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LIGHT WEIGHT CONCRETE {PARTIAL REPLACEMENT OF COARSE AGGREGATE USING POLYSTYRENE BEADS}

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Abstract-*With the development of modern construction techniques, the demand for the construction materials increases day by day. Hence the need for strong abundant alternative is mandatory. The usage of partial replacement of coarse aggregate using polystyrene beads in concrete gives prospective solution to the construction industry. Polystyrene beads are the waste material obtained from packaging industries. This paper handles the partial replacement of coarse aggregate in concrete by polystyrene beads. Then the result shows the amount of polystyrene beads is a hardened concrete. The casted specimens (10%, 20%, 30% replacement of coarse aggregate in M_{40} grade on concrete by beads) were tested for compressive strength test, split tensile strength and Scanning Electron Microscope test. In this project, the results suggested that, Expanded Polystyrene Concrete has scope for ^{non}-structural applications like wall panels, partitions wall, etc., and it may be recommended for structured applications after adding admixtures.*

Key words: M-Sand, Polystyrene beads, Physical properties, Mechanical properties, SEM analysis.

1. INTRODUCTION

Increase in the development activities world over, the demand for the construction material is increasing exponentially. This trend will have certainly greater impact on the economic system of any country. In this work the Expanded Polystyrene Beads (EPS), it is a packing material. 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 the coarse aggregate using EPS. The production and applications along with environmental concerns of EPS are also being discussed.

Expanded Polystyrene (EPS) is a light weight cellular plastics material. It is consisting of fine spherical shaped particles. which are comprised of about 98% air and 2% polystyrene. It has a good sound and thermal insulation characteristics as well as impact resistance these are the properties of Polystyrene beads. Polystyrene it is a waste material its used from packaging industry. It creates disposal problem. Lightweight concrete is generally accepted as concrete having a density of about 1800kg/m^3 or less.

The present study aims at utilization and the suitability of Expanded Polystyrene beads as coarse aggregate in concrete. A comparative study on strength parameters is also done against conventional concrete to study the behavior of polystyrene aggregate. An attempt of 10%, 20% & 30% replacement of coarse aggregate by EPS is carried out here.

There are many advantages of light weight concrete.

- Lighter loads during construction.
- Reduction in self-weight of structures.
- Increased thermal resistance.

2. MATERIALS USED

The materials used for the construction purpose from many naturally occurring substances are Cement, M-sand, Coarse Aggregate, Polystyrene Beads, Water. The quality of material plays a vital role in making of light weight concrete. Polystyrene beads is a light weight cellular plastic material. It consisting of fine spherical shaped particles. which are comprised of 98 % of air and 2% polystyrene. It has closed cell structure and cannot absorb water. It has good sound and thermal insulation characteristics as well as impact resistance.

3. MATERIALS TESTING

- Specific Gravity Test
- Properties of Cement
- Gradation Test

4. EXPERIMENTAL WORKS

The physical properties of individual ingredients were determined. The mix proportion for M_{40} conventional concrete mix was arrived as per IS:10262-2009

Adopting w/c= 0.45, the proportion of concrete mix is,

Cement : fine aggregate : coarse aggregate

1 : 1.2 : 2.1

This concrete mix proportion is taken as the reference or control mix in the present study. The mix proportion for EPS beads its partially added from coarse aggregate with different percentage. The quantities of material for various mixes are obtained by partial replacement of coarse aggregate by EPS beads.

Cubes of 150 mm size for compressive strength evaluation and cylinder of 150mm diameter for split tensile tests were prepared. The specimens were cured in water for 28 days and then tested. For every mix, 12 cubes of 150 mm size (for compression tests: 3 numbers of each 7,14,28 days), and 4 cylinders of 150 mm diameter and 300mm height (for split tensile test). Were used.

Table -1: Properties of Eps

Specific Gravity	0.012
Bulk density	6.87
Particle size	6-9(spherical)

Table -2: Properties of Cement

S. No.	Properties	Value
1	Specific Gravity	2.92
2	Standard Consistency	30%
3	Initial Setting Time	34 minutes
4	Final Setting Time	550 minutes
5	Fineness	8.5%

Table -3: Properties of M-Sand

Test Particulars	Fine aggregate
Specific Gravity	2.14
Grading Zone	IV

Table -4: Properties of Coarse Aggregate

Test Particulars	Coarse aggregate
Specific Gravity	2.88
Maximum Size	20 mm

5. TESTING ON EPS BEADS

The various experimental tests and their procedure carried out in this project are explained in the following sub section.

5.1 Workability Test

The proper placing and transportation without any segregation is called workability. Its measure consistency of the concrete. Then the consistency of concrete is closely related to workability.

