

Light Weight Precast Concrete Panel by Using Polystyrene

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ABSTRACT:-This paper present of an experimental study on the effect of using industrial waste Polystyrene as a potential aggregate in light weight precast concrete panel. Also in place of natural sand, crush sand stone were used. The effect of Polystyrene aggregate on several properties of concrete were investigated. For this purpose, five series of concrete sample were prepared. The polystyrene aggregate was used as a replacement of natural aggregate, at the level of 40%, 50%, 60%, by volume and crush sand stone was also replaced by polystyrene at the level of 10%,20% by volume. The 7-d compressive strength of polystyrene concrete ranges from 3.91Mpa to 6.18 Mpa which satisfies the strength requirement of light weight precast concrete panel. Light weight precast concrete panel made using Polystyrene are effectively used in partition walls, compound wall, parapet wall, w/c unit, road divider and other non-load bearing elements of the buildings as they provide required compressive strength. These elements shows good thermal insulations and durability. Light weight concrete can be made in any size and shape as per the requirement.

KEYWORDS:-Light weight, Economy, waste minimize, Easy Handling and Installation, Eco-friendly, High Durability.

I. INTRODUCTION

With the rapid development and technological increase, the need of substitutes for aggregate in concrete has increased. Day by day new materials are being used as replacement of aggregates in concrete construction such as expanded glass, expanded polystyrene, etc. Polystyrene can be used to produce low density concretes required for building applications like cladding panels, curtain walls, composite flooring system, and load bearing concrete blocks. Polystyrene has following properties:

- Excellent thermal insulation capacity.
- Easily controllable protection against the impact of shocks and drops.
- Flexibility of moulding.
- Stable in adverse weather conditions.
- Neutral for the environment and free of CFC.

In this paper the light weight concrete panel was constructed by using polystyrene. The natural Aggregate and crush sand was replaced by polystyrene at the level of 40% and 10% by volume respectively. This preparation gives good strength at lower cost also it protect the environmental problem and it is economical as compared to standard concrete. The polystyrene used in this concrete are waste generated by the industries. This waste polystyrene are not easily disposed in environment so that it can be used as an aggregate in concrete to construct a precast panel which can be used in partition walls, compound wall, parapet wall, w/c unit, road divider and other non-load bearing elements of the buildings. Due to the use of precast concrete panel it is easy to install less time consuming environment friendly and cheapest as compared to standard concrete panel due to the finished panel is does not required plastering hence it reduces the material cost and labour cost also.

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II. RELATED WORK

The essential characteristic of lightweight concrete is its porosity, which results in low apparent specific gravity. In concrete construction, self-weight represents a very large portion of the load on the structure, and there are considerable advantages in reducing the density of concrete. Furthermore using lightweight concrete improves construction and handling techniques; larger units are often desirable; obviously transportation and on-site handling would be made more economical. Lightweight concrete reduces the cost of formwork and steel and it also increases productivity. Giving better thermal insulation than ordinary concrete. The practical range of densities of lightweight concrete is between about 300 and 1850 kg/m³. Concrete weight is lightened by; - The introduction of air as air bubbles of rather coarse size (1-3 mm diameter) in the mortar, this is called "aerated concrete". - The introduction of air by using a special agent, this is called "air entrained concrete". - The use of lightweight aggregate as a substitute to normal aggregate. The process of manufacturing lightweight concrete is very costly as complex machinery, chemicals and/or expensive lightweight aggregate are used. This has led to a search for a substitute for expensive lightweight aggregate. The idea of using Polystyrene particle as a substitute of air bubbles (lightweight aggregate) has been introduced, as the density of Polystyrene is nearly negligible (2-27 kg/m³) when compared to that of concrete aggregates (1700-2000 kg/m³). An intensive literature survey on light weight concrete has been carried out to seek references to the use of polystyrene in concrete mixes, more than 3000 websites were visited over the internet, and nothing was directly related to the topic of this paper. Accordingly extensive work is needed to explore all chemical, physical and structural properties.

