PARTIAL REPLACEMENT OF COARSE AGGREGATE BY EXPANDED POLYSTYRENE BEADS IN CONCRETE

N.Shifu Jahan[1], CH Sangitha[2],

[1] *Assistant Professor, Civil Engineering, Prathyusha Engineering College, Tamil Nadu, India*
[2] *Student, Civil Engineering, Prathyusha Engineering College, Tamil Nadu, India*

ABSTRACT

With the increase in demand for construction materials, there is a strong need to utilize alternative materials for sustainable development. The main objective of this investigation is to study the properties, such as compressive strength and tensile strengths of lightweight concrete containing Expanded Polystyrene (EPS) beads. Its properties are compared with those of the normal concrete i.e., without EPS beads. EPS beads are used as partial replacement to coarse aggregates. The results showed that the amount of polystyrene beads incorporated in concrete influences the properties of hardened concrete. It was found that compressive strength of 10%, 15%, 25%, 35% and 35% EPS incorporated concrete strengths were 91%, 77 %, 71%, 63%, 57%, and 45%, respectively when compared to concrete. Expanded polystyrene (EPS) is a lightweight cellular plastics material consisting of fine spherical shaped particles which are comprised of about 98% air and 2% polystyrene. It has a closed cell structure and cannot absorb water. It has a good sound and thermal insulation characteristics as well as impact resistance. Polystyrene foam is a non-biodegradable material.

Keyword: - *Expanded Polystrene Beads, Coarse Aggregate , Fine Aggregate*

1. INTRODUCTION

Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work Introduction related your research work. 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.

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, which otherwise is posing a threat to waste disposal as well as for waste management. This material is a cause of concern to environmentalists. In this study, it is attempted to partially replace coarse aggregates by means of EPS beads. A general discussion on EPS, its production and its application along with environmental concerns are being discussed.

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. Lightweight concrete is generally accepted as concrete having a density of about 1800 kg/m3 or less. 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. The present study aims at utilization and the suitability of polystyrene beads as coarse aggregate. A comparative study on strength parameters is also done against conventional concrete to study the behavior of the polystyrene aggregate. For this 10%, 15%, 25%, 30% and 35% replacement of coarse aggregate by expanded polystyrene beads is attempted in this work.

1.1 Expanded polystyrene (EPS)

Expanded polystyrene (EPS) is a plastics substantial which is contained around 98% air and 2% polystyrene. These are light in weight comprising of fine circular shaped particles. It's like closed cell arrangement cannot absorb water. It as decent thermal and sound resistance qualities and additionally impact resistance. EPS material is non biodegradable. The waste material which is coming after packing industry. It makes transfer issue. Using pulverized polystyrene particles in concrete are profitable waste transfer strategy. There are numerous benefits to be chosen since the utilization of lightweight concrete. These incorporate smaller loads amid at construction Increased thermal resistance and decreases self-weight in structures, Lightweight concrete is for the most part recognized as concrete having a density of around 1800 kg/m3 or less. The current examination was taken up, keeping mainly two focuses, polystyrene waste transfer from the perspective of environment and replace with normal aggregate. The present study goes for usage and the suitability of EPS beads as coarse aggregate.

1.2 There are many advantages of light weight concrete of Expanded Polystyrene(EPS)

1. Thermal Insulating
2. Light Weight
3. Inexpensive
4. Low thermal conductivity
5. It is insect resistance
6. Durability

2. SCOPE AND OBJECTIVES

1. To evolve a light weight concrete which provides thermal and sound insulation and also aesthetically good appearance
2. To evolve a light weight concrete which can be used at various sections of a building.
3. The important objective of this investigation is to study the strength features of concrete containing different proportions of EPS beads and replacement to natural coarse aggregate, like compressive strength, tensile strengths and flexure test of light weight concrete comprising Expanded Polystyrene beads.
4. To know the essential properties of materials used as a part of the concrete and design the mix for conventional concrete
5. To determine the effect on partial replacement on EPS beads with variable percentage by weight of coarse aggregate, in properties of fresh concrete.
6. To determine the effect on partial replacement on EPS beads with variable percentage by weight of coarse aggregate, in properties of hardened concrete.
7. To study the durability properties of EPS concrete.
8. To know the behavior of EPS concrete on density compared to conventional concrete mixes.

