

Lightweight Expanded Polystyrene Beads Concrete

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Abstract- With increase in demand for construction materials, man has improved a lot in construction techniques of structures. In earlier ages structures were constructed with heavy materials, but in this modern era of construction old techniques are being more costly due to heavy loading. So the uses of lightweight materials are started. The Expanded polystyrene beads are the material which substitutes in the place of coarse aggregate. The main objective of this investigation is to find a concrete mix proportion which gives better results than the Burnt Brick (compressive strength and density), and to study the properties, such as density, compressive strength and splitting tensile strength of lightweight Expanded Polystyrene (EPS) beads concrete. Then its properties are compared with M20 grade conventional concrete.

Keywords: Expanded polystyrene Beads (EPS); Density; Compressive Strength; Splitting Tensile Strength.

1. INTRODUCTION

In this work, an attempt is made to make the concrete mix design as replacement to the Burnt Brick with more benefits as high strength and low density. In this study the partial replacement of coarse aggregate was done by Expanded Polystyrene (EPS) beads to reduce its density.

The Expanded Polystyrene is a stable, low density Foam, which consists of 98% of air and 2% of polystyrene material. It has closed structure and cannot absorb water. It has good impact resistance. Polystyrene is packaging material in medical industry. Polystyrene is non-biodegradable material, so it creates disposal problems. Utilizing crushed polystyrene in concrete is good waste disposal method. ⁽⁷⁾

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. Polystyrene concrete was used to produce load bearing concrete wall, also as the material of construction for floating marine structures.

Expanded polystyrene beads concrete was popular through the ages. One of the main problems associated with the use of conventional lightweight aggregates produced from clay, slate and shale in concrete is that these porous aggregates absorb very large amount of the water mixed in concrete. This is affecting the performance of the concrete, apart from the fact that it is difficult to maintain specific water content during the casting. Also, this absorption of water by the aggregates will mean that the additional water will be required to maintain the slump at acceptable levels. These increased water contents requires higher cement contents, even without any benefit.

2. MATERIALS

The raw material used in this experimentation were locally available and these included PPC (fly ash based cement) as a binding agent, river sand as fine aggregates, crushed coarse aggregates and EPS beads. Potable tap water was used for mixing and curing throughout the entire work.

2.1 Cement

The Portland Pozzolana Cement (PPC) (Fly Ash Based) cement was used conforming to IS 1489 – 1991 (Part 1) and properties are shown in Table 1.

Table 1: Properties of Cement

Sr. No.	Physical Property	Results
1.	Setting Time	
A)	Initial setting Time	< 30 minutes
B)	Final Setting Time	> 600 minutes
2.	Fineness	> 300m ² /kg
4.	Specific Gravity	3.00

2.2 Fine Aggregates

The aggregates having size less than 4.75 mm. Fine aggregates used for project work was river sand. The sand was air dried and free from any foreign material, earlier than mixing. Specific gravity of sand is 2.72.

2.3 Coarse Aggregates

The aggregates having size more than 4.75 mm are called as coarse aggregate. Locally available crushed stone was used as coarse aggregate. The properties of coarse aggregates as follows -

Sr. No.	Physical Property	Result
1.	Maximum Size (mm)	20
2.	Minimum Size (mm)	12.5
3.	Specific Gravity	2.66

2.4 EPS beads

The Expanded Polystyrene beads used in this project was spherical in shape and size varying between 1.18 to 2.36 mm in diameter.

3. MIX PROPORTION

The physical properties of ingredients are determined individually. The mix proportion for conventional M20 grade concrete is arrived as per IS: 10262-2009.

Assumed w/c ratio = 0.50, the proportion of concrete mix is,

W	C	FA	CA
160	320	797.5	1169.87
0.50	1	2.49	3.66

This mix proportion of conventional concrete is taken as the reference to the EPS beads concrete. The mix proportion of EPS beads concrete taken by replacing coarse aggregates by EPS beads and also by changing proportions of all other ingredients.

Three mix proportions are created and tests are taken on that EPS beads concrete mix proportion. The mix proportions for EPS beads concrete are.

Table 2: Mix proportion for TYPE A

PROPORTION				
Cement (kg)	Sand (kg)	Aggregate (kg)	EPS bead (kg)	w/c ratio
493.82	987.65	0.00	17.78	0.50

Table 3: Mix proportion for TYPE B

PROPORTION				
Cement (kg)	Sand (kg)	Aggregate (kg)	EPS bead (kg)	w/c ratio
592.59	1283.95	0.00	10.86	0.50

Table 4: Mix proportion for TYPE C

PROPORTION				
Cement (kg)	Sand (kg)	Aggregate (kg)	EPS bead (kg)	w/c ratio
543.20	790.123	444.44	12.84	0.50

4. PROCEDURE

4.1 Batching and Mixing

Weigh batching was practiced with the help of electronic weigh balance. Batching was done as per mix proportion.