An attempt has been made to explore, provisionally, the structural, physical and chemical behaviour, advantages and disadvantages of Polystyrene concrete by carrying out an extensive experimental work at concrete laboratory of BIT Engineering College, Barshi (Solapur University). The Polystyrene concrete mix is very critical to water/cement ratio; simply no mix was possible for water/Cement ratio above 0.42, above this ratio polystyrene has been segregated leaving the mortar.

III. SCOPE

Our country is developing day by day so that most of building have compound wall and all building have parapet wall. Currently the construction of compound wall, partition wall, w/c block, road divider and parapet wall is done by using brick work or by precast concrete panel. There is a lot of scope for utilization of precast concrete panel for all above building component also in the most of the villages of our country there is a lack of w/c block or unit. Approximately only 40% peoples are use w/c. At present the w/c block are constructed by using precast panel due to the easy installation and speedy work. So that it is necessary to construct the precast concrete panel of lower cost with good strength.

Our project aim is to constructing the precast panel of light weight concrete by using polystyrene. It gives the good strength at lower cost and also it is light weight and have longer durability and environment friendly. Due to the use of 40% polystyrene and 60% natural aggregate proportion of concrete, it gives the good strength and at low cost. The polystyrene used in it is the waste generated in the industries hence it decrease the solid waste load of environment. Hence this light weight precast panel are cheaper than standard panel. So that this type of panel can be used in the partition walls, compound wall, parapet wall, w/c unit, road divider and other non-load bearing elements of the building.

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IV. METHODOLOGY

In order to study the behavior of lightweight concrete, concrete testing was done to determine the material and structural properties of lightweight concrete and how will these properties differ according to a different type of mixture and its composition. When the concrete has hardened it can be subjected to a wide range of tests to prove its ability to perform as planned or to discover its characteristics. For new concrete this usually involves casting specimens from fresh concrete and testing them for various properties as the concrete matures.

M₁₅ standard concrete mix design:

- a) Type of cement- OPC 53 grade
- a) Max. size of aggregate- 10MM
- b) Exposure condition sever- mild
- c) Workability – 0.90 C.F.
- d) Min. cement content- 220 kg/m³
- e) Max. cement & water ratio- 0.60
- f) Degree of saturation- good
- g) Type of aggregate- crushed angular aggregate
- h) Specific gravity of course aggregate- 2.76
- i) Specific gravity of fine aggregate- 2.79
- j) Water absorption of course aggregate & fine aggregate - 0.5% & 1%
- k) Free surface moisture of course aggregate & fine aggregate – Nil
- l) Gravity of fine aggregate confirming the grading zone IV

The mix proportion then become:

Water	Cement	F.A.	C.A.
206	375 kg	652 kg	1146 kg
0.54	1	1.73	3.056

Table: Mix Proportion

Quantities required for standard cube (0.15m x 0.15m x 0.15m)= 0.003375 M³ with Proportion M₁₅= 1:1.73:3.056 obtained as:

Material	Quantities	Unit
Cement	1.25	kg
Crush Sand	2.57	kg
Aggregate	4.21	kg
Water	675	ml

Table: Quantities required

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• **Trial Mix design of concrete mixes with partial replacement of coarse aggregate with polystyrene:**

Cube casting is done by trial and error method, the quantities of cement is kept constant. Quantities of Crushed sand stone, polystyrene, and water is changed for getting desired results. The following table shows the various quantities of material used.

Trial Mix Design:

Block Casting:

Block size (0.15m x 0.15m x 0.15m)

M₁₅ = 1 : 1.73 : 3.056

a. Block No. 1 (standard)

Material(kg/m ³)	Volume(m ³)	Weight (kg)	Strength after 7 days(N/mm ²)
Cement	8.86 x 10 ⁻⁴	1.25	10.37
Crush sand	1.53 x 10 ⁻³	2.57	
Aggregate	2.70 x 10 ⁻³	4.21	

b. Block No. 2

Material(kg/m ³)	Volume(m ³)	Weight (kg)	Strength after 7 days (N/mm ²)
Cement	8.86 x 10 ⁻⁴	1.25	5.70
Crush sand	1.53 x 10 ⁻³	2.57	
Aggregate	60 % of 2.70 x 10 ⁻³	2.43	
polystyrene	40 % of 2.70 x 10 ⁻³	0.00872	

c. Block No. 3

Material(kg/m ³)	Volume(m ³)	Weight (kg)	Strength after 7 days(N/mm ²)
Cement	8.86 x 10 ⁻⁴	1.25	6.18
Crush sand	90 % of 1.53 x 10 ⁻³	2.21	
Aggregate	60 % of 2.70 x 10 ⁻³	2.43	
polystyrene	40 % of 2.70 x 10 ⁻³ & 10 % of 1.53 x 10 ⁻³	0.00995	

d. Block No. 4

Material(kg/m ³)	Volume(m ³)	Weight (kg)	Strength after 7 days(N/mm ²)
Cement	8.86 x 10 ⁻⁴	1.25	3.91
Crush sand	1.53 x 10 ⁻³	2.57	
Aggregate	50 % of 2.70 x 10 ⁻³	2.105	
polystyrene	50 % of 2.70 x 10 ⁻³	0.0109	

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e. Block No. 5

Material(kg/m ³)	Volume(m ³)	Weight (kg)	Strength after 7 days(N/mm ²)
Cement	8.86 x 10 ⁻⁴	1.25	4.26
Crush sand	1.53 x 10 ⁻³	2.57	
Aggregate	40 % of 2.70 x 10 ⁻³	1.684	
Polystyrene	60 % of 2.70 x 10 ⁻³	0.01308	

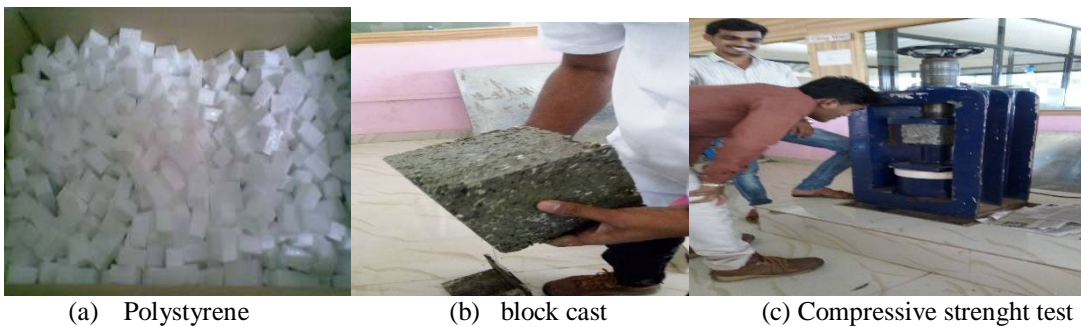


Figure 1. Casting and testing of Polystyrene concrete block

In Figure 1, fig (a) shows the polystyrene that are used as a aggregate in concrete. Its size is approximately of 10 mm. Fig (b) shows the polystyrene concrete casted block. It is generally more light weight than the conventional concrete block. Fig (c) shows the compressive strength test on polystyrene concrete casted block after curing. As per the IS : 11447-1985, for cellular precast concrete panel, a minimum strength of 5 N/mm² is recommended. Hence From above test result it was conclude that block no. 3 gives the satisfied strength with 40% of natural aggregate and 10% of crush sand stone was replaced by the polystyrene by volume.

V. RESULT AND DISSCUSSION

Figure 2 shows that relationship between the compressive strength development and curing period for all the concrete series that have employed. The designation for each block is given in above Table. The highest compressive strength was obtained by block 3 while samples from block 4 gave the lowest strength throughout the curing time. The strength of the concrete will gets stronger with time as the hydration process progressed.

Due to lower modulus and porous characteristics of polystyrene as it exhibits high values of aggregate crushing value (ACV), lightweight palm oil clinker aggregate concrete produces lower strength compared with control concrete using crushed gravel as aggregates. Existence of air voids will trapped the water and therefore the moisture is higher and lower the compressive strength of the concrete. From the figure shown, we can observe that a significance lower compressive strength. All polystyrene concrete performed 57-62% and 60-65% lower at 28 days and 180 days respectively than normal concrete. The increase of strength rate was significant for first 90 days and remains slower up to 180 days. The compressive strength for the 7-days samples in the range of 5-11 N/mm². Although polystyrene concrete shows lower value compared to conventional aggregates concrete, the values obtained is beyond the minimum requirement for structural lightweight concrete purposes. BS8110 indicates that the range of concrete strength for structural purposes is within 17-35MPa after 28 days.

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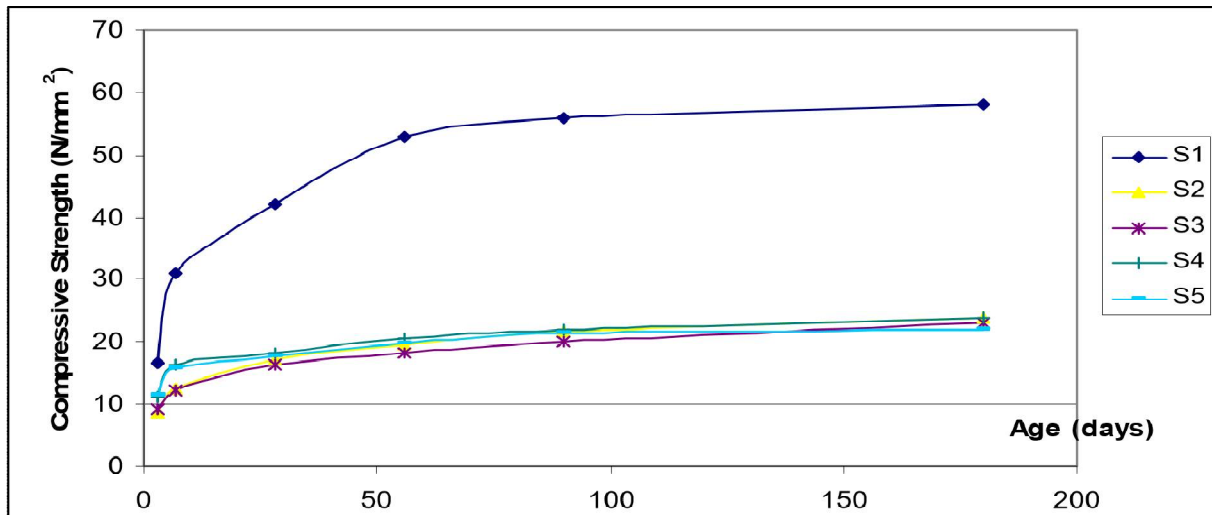


Figure 2: Compressive strength development of different series

Sr. No.	Particular	Conventional Concrete Panel	Polystyrene Concrete Panel
1.	Weight	Heavy	Light
2.	Transportation and handling	Costly and difficult to due to heavy weight	Less costly and easy to handling due to light weight
3.	Installation	Difficult to install	Easy to install
4.	Vibration	Needle or heavy vibration is required for compaction	Plate vibrator or Hand compaction can be used
5.	Dead load	High	Less
6.	Economical	Less	More
7.	Environment	Affect on environment because of use of river sand.	It doesn't affect on environment because of use of crush sand stone.
8.	Waste minimize	It doesn't minimize the waste	It minimize the waste

Table: Comparison between Conventional concrete panel and polystyrene concrete panel

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VI. CONCLUSION

After the entire test has been done to determine the strength development of polystyrene, the following conclusions can be drawn from the investigation;

1. The block no. 3 gives the satisfied result has a strength is 6.18 N/mm^2 . And this strength of polystyrene concrete panel can be used in partition walls, compound wall, parapet wall, w/c unit, road divider and other non-load bearing elements of the building.
2. The concrete panel made by using Polystyrene is 30% - 40% more light weight than conventional concrete panel.
3. With increase in the amount of Polystyrene in concrete blocks, the cost reduces but also the compressive strength and tensile strength decreases gradually.
4. This panels are easy to transport, Handle and Install.
5. The cost of this panel is 30% - 40% less than conventional concrete panel.
6. By the use of Industrial waste polystyrene in this panel, it reduces the waste load on environment.
7. The long-term behavior of polystyrene concrete is about similar to control concrete in any curing period.

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