3. LITERATURE SURVEY

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

Miled, K., K. Sab and R. Le Roy They were explored the Particle size impact of the polystyrene beads on the compressive strength of EPScrete. It was watched that smaller the size of EPS beads, increases the concrete compressive quality. for a similar concrete porosity.

Abdulkadir Kana and RamazanDemirbodaba The**y** have done an exploratory examination on the impact of the proportion of eps beads to cement 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.

E.M. Mbadike and N.N. Osadebe made a study for the assessment of concrete manufactured from polystyrene beads. It was also found that the strength development of polystyrene concrete increases with increase in hydration period.

ZaherKuhail This Study works on the qualities of lightweight concrete comprising of polystyrene, coarse aggregate, cement and water. by this it has been demonstrated that suggested mixes is extremely good strength qualities of to 200 kg/cm2 with a lower density. The chemical and mechanical properties are discussed about with a specific polystyrene behavior under different environments such as field usage, the workability of the mix will be higher at a lower w/c proportion. This study conclude that the mixing technique of lightweight concrete is exceptionally very easy, cheap and do not require complex apparatus machineries.

Jayanth M P, Sowmya S M, this study is based on work, try to address the option of using Expanded Polystyrene (EPS), It is a non-biodegradable waste material which is coming from packaging industry. Concrete has to be designed based on density factor to accomplish reduction of the concrete self-weight with is ranging from 2000kg/m3 to 990kg/m3 total volume of eps 0-100% and water cement ratio 0.40 Structural self-weight is quite important it shows a maximum portion of the load details. Substituting partially or completely the coarse part of low weight aggregate (EPS Beads) with normal aggregates produces lightweight concrete that can achieve a reliable decent compressive strength. Substitution of various percentage of eps beads according to desirable design details for different proportion. Various test was conducted for fresh and harden concrete to know physical and mechanical properties of concrete at age of 7,14 and 28days. The outcome indicates that increasing the quantity of EPS beads there will be decreasing strength of concrete with reduction in density. As the density of concrete decreasing, the dead weight of structure also decreasing by replacing the polystyrene we can achieve light weight concrete.

Thomas Tamut, Rajendra Prabhu, Katta Venkataramana, Subhash C Yaragal the increase in demand for construction materials, there is a strong need to utilize alternative materials for sustainable development. The main objective of this investigation is to study the properties, such as compressive strength and tensile strengths of lightweight concrete containing Expanded Polystyrene (EPS) beads. Its properties are compared with those of the normal concrete i.e., without EPS beads. EPS beads are used as partial replacement to coarse aggregates. The results showed that the amount of polystyrene beads incorporated in concrete influences the properties of hardened concrete. At 28 days, it was found that compressive strength of 10%, 15%, 25%, 30% and 35% EPS incorporated concrete strengths were 91%, 77 %, 71%, 63%, 57%, and 45%, respectively when compared to concrete with no EPS case. All the EPS concrete without any special bonding agent show good workability and could easily be compacted and finished.

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DanetiSaradhiBabu a, K. Ganesh Babu b, Wee TiongHuan a, "Effect of polystyrene aggregate size on strength and moisture migration characteristics of lightweight concrete", Cement & Concrete Composites. They were explored the Particle size impact of the polystyrene beads on the compressive strength of EPScrete. It was watched that smaller the size of EPS beads, increases the concrete compressive quality. for a similar concrete porosity.

4. METHODOLOGY

4.1. GENERAL

The general method used for conducting test on the strength aspect is by casting concrete specimens and conducting the test as per the code provision.

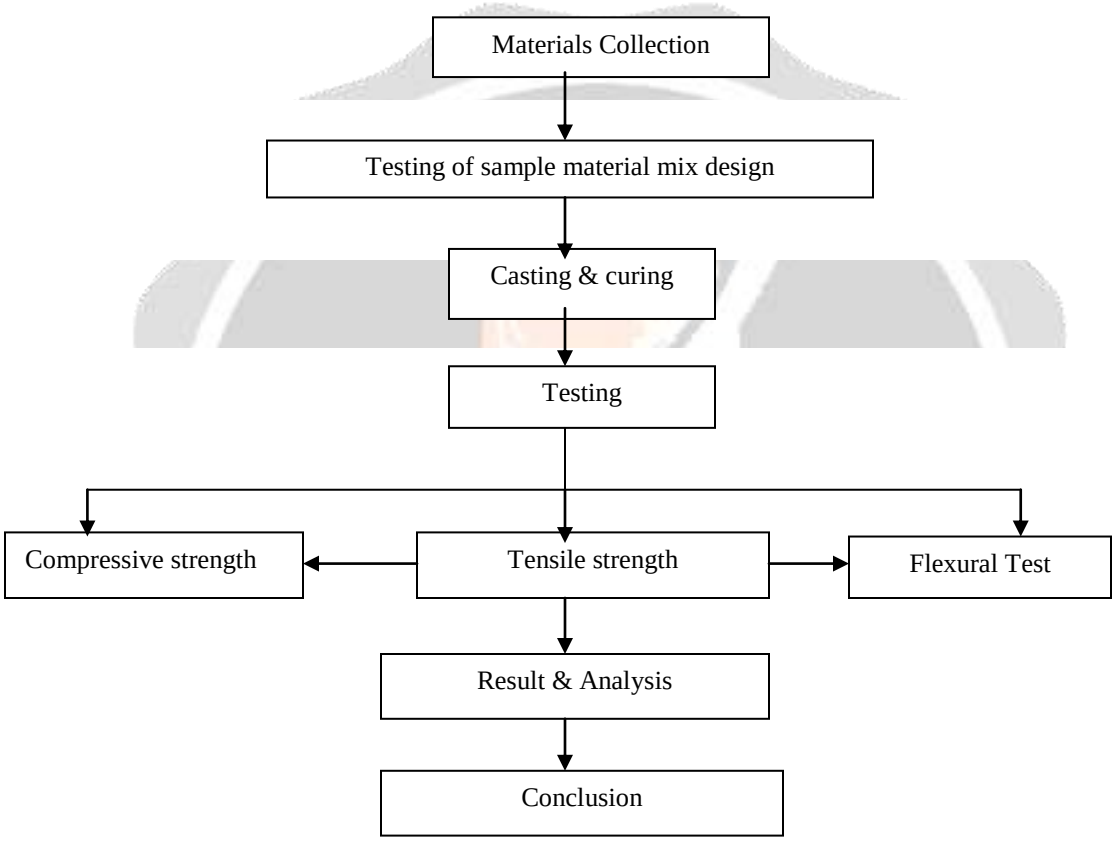

Fig 1.Flow chart

4. EXPERIMENTALINVESTIGATION

A. CEMENT - Opc53 grade with specific gravity 3.15 was used in this work

B. COARSE AGGREGATE- Aggregate passing through 20mm IS sieveandretainedon16mmIS sieve was used. The specific gravity of coarse aggregate is 2.70.

C. FINE AGGREGATE- Locally available river sand of size less than 4.75mm was used. The specific gravity of fine aggregate is 2.65, fineness modulus was found to be 2.7 as perIS383:1970.

D. POLYSTYRENE- Polystyrene is one of the most widely used plastics. Expanded polystyrene of size, 20mm cubes with Density of EPS 60 kg/ cum was used in this work.