5.2 Compressive Strength Test

For cube compression testing of concrete, 150×150×150mm cubes were used cubes were tested at the age of 7,14, and 28 days after curing using Compression Testing Machine (CTM). Capacity of the CTM is 10000 KN. Loading is continued till the dial gauge needle reverse its direction of motion. The reversal in the direction of motion of the needle indicates that the specimen has failed. The dial gauge reading at that instant was noted. The ultimate load divided by the plan area of the specimen is equal to the cube compressive strength.

5.3 Split Tensile Strength Test

This test is used to determine the tensile strength of concrete. Split tensile strength test was carried out on cylindrical specimens of size 150 mm dia and 300 mm long at the age of 28 days after curing using CTM. To avoid the direct load on the specimen, the cylindrical specimens were kept between two wooden pieces and the reading were noted. The split tensile strength of concrete was found using the relation: split tensile strength=($2P/\pi LD$) where P is the maximum load on the cylinder and D is the diameter of cylinder, L is the length of the cylinder.

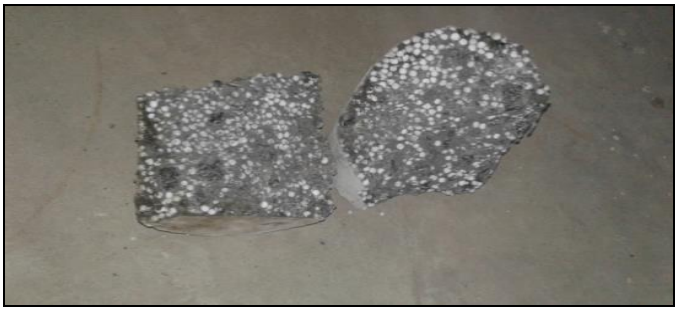

Fig -1: Spliting of Specimens

5.4 SEM Test

A Scanning Electron Microscope (SEM) is an important supplement to the optical microscope when examining new, old and deteriorated concrete. In quality assurance of concrete scanning electron microscopy provides important information about:

- Degree of hydration of cement
- Formation and distribution of hydration products
- Adhesion to concrete
- Homogeneity of cement paste

6. RESULTS AND DISCUSSION

6.1 Workability Test

The workability test results for light weight concrete made with polystyrene are shown

Table -5: Workability Test

Mix	Trial 1 mm	Trial 2 mm	Average mm
0%	35	38	36
10%	40	42	41
20%	45	48	47
30%	60	65	63

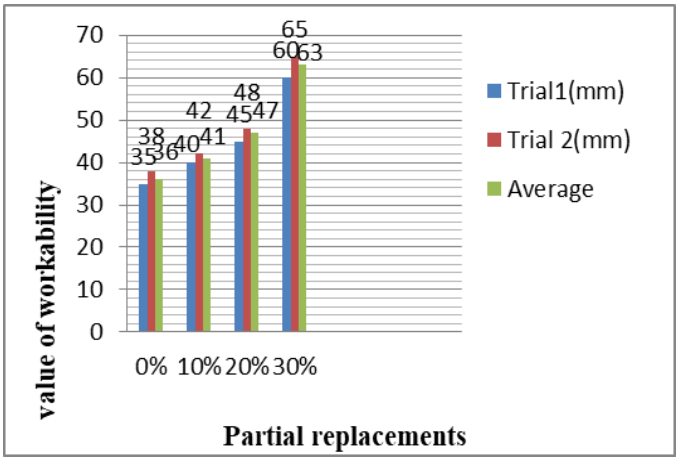

Chart -1: Workability Test

DISCUSSIONS

The tests were carried out on each mix to evaluate the workability. The workability of conventional concrete is better when compared to Expanded Polystyrene Beads. The slump test is most well known and widely used test method to characterize the workability of fresh concrete.

6.2 Compressive Strength Test

Table -6: Compressive Strength Test Results

Specimens Details	Compressive Strength at (N/mm²)		
	7 days	14 days	28 days
0%	22.4	26.2	28.44
10%	5.00	7.88	10.33
20%	8.5	11.99	15.33
30%	10.22	16.35	22.5

The compressive strength results for light weight concrete made with polystyrene are shown in Table 6

