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# A Study on light weight brick using EPS beads and Silica fume.

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**ABSTRACT**

***The principal reason behind the study carried out here is to diminish the dead load of structures with the potential use of light weight bricks. The study enhanced, with numerous literature study to find out the utilization of Expanded polystyrene (EPS) beads and silica fume in a light weight brick. The light weight brick is formed with the partial substitution of cement with silica fume and the substitution of aggregates with EPS beads. EPS beads are one of the most commonly available non renewable material which is used in packaging industries. It is light in weight as it contains air and have great thermal insulating properties, Minimum thermal conductivity observed by researcher was 0.79 W/m-$^{o}$C for brick having 25% EPS. It was studied that the light weight bricks give great compressive quality, as the content of EPS beads increase the quality diminished, compressive strength varies from 2nd class brick (i.e., higher than 7N/mm$^2$) to 3rd class brick(i.e., higher than 3.5N/mm$^2$). The addition of silica fume with cement gives great quality as in strength and provides good durability. It was also studied that there were no changes in the efflorescence with the increase in EPS content of the bricks, less than 10 % efflorescence was found. Therefore, the literature study suggest that the utilization of EPS beads with silica fume in a light weight brick is economical, sustainable, provide good strength as well as it has better thermal resistance and has a very good durability.***

***KEY WORDS** : EPS beads, Silica fume, Compressive Strength, Thermal Conductivity.*

## I. INTRODUCTION

In the recent times there are two crucial environmental issues that have been emerging across the world. On one hand is the conservation of natural resources while on the other hand is the environmental pollution caused by non degradable materials like polythene and so on. Therefore, in support of this, recyclable and environmental friendly substitutes are acquiring much importance in civil industries. Hence, numerous literature results are reviewed for the need of sustainable recyclable and environmental friendly materials [5].One such material is Expanded polystyrene(EPS) beads which are non renewable material and can be utilized in civil construction works. EPS beads can be utilized in different proportions in the mixture of sand stone, cement, fly ash to produce a light weight brick. EPS beads are non biodegradable materials which are not easy to dump and decompose which creates landfill problems. Therefore, utilizing recycled EPS beads as a construction material can be a decent waste disposal technique [1]. The replacement of cement with silica fume is promising as it is well known to enhance the mechanical properties of concrete. The major physical effect of using silica fume in a concrete is silica behaves as a filler, which efficiently minimizes permeability as well as decreases the PH value. The demand of water increases with the increase of silica fume in a fresh concrete reason being the silica fume has a high surface area [3]. The production process of cement is a very high energy consuming process as well as production of each tonne of cement produces about 1 ton of CO2 in the environment which is very harmful for people residing near the cement industry and for the ecosystem. In light of the economic benefits, conservation of natural resources, energy saving and environmental friendliness, the utilization of these alternative materials from waste products has become the main focus of engineers and researchers [8].

## II. EXPANDED POLYSTYRENE(EPS)

Expanded polystyrene (EPS) beads can supplant mostly or totally the fine aggregates that are regularly utilized in fly ash bricks[1]. Numerous investigations were completed by the researchers with expanded polystyrene beads fused with the Portland cement as a binding agent. Manufacturing of lightweight bricks and blocks using higher thermal insulating materials is promising with combustible properties in approximate amounts and particle size. EPS foams contains approximately 98% of air and 2% of polystyrene and is closely packed fine circular shaped particle. Due to its closely packed cell arrangements it does not have property to absorb water[1-11].

 

Figure 1 : Expanded polystyrene beads

### III. Silica fume

The by product generated from the production of silicon metal or ferrosilicon alloys is called silica fume. One of the most valuable uses of silica fume is in concrete. Concrete which contains silica fume can have very high strength and can be very durable[3]. Silica fume cab be easily available from the suppliers of concrete admixtures and it is used when specified, it is simply added during concrete production. Placing, finishing, and curing silica-fume concrete require special attention. The amorphous(non crystalline) silicon dioxide(SiO2) is the main primary material present in silica fume. The particles of silica fume are extremely small, approximately 1/100th the size of an average cement particle. Due to being very fine material, large surface area, and the high SiO2 content, silica fume is a very reactive pozzolan when it is used in concrete[11].