The mix was prepared manually. First all three dry materials cement, sand and coarse aggregate mixed dry through, then properly mix these three ingredients by adding water after that mix all by adding EPS beads it makes uniform mixture.



Fig 1- Showing Weight Batching and Mixing of concrete Materials.

4.2 Placing and Compacting

Moulds are cleaned and oiled to prevent the formation of bond between concrete and moulds. The fresh concrete filled into the moulds in three layers with hand compaction at least of 25 blows after adding each successive layer. The entrapped air in concrete is removed by table vibrator. In case of concrete with EPS beads vibration makes the segregation. Vibrations are given as there no segregation was occur and EPS beads does not float on concrete, So give more preference to hand compaction method for concrete containing EPS beads. After the compaction has been completed, the excess mortar was removed from the mould with the help of trowel and the surface was levelled.



Fig 2 - Finishing the top surface of concrete mould.

4.3 Demoulding and Curing

After placing fresh concrete in moulds, it was allowed to set for 24 hours. Concrete samples were demoulded and it was marked with some permanent identification mark. Concrete samples now kept in curing tank for required time span of 7 days, 14 days and 28 days, after that time span, concrete samples were removed from curing tank to conduct tests on hardened concrete.

4.4 Testing

After curing concrete sample were taken on dry platform for an hour to remove the water content for some extent in sample. Then samples are tested on universal testing machine (UTM), available in college.

5. TESTS ON CONCRETE

5.1 Workability Test (Slump Cone Test)

The concrete slump test is an empirical test that measures the workability of fresh concrete. More specifically, it measures the consistency of the concrete in that specific batch. This test is performed to check the consistency of freshly made concrete.



Fig 3- Testing Workability.

5.2 Compressive Strength Test

Compression strength test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength.

A compressive strength test is a method of determining the behavior of materials under a compressive load. Compression strength test are conducted by loading the test specimen between two plates and then applying a force to the specimen by moving the crossheads pushing towards.

5.3 Split Tensile Strength Test

The tensile strength is also the important properties of concrete. However the determination of tensile strength of concrete is necessary to determine the load at which the concrete member may crack. The cracking may be in the form of tension failure. Splitting tensile strength test taken on concrete cylinder and it is a method to determine the tensile strength of concrete.

5.4 Density Test

Density of concrete is one of the important parameter in structural behaviour. The density of concrete is a measure of its weight. As the more density of concrete the dead load on structure is more.

6. RESULTS AND DISCUSSION

6.1 General

In this, the results of various tests are taken on both conventional and Expanded Polystyrene Beads concrete also compression strength test and density test on Burnt Brick.

6.2 Fresh Concrete

Bleeding was observed when water/cement ratio increases. First hand compaction was done after that vibrations are given, as more percentage of vibrations it results in segregation and EPS beads floats on the concrete surface.

It was seen that because of the presence of electric charge on EPS beads, concrete with EPS beads material shows low workability but by experimentally we concluded that the concrete containing EPS beads gives more and more workability than normal concrete and the workability increases with increase in EPS beads content. Obtained slump values from bottom were given in Table 5.

Table 5: Slump Values

Type	Conventional	TYPE A	TYPE B	TYPE C
Slump (cm)	22	28.8	24	26.5

6.3 Hardened Concrete

6.3.1 Compressive Strength Test

Compressive strength test of the cube was carried out on Universal Testing Machine (UTM). The load applied on specimen uniformly, without any shocks up to the specimen

fails. The specimen placed like the center of specimen and center of moving plates are same. A set of three cubes are tested for Burnt Brick and each concrete mix for 7days, 14 days and 28 days of curing. The maximum load taken by specimen was noted for each specimen. Average strength was calculated for every set of specimens. After testing the specimen was checked for cracks, EPS beads distribution. The results of compressive strength test were given in chart 1.

It was observed that, the compressive strength of all the concrete mixes increases with increase in age of concrete. It is seen that the larger the amount of EPS beads lesser the compressive strength. The conventional concrete has more compressive strength at all the ages compared to EPS beads concrete. All the EPS beads concrete are having more strength than the Burnt Brick.