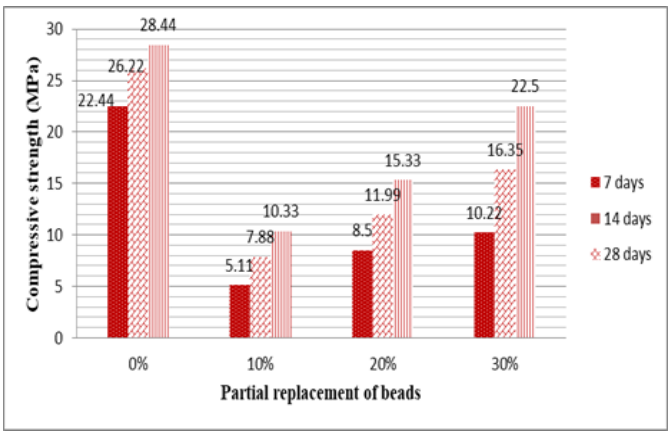

Chart -2 Compressive Strength Test

DISCUSSIONS

The tests were carried out on each mix to evaluate the compressive strength of concrete. From the chart, the compressive strength of conventional concrete on 28th day was 28.44 MPa and for the polystyrene beads concrete, it was 10.33 MPa, 15.33MPa and 22.5 MPa respectively for 10%, 20% and 30% replacement of beads. About 10%, 20% and 30% replacement of polystyrene beads with coarse aggregate the compressive strength was decreased about 77.23% , 62.12% and 55.19 % on 7th day. When 10%, 20% and 30% replacement of polystyrene beads with coarse aggregate the compressive strength was decreased about 69.94%, 54.27% and 37.64% on 14th day. And also 10%, 20% and 30% replacement of polystyrene beads with coarse aggregate the compressive strength was decreased about 63.17%, 46.09% and 20.88% on 28th day. So it is clear that adding polystyrene resulted in decreasing the compressive strength of Concrete mix.

6.3 Split Tensile Strength Test

The split tensile strength results for light weight concrete made with polystyrene is shown in Table 7

Table -7: Split Tensile Strength At 28 Days

SPECIMENS DETAILS	SPLIT TENSILE STRENGTH AT 28 DAYS (N/mm²)
0% Replacement	3.95
10% Replacement	3.82
20% Replacement	2.53
30% Replacement	2.45

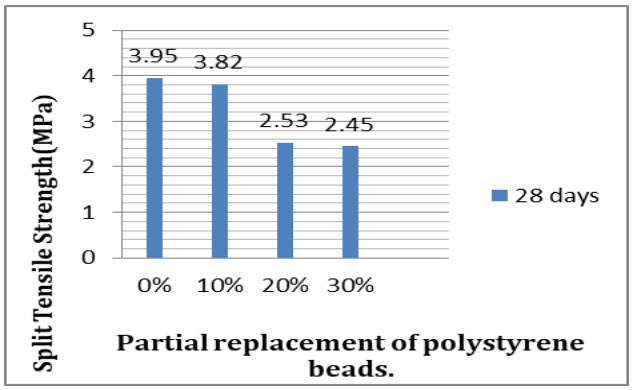

Chart -3: Split Tensile Strength Test

DISCUSSIONS

The tests were carried out on each mix to evaluate the split tensile strength of concrete. From the chart, the split tensile strength of conventional concrete on 28 th day was 3.95 MPa and for the polystyrene beads concrete, it was 3.82 MPa, 2.53 MPa and 2.45 MPa, respectively for 10%, 20% and 30% replacement of beads. After 28th days partial replacement of coarse aggregate was decreased 3.29%, 35.94%, 37.97% of

10%, 20% and 30% replacements. So it is clear that adding polystyrene resulted in decreasing the split tensile strength of Concrete mix.

6.4 SEM Test Result

The SEM test result Partial Replacement of Coarse Aggregate Using Polystyrene Beads in concrete are shown in fig.2

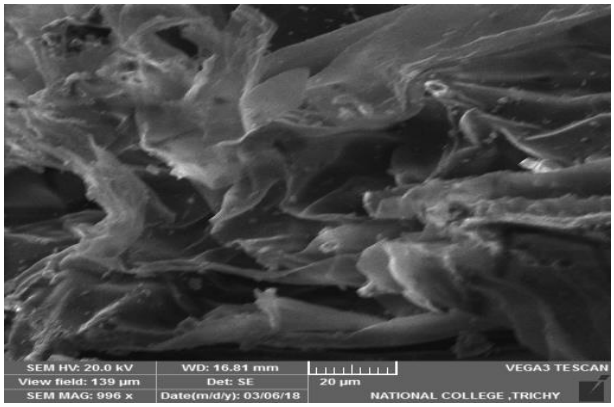

Fig -2: SEM Test

DISCUSSIONS

The Field Emission Microscopic of the polystyrene beads samples are shown in figure 5. The collected samples were carbon coated and analysed using a Scanning Electron Microscope (SEM) in the back scattered electron mode with an accelerating voltage of 20Kv. The back scattered intensity was set to the same parameter for each sample. The magnification of the microscopically views are 10µm and 100 µm. The working distance of the Field Emission Scanning Electron Microscopy views was 16.81 mm.

7. CONCLUSIONS

The following conclusions were drawn from the study.

- Workability increases with increase in EPS beads content
- All the EPS concrete without any special bonding agent has shown good workability and could easily be compacted and finished.
- Increase in EPS beads content in concrete reduces the compressive and tensile strength of concrete.
- The replacement by using EPS that means Expanded Polystyrene Beads is used from non-structural building.
- Obtained results suggested that, Expanded Polystyrene Concrete has scope for non-structural applications, like wall panels, partitions wall, etc., and if it may recommend for structure application after adding admixture.
- It is recommended to study above 30% replacement for finding optimum % replacement in future.

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