**Table 1. Chemical Composition of OPC and Silica fume**

| **Compositions** | **Percentage of Weight (% Wt.)** | |
|---|---|---|
| | OPC | SF |
| Silicon dioxide ($SiO_2$) | 21.23 | 92.8 |
| Aluminium oxide ($Al_2O_3$) | 5.48 | 0.46 |
| Iron oxide ($Fe_2O_3$) | 3.24 | 0.54 |
| Calcium oxide (CaO) | 63.70 | 1.94 |
| Magnesium Oxide | 0.68 | -- |
| Sulphur Trioxide ($SO_3$) | 2.47 | 0.32 |
| $K_2O$ | 0.16 | 0.79 |
| $Na_2O$ | 0.53 | 0.26 |
| Chloride (Cl-) | -- | 0.2 |
| Loss of Ignition (LOI) | 2.32 | 2.2 |

Figure 2 : showing silica fume powder

### IV. LITERETURE SURVEY

Tarun Jain & Archana Tiwari[1] (2017) In this experiment the researcher is intended to examine the mechanical properties of lightweight bricks and evaluate its functions with regular bricks. EPS Styrofoam is a light weight substance which has been utilized in building applications since significant period of time. EPS beads represents a decent thermal insulating properties alongside hardness and compressive quality when contrasted with medium clay. In this experimental study an exertion is made to develop a light weight block with the mix of EPS beads, cement fly-ash powder and sand.

In this paper the researcher prepared four different brick blocks with different proportions of fly ash, sand, cement, EPS beads and water. Moulds for block were set up of the size (230x110x70) mm and were greased up with oil, casting was done and the blocks were immersed in water and restored for the times of 3, 7 and 21 days. Weight of the block were noted down and compressive quality test was performed and it was contrasted with the fly ash block.

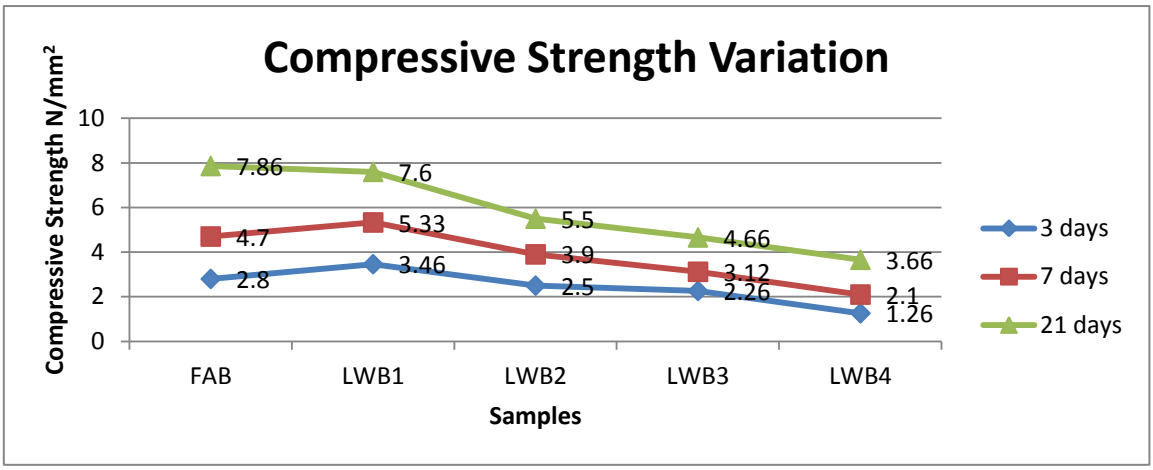


Figure 3 : Graph showing compressive strength at 3,7,21 days

The sample LWB1 (7.6N/mm2) had almost equal strength as the fly ash brick (FAB = 7.86N/mm2), which comes under 2nd class brick (7N/mm2) category. The rest of the samples come in third class brick (i.e. higher than 3.5N/mm2).