E. WATER – Potable fresh water available from local sources was used for mixing and curing as perIS456:2000.

5. TESTING OF HARDENED CONCRETE

5.1 Types of Specimen

Cube – 150X150X150 mm
Cylinder – 300X150 mm
Beam – 1100X100X150 mm

5.2 Construction material is tested:

1. To ensure the QUALITY of the material
2. To Minimize the maintenance cost
3. To spare or reduce the involved parties in the construction from facing problem at later stage.

5.3 There are 2 types of concrete test that is:

1. Destructive test
2. Non – Destructive test

5.4 Destructive Test

Can be done testing:

1. Compression strength concrete
- Cube test
2. Tensile Strength of concrete
- Direct Tension Test
- Split-cylinder test
- Flexural Test
3. Flexural Test

5.5 CUBE TEST

- **Compressive Strength** is the capacity of a material or structure to withstand axially directed pushing forces.
- When the limit of compressive strength is reached, brittle materials are crushed.
- The compressive strength is used to determine the hardness of cubical and cylindrical specimens of concrete.

- Concrete cube testing is a primary quality compliance check on the specified design characteristic compressive strength of concrete supplied to the site.
- Concrete cube is prepared by placing 3 layer of concrete in mould.
- Each layer is compacted using rod is 35 times
- Then it is cured in a tank of water for 7,14 and 28 days.
- On the 7th day cube will be taken out for compressive strength test.

5.5.1 Formula for compressive strength

F=P/A

Where F=Compressive strength

P= Load applied on the specimen

A = Area of the specimen

Fig:2 **Testing of cube**

Sr.No.	**Concrete Cubes of EPBs**	**Compressive Strength (N/mm^2) of 7 days**	**Compressive Strength (N/mm^2) of 14 days**	**Compressive Strength(N/mm^2) of 28 days**
1	Standard	14.40	17.95	23.40
2	10	15.90	19.30	24.80
3	15	15.50	16.80	24.23
4	25	14.43	17.83	23.25
5	30	14.32	17.83	23.38
6	35	12.90	16.80	22.82

Table No. 1.Compressive strength(N/mm^2) of 7 days Curing

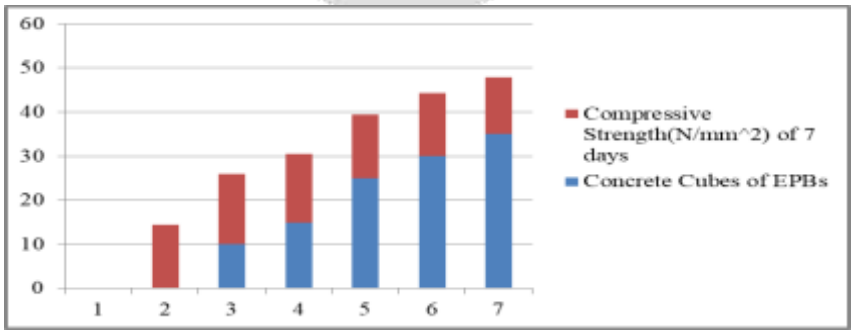

Fig 3: Compressive Strength

5.5.2 Results and Discussion

1. While considering above figures, the compressive strength is plotted for all the concrete mixes(Standard, 10%, 15%, 25%, 30%, 35%) with the replacement of coarse aggregate.
2. Here it is seen that, the compressive strength of mix of 10% replace shows the strength much higher than the controlled concrete, in 28 day test than the 7 day and 14 day test.
3. To ascertain the structural strength of the concrete cubes, casted using EPS beads in concrete and Compressive strength test was conducted at the end of 7, 14 and 28 days curing period using compressive testing machine capacity 2000 kN.

5.6 TENSILE STRENGTH

- Tensile strength of concrete should be high enough to resist cracking from shrinkage and temperature changes.
- It can be measured using the following test

a. Direct Tension Test
b. Split-Cylinder Test
c. Flexural Test

- Normally tensile strength is assessed using flexural or Split- Cylinder test.

