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# Proportioning of Lightweight Concrete by the Inclusion of Expanded Polystyrene(EPS)

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***Abstract*— This paper handles the characteristics of new lightweight concrete consisting of polystyrene, sand, cement, coarse aggregate and water. This work can be considered a new line of research for lightweight concrete as the mixing method is very simple, relatively inexpensive and does not need complex machinery systems and also to determine the optimum dosage of Expanded Polystyrene Beads. In the present work the Expanded Polystyrene beads are added at 10%, 20% and 30%. Their strength such as compressive, split tensile and flexural strength are studied. From the results obtained it is observed that an optimum of 10% of Expanded Polystyrene beads can be replaced by volume of fine aggregate. It can be used for plain concrete structure, where M25 concrete is preferred.**

***Keywords*— EPS beads, lightweight concrete, Replacement of fine aggregate.rds)***

## I. INTRODUCTION

Concrete is the most commonly used construction material in the world. It is basically composed of two components paste and aggregate. The paste contains cement and water and sometimes other cementitious and chemical admixtures, whereas the aggregate contains sand and gravel or crushed stone. Scarcity of natural sand due to depletion of natural resources and restrictions due to environmental considerations made concrete manufactures to look for suitable alternative fine aggregate. One such alternative is Manufactured sand.

The use of lightweight material as a substitute to normal fine aggregate. In the subsequent method an attempt has been made to reduce the weight of concrete by using a material Expanded Polystyrene (EPS) beads as a partial replacement to fine aggregates. The specific gravity of fine aggregate is 2.6 but the specific gravity of EPS beads is 0.046 which very much lesser when compared to fine aggregate. These EPS beads create cellular voids inside concrete which reduces the weight of concrete to a greater extent. Further these voids are occupied by EPS beads itself so that there is no much effect on the strength and permeability factors. Therefore authors have been studied to find the optimum dosage of EPS beads and for understanding the mechanical properties of lightweight concrete using EPS beads.

## II. STUDY MATERIAL

### *A. cement*

In present studies, cement of 53 grade confirming to grade IS 12269-2013 is used and cement sample will be tested as per IS 4031-1988 part 4 and IS 4031-1988 part 5. Physical properties like specific gravity, standard consistency, initial setting time and final setting time of cement will be determined by using the codes IS 4031-1988.

TABLE I PROPERTIES OF CEMENT

| Property | Value |
|---|---|
| Specific Gravity | 3.07 |
| Fineness | 98% |
| Initial setting time | 65 minutes |
| Final setting time | 210 minutes |

### *B. Fine aggregate*

Fine aggregates is used an artificial material of M-Sand. The EPS Partial replacement of manufacture sand and cement. Now-a-days good sand is not readily presented. The Fine Aggregates day by day demand in construction sector. Fine aggregates are the aggregates whose size is less than 4.75mm.

TABLE II PHYSICAL PROPERTIES OF FINE AGGREGATE

| Property | Value |
|---|---|
| Specific Gravity | 2.7 |
| Water Absorption | 0.84% |
| Fineness modulus | 3.718% |
| Unit weight | 1537.7kg/m$^3$ |

### *C. Coarse aggregate*

Coarse aggregate of nominal size 20mm is chosen and tested to determine the different physical properties as per IS 383-1970. Test results conform to the IS 383(part-3) recommendations.

TABLE III PROPERTIES OF COARSE AGGREGATE

| Property | Value |
|---|---|
| Specific Gravity | 2.64 |
| Fineness modulus | 5.26% |
| Water Absorption | 0.1% |
| Unit weight | 1879.15kg/m$^3$ |

### *D. Expanded polysterene*

Light Weight. Comprised of about 98 percent air, expanded polystyrene is extremely lightweight, making it ideal for transport and installation.

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TABLE IV PROPERTIES OF EXPANDED POLYSTERENE

| Property | Result |
|---|---|
| Specific Gravity | 0.044 |
| Size | 2mm-3mm |
| Water absorption | Nil |

*E. Water*

Portable water is used which is easily available in the lab premises for blending of concrete ingredients and curing of concrete specimens.

## III. EXPERIEMENTAL STUDY

The cement and EPS were measured and mixed together until a uniform colour is obtained. The blended mix is spread on already measured fine aggregate placed on an impermeable platform and mixed thoroughly before the coarse aggregate and water added.