Chandru. G[2] et. al. (2017) The main objective of this paper is to replace the aggregates in concrete with expanded polystyrene(EPS) beads. Here, Cement is somewhat substituted by Fly ash remains in the concrete and the properties were inspected, for example, the compressive and tensile quality of EPS concrete and afterward it was contrasted with the M20 grade of normal concrete. As old production systems are all the more exorbitant because of overwhelming loading, along these lines light weight concrete with EPS dots is utilized. The researcher here exhibits the results of a trial investigation in the designing properties of utilizing EPS concrete.

A.Magdy ElAziz-Abd [3] et. al. (2017) In this study the investigation of the properties of light weight concrete with the presence of EPS beads. Distinctive extents of EPS foamed concrete has been framed by the fractional substitutions of normal aggregates by 0%, 15%, 25%, 35% and 50% of EPS foam beads by volume. In this light weight concrete, the cement has been substituted by silica fume (SF) with various extents of 0% to 15% with 5% margin by weight. Sixteen samples were made and the testing was performed for the determination of mechanical properties of EPS foamed light weight concrete. In this examination program distinctive testing which has been performed are fresh density test, workability test, compacting factor, compressive quality, splitting tensile strength, flexural quality, modulus of flexibility and thermal conductivity.

Aman Mulla & Amol Shelake[4] (2016) The primary reason for this examination is to find a solid blend proportion utilizing EPS beads as the substitution of coarse aggregates which gives way preferred outcomes over that of Burnt Brick (compressive quality and density), and to discover the properties, for example, density, compressive quality and split tensile quality of concrete which has EPS balls in it due to which it acts as a light weight material. After that these properties of light weight concrete is contrasted with the M20 grade conventional concrete.

Saride Lakshmi Ganesh & Sambangi Arunchaitanya [5] (2016) This paper demonstrate to us the conclusions of a test done on solidified and thermal properties of fly ash blocks with the mix of extended polystyrene beads (EPS) as the partial substitution of common fine aggregates. The exploratory tests that has been performed in this paper were compressive quality, water absorption, efflorescence and thermal conductivity. In this research paper the fine aggregates were substituted with EPS beads at a 5% interval from 0% to 25 % (by volume) of EPS beads. The consequence of the test had a slight decline in water absorption of the block and a decline in the compressive quality and thermal conductivity with the increase in EPS beads in the fly ash based blocks. The below table show the proportions used for the experiment.

**Table 2. Showing mix proportions**

| S. no. | Sample with EPS | Fly ash | Cement | Sand |
|---|---|---|---|---|
| 1. | 0% | 55% | 10% | 35%(100% of sand + 0% of EPS) |
| 2. | 5% | 55% | 10% | 35%(95% of sand + 5% of EPS) |
| 3. | 10% | 55% | 10% | 35%(85% of sand + 10% of EPS) |
| 4. | 15% | 55% | 10% | 35%(80% of sand + 15% of EPS) |
| 5. | 20% | 55% | 10% | 35%(75% of sand + 20% of EPS) |
| 6. | 25% | 55% | 10% | 35%(70% of sand + 25% of EPS) |

Results of water absorption test

**Table 3. Showing water absorption results**

| Sample with EPS % | Initial weight ($W_1$) KG | Final weight ($W_2$) KG | Water Absorption % |
|---|---|---|---|
| 0% | 3.215 | 3.71 | 15.4 |
| 5% | 3.14 | 3.6 | 14.8 |
| 10% | 3 | 3.43 | 14.3 |
| 15% | 2.89 | 3.29 | 14 |
| 20% | 2.775 | 3.155 | 13.7 |
| 25% | 2.705 | 3.07 | 13.4 |

The test is performed with the help of IS 3495: 1992 (part 1). Figure beneath demonstrates the after effects of compressive quality test performed at 7, 14, 28 days for various blending proportions. The diagram exhibits the changes in compressive quality with augmentation in EPS rate. It plainly demonstrates that there is an impressive decrement in compressive strength with increment in EPS content in 7, 14, 28 days strength test.