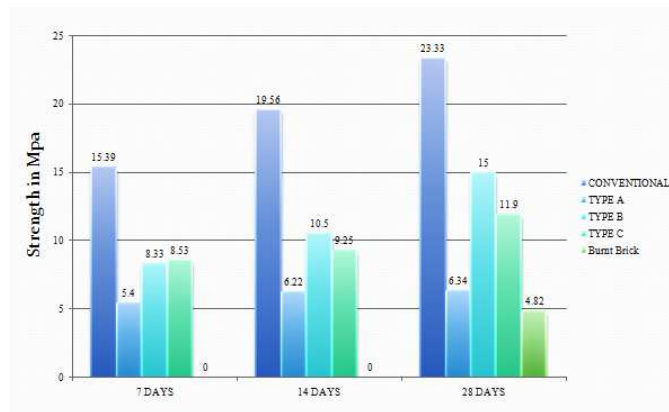


Chart 1: Compressive Strength Test Results for Specimens

6.3.2 Split Tensile Strength Test

Split Tensile strength test of the cylinder was carried out on Universal Testing Machine (UTM). The load applied on specimen uniformly, without any shocks up to the specimen fails. The specimen placed like the center of specimen and center of moving plates are same. A set of three cylinders are tested for each concrete mix for 7days, 14 days and 28 days of curing. The maximum load taken by specimen was noted for each specimen. Average strength was calculated for every set of specimens. After testing the specimen was checked for cracks, EPS beads distribution. The results of Split Tensile strength test were given in chart 2.

It was observed that the split tensile strength of all concrete mixes increases with increase in ages. It was seen that the larger the amount of EPS beads lesser the split tensile strength. The concrete mix proportion for TYPE B gives more split tensile strength than conventional concrete.



Fig 4- Cylinder after Split Tensile Test, Showing EPS beads Distribution.

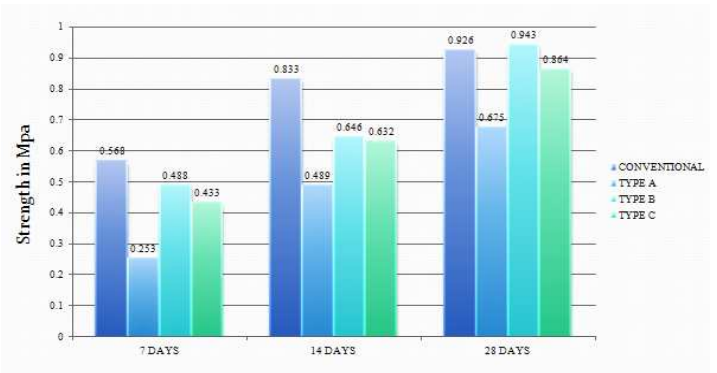
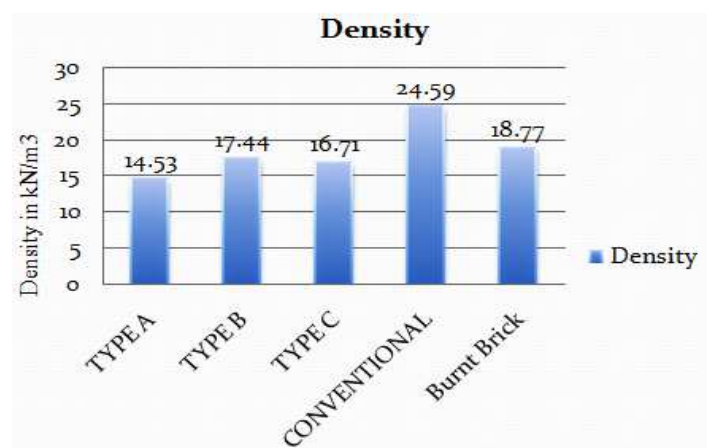


Chart 2: Split Tensile Strength Test Results for Specimens

6.3.3 Density Test

The density test was carried out on different concrete proportion and Burnt Brick. For Density Test, volume of specimen was carried out and its weight was taken. Then density calculated by taking ratio of weight in kN and volume in m³. Three specimens of each mix proportion and Burnt Brick are tested for density test.



7. CONCLUSIONS

- The following conclusions were drawn from the study.
 1. EPS concrete gives good workability and could easily be compacted and finished. Workability increases with increase in EPS content.
 2. The compressive strength of EPS concrete is less than Conventional concrete.
 3. The concrete mix of TYPE-A having lowest density and it gives the strength more than Burnt Brick so this concrete mix proportion was useful as Lightweight concrete Brick in construction work.
 4. Also as per results observed for mix proportion, the mix proportion of TYPE-B gives more strength as 15 Mpa and density nearly as a brick and also gives tensile strength more than normal concrete so this TYPE-B mix proportion concrete was also used filling material in slabs concreting.
 5. Also concluded that designed all mix proportions are useful in cladding panels and tilt up panels.
 6. The concrete mix proportion also useful as precast concrete members with low density and more workability.

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