TABLE V MIX PROPORTION OF CONCRETE

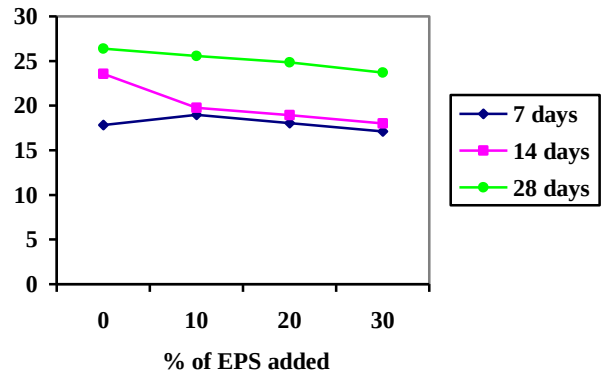
| Grade | Cement | M-Sand | C.A | W/C ratio |
|---|---|---|---|---|
| M25 | 1 | 1.12 | 2.88 | 0.47 |

*A. Compressive strength test*

Compressive strength is the ability of material to carry the loads on its surface without any crack or deflection. Total 15 cubes for different percentage of mix proportion are tested and cubes are taken as compressive strength of concrete. The compressive strength test is done with BS:1881-Part-116:1989. After 24hours these moulds are removed and test specimens are put in water for curing. After the test will be carried out at age of 28 days. The tested 3 cubes per day like 7 days, 14 days and 28 days for compressive strength.

TABLE VI TEST FOR COMPRESSIVE STRENGTH

| Percentage Of EPS | 7 days | 14 days | 28 days |
|---|---|---|---|
| 0 | 17.83 | 23.54 | 26.4 |
| 10 | 18.98 | 19.75 | 25.56 |
| 20 | 18.04 | 18.95 | 24.83 |
| 30 | 17.10 | 18.01 | 23.71 |

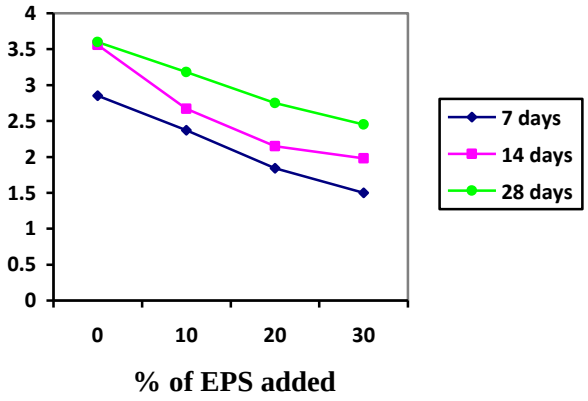



*B. Split tensile strength test*

Cylindrical specimens of size 150 mm diameter x 300 mm in height were cast for varying dosage of expanded polystyrene at 10%, 20%, 30% and tested for split tension. The obtained results are tabulated in table 7 and plotted in the below graph,

TABLE VII TEST FOR SPLIT TENSILE STRENGTH

| Percentage Of EPS | 7 days | 14 days | 28 days |
|---|---|---|---|
| 0 | 2.85 | 3.56 | 3.6 |
| 10 | 2.37 | 2.67 | 3.18 |
| 20 | 1.84 | 2.15 | 2.75 |
| 30 | 1.5 | 1.98 | 2.45 |

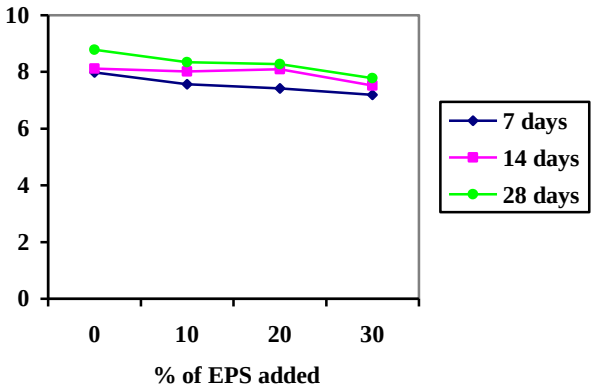



*C. Flexural strength test*

It is a measure of an unreinforced concrete to resist failure in bending. Very few use flexural testing for structural concrete. Agencies not using flexural strength for field control generally find the use of compressive strength convenient and reliable to judge the quality of the concrete as delivered. Flexural strength of concrete will be tested on 100mmx100mmx500mm prisms at the age of 7 days,14 days and 28 day.

TABLE VIII TEST FOR FLEXURAL STRENGTH

| Percentage Of EPS | 7 days | 14 days | 28 days |
|---|---|---|---|
| 0 | 7.98 | 8.12 | 8.78 |
| 10 | 7.56 | 8.02 | 8.34 |
| 20 | 7.42 | 8.10 | 8.27 |
| 30 | 7.19 | 7.52 | 7.78 |



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## IV. CONCLUSION

From the investigation on the effect of addition of EPS as partial replacement of fine aggregate in concrete and the following conclusions can be drawn.

- The fineness of EPS and M sand contributes higher bonding between cement and aggregates, thereby producing quality concrete.
- The compressive strength generally increases with age at curing, but it decreases densities and strength when EPS beads increase accordingly.
- The split tensile strength decreases when EPS beads replaced content decreased accordingly.
- The flexural strength decreases when EPS beads replaced content decreased accordingly.
- As the fine aggregate is partially replaced by EPS beads, the dead load can be decreased. Hence it is called as light weight concrete.
- The maximum strength (compressive, split tensile and flexural ) was attained at 10% of expanded polystyrene and was found to reduce for 30% of expanded polystyrene but it can be used for single floor building to make economical and to reduce the dead load.

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