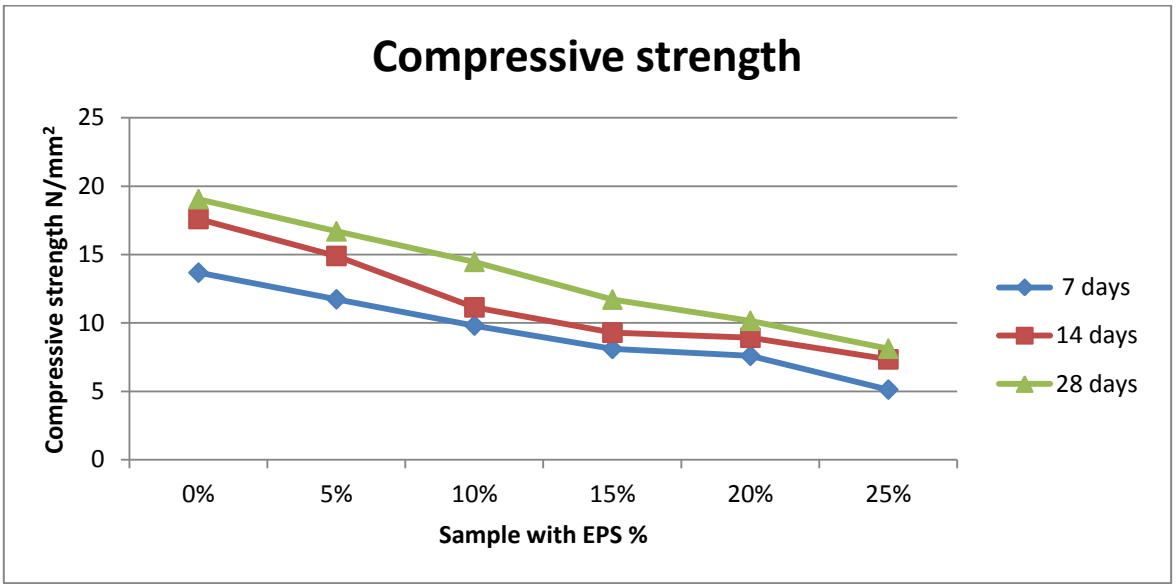


Figure 4 : Graph showing compressive strength variation at 7,14,28 days

Strecker Kurt[6] et. al. (2016) The point of this paper is to discover the impact of fine grained sand under 1mm size in increments of 5, 10 and 20% on the properties of the block comprising of cement with styrofoam considerations of 20, 40 and 60% has been contemplated. The compressive quality of the material is examined by remembering the measure of the molecule and extents being utilized with the Finite element analysis (FEA), by utilizing the abaqus programming bundle. The composites were demonstrated by their density, porosity and compressive quality following 28 days. The density of the composites had an assortment some place in the scope of 1250 and 1600 kg/m3 with a compressive nature of 18 and 9 MPa for 20 and 60% of Styrofoam fuses, independently.

Pratichhya Pradhan & Sanjeev Maharjan[7] (2016) In this paper the concrete bricks which were earlier prepared of cement, sand, coarse aggregate(CA) and Reused EPS beads were changed with Cement : Sand : (EPS and CA) of the ratio 1:1.5:3. To examine the result of EPS/CA ratio on cost production per brick, 100/0, 90/10, 80/20, 70/30 and 0/100 mix quantity by volume has been used. These brick blocks were made by hand compacting and the mixing of these materials was also done with the help of hand. The money invested on the production per brick for every composition has been investigated and calculated which includes material expense, labour expense and wastage cost.

