mandlik, Tarun Sarthak Sood, Shekhar Karade, Sangram Naik, AmrutaKulkarni. "Light-weight concrete using EPS," International Journal of Science and Research (IJSR). ISSN (Online): 2319-7064