5.6.1 Split Cylinder Test

a. A Cylinder specimen of minimum 2-in (50mm) dia placed with its axis in a horizontal plane.
b. Then it is subjected to a uniform load along the length of the specimen.
c. Since concrete is weather in tension than compression, the specimen fails where it breaks into 2 following the formation of a nearly vertical crack called a flexural crack near the section of maximum moment.

Fig 4: Tensile Strength test on specimen

SL. No.	Concrete Cylinders of EPBs	Tensile Strength (N/mm^2) of 7 days	Tensile Strength (N/mm^2) of 14 days	Tensile Strength (N/mm^2) of
1	Standard	2.26	2.84	3.56
2	10	2.30	2.88	3.60
3	15	2.28	2.86	3.61
4	25	2.26	2.83	3.58
5	30	2.26	2.83	3.56
6	35	2.24	2.80	3.55

Table No. 2: Tensile strength of the specimen

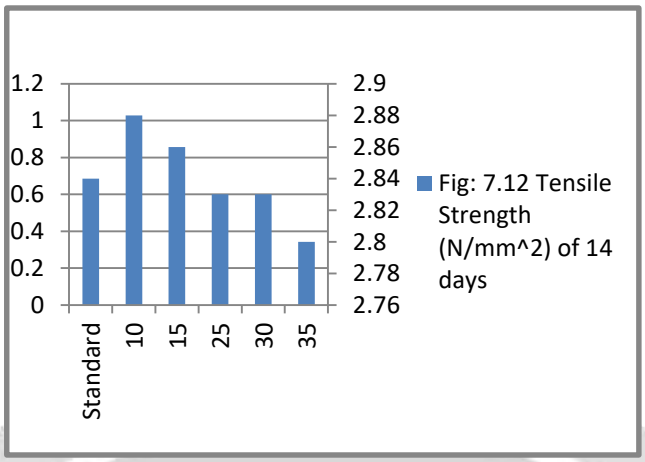

Fig 5: Tensile Strength of the specimen

5.6.2 Results and Discussion

The tensile strength of the standard concrete for 7,14 and 28 days are 2.26 N/mm2 , 2.84 N/mm2 and 3.56N/mm2 .

For the first mix, that is for the concrete made by replacing coarse aggregate with 10%polystyrene by volume, the 7 days strength seems to be 2.3N/mm2 , 2.88N/mm2 for 14th day test and the 28 days strength is 3.66 N/mm2 . Similarly for other mixes, the 7th 14th and 28th day rest tensile strength results are 2.28N/mm2 , 2.86N/mm2 , 3.61N/mm2

for B, 2.26N/mm2 , 2.83N/mm2 , 3.58N/mm2

for C, 2.26N/mm2 , 2.83N/mm2 , 3.56N/mm2

for D and 2.24N/mm2 , 2.8N/mm2 , 3.55N/mm2

CONCLUSION

Polystyrene is chemically very inert, being resistant to acids and bases but is easily dissolved by many chlorinated solvents, and many aromatic hydrocarbon solvents. The Expanded Polystyrene is a stable, low density Foam. It has closed structure and cannot absorb water. It has good impact resistance. Polystyrene is packaging material in medical industry and a non-biodegradable material, so it creates disposal problems. Utilizing crushed polystyrene in concrete is good waste disposal method. The polystyrene beads can be easily merged into mortar or concrete to produce lightweight concrete with a wide range of density. An application of polystyrene concrete includes walls, cladding panels, tilt up panels and composite flooring .From the literature survey, it is understood that there is scope for future studies in this field.

The following conclusions were drawn from the study.

1. Increase in the EPS beads content in concrete mixes 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. Workability increases with increase in EPS beads content.
4. The replacement by using EPS has shown a positive application as an alternate material in building non structural members, and it also serves as a solution for EPS disposal.

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