Ling I.H [8] et. al. (2011) The goal of this paper is the potential utilization of waste rice husk slag (RHA) and extended polystyrene (EPS) dots for the generation of lightweight solid blocks. Since RHA is light in weight and is a have reactive pozzolanic behaviour it can be substituted with the cement. RHA was utilized for the partial substitution of cement, while the EPS globules were utilized as the partial substitution of aggregate in the blends. The moulds prepared for the casting of these blocks were of the size of 215mm, 102.5mm, 65mm. The test examinations done on the blocks were hardened concrete density, compressive quality and water assimilation test. These Bricks were also tested for the electron microscopy scanning. Curing conditions were done in four different ways that were water restoring, air dry restoring, 3-day relieving and 7-day relieving. The curing condition utilized just as the substance of EPS and RHA in the blend affected the properties of the blocks.

Bing Chen & Juanyu liu.[9] (2003) In this examination, a premix strategy like the 'sand-wrapping' system was used to make EPS concrete. The mechanical properties of the material shaped were made sense of. The examination delineates that these EPS concrete have a density differing from 800– 1800 kg/m3 and the compressive quality fluctuating from 10–

25 MPa which can be accomplished by partially supplanting coarse and fine aggregates by EPS dots. The bond among the concrete formed with EPS and cement paste was significantly enhanced with the incorporation of fine silica fume which helped in the increment of compressive quality too. Also, including steel fiber essentially enhanced the drying shrinkage.

Veiseh Sohrab and Yousefi Ali.A.[10] (2003) In this present work an exertion is made to diminish the blocks density, and an exertion is made to give great thermal insulation properties. Polystyrene foam is an insulating material that has been added to the raw materials of blocks, which is utilized as a pore-framing material. The result of PSF class and its substance in the blend, and furthermore the result of burning process temperature of the blocks on density, water ingestion and compressive quality, are examined and talked about in this paper.

K. Ganesh babu & D. Saradhi Babu.[11] (2002) The goal of this venture is to inspect the quality just as the durability performance of EPS based concretes. Diverse rates of silica fume were utilized for making the productive blend plans. The densities of the subsequent concrete were seen to shift from 1500 to 2000 kg/m3, though the relating strength lies between 10 to 21 MPa. As the level of silica fume increase rate of strength gain for these solid increments at 7-day quality. This was inspected to be about 75%, 85%, and 95% of the corresponding 28-day quality when the silica fume were substituted at the level of 3%, 5%, and 9%, respectively. The consequences of absorption, at 30 min and the last absorption, demonstrate that the EPS blends made with sand have bring down levels of absorption contrasted with the blends containing ordinary aggregates. Further, the absorption esteems supposedly was diminishing with expanding cementitious substance.

## V. CONCLUSION

As per the investigations performed by several researcher over the utilization of Expanded polystyrene beads and Silica fume in a light weight material, several results were concluded related to workability, Density, Compressive Strength, Water Absorption, Thermal conductivity, efflorescence etc. EPS blocks give great workability and could without much of a stretch be compacted and wrapped up[1-11]. The water absorption of EPS beads was less than fly ash brick as well as other conventional bricks, which indicates a good sign, as bricks should not absorb more water[1]. Minimum water absorption observed is 13.4% for brick with 25% EPS beads[5]. It was observed to be economical as compared to the Fly ash and Cement brick as the cost is directly dependent on amount of cement used [7]. The weight of a normal burnt clay brick is around 3.5kg and the weight observed in the above journals were around 1.8kg to 2.4kg which shows the reduction in weight by using EPS beads. The compressive strength of the brick decreased with the increase of EPS beads[1,5,10,11]. It was observed that the compressive strength varies from 2nd class brick (i.e., higher than $7N/mm^2$) to 3rd class brick(i.e., higher than $3.5N/mm^2$) [1]. Thermal conductivity of brick also decreased with increase of EPS content[3,5]. Minimum thermal conductivity was 0.79 W/m-$^oC$ for brick having 25% EPS [5]. The strength of concrete increased with the increasing percentage of silica fume at most 15% [9]. It was observed that there was no change in the efflorescence with the increase in EPS content in bricks. There was very slight efflorescence less than 10% was observed[5].

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