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# Sustainable toilets by using lightweight precast concrete panels

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## ABSTRACT

***With increasing concern over the excessive exploitation of natural aggregates, synthetic lightweight aggregate produced from environmental waste is a viable new source of structural aggregate material. The uses of structural grade lightweight concrete reduce considerably the self-load of a structure and permit larger precast units to be handled. BS EN 12504-4. 2004. Testing concrete. Determination of ultrasonic pulse velocity. The mechanical properties of a structural grade lightweight aggregate made with fly ash and clay will be presented. Indicated that water absorption of the green aggregate is large but the crushing strength of the resulting concrete can be high. The 28-day cube compressive strength of the resulting lightweight aggregate concrete with density of 1590 kg/m^3 and respective strength of 34 mpa. Experience of utilizing the green lightweight aggregate concrete in prefabrication of concrete elements is also discussed.***

***Keywords—*** *Precast Concrete, Sustainable Toilet, Polystyrene, Light Weight Concrete*

## 1. INTRODUCTION

The materials used for preparing concrete are selected from those by the conventional concrete industry. Materials used for Light Weight Concrete using polystyrene are Crush sand stone, cement, aggregate, polystyrene. Light Weight Concrete can be designed and constructed using a broad range of concreting materials, and that this is essential for Light Weight Concrete to gain popularity.

Cement concrete is a product obtained by hardening of the mixture of cement, sand, gravel or aggregate and water in predetermined proportions. When these ingredients are mixed, they form a plastic mass which can be poured in suitable molds, called forms, and set on standing into hard solid mass. The chemical reaction of cement and water, in the mix, is relatively slow and requires time and favorable temperature for its completion. This time, known as setting time may be divided into three distinct phases. The first phase, designated as the time of initial set, requires from 30 minutes to about 60 minutes for completion. During this phase, the mixed concrete decreases its plasticity and develops pronounced resistance to flow. The second phase, known as final set, may vary between 5 to 6 hours after the mixing operation. During this phase, concrete appears to be relatively soft solid without surface hardness. The process is rapid in the initial stage, until about one month after mixing, at which time the concrete almost attains the major portion of its potential hardness and strength. Polystyrene is a synthetic aromatic polymer made from the monomer styrene. Polystyrene can be solid or foamed. General purpose polystyrene is clear, hard, and rather brittle. It is an inexpensive resin per unit weight. It is a rather poor barrier to oxygen and water vapor and has a relatively low melting point. Crystal polystyrenes have very low impact strengths of less than 0.5ft-lb. commercially available impact polystyrene grades can be obtained with values of 1.0 - 4.0 ft-lb. Generally, polystyrenes are not produced with greater than 15% total rubber because of polymerization processing constraints. Nevertheless, impact properties can be increased substantially without additional rubber by the proper control of rubber particle size, percentage of grafting, cross-linking, and percentage of gel. Solvent crazing of polystyrene is a commercially important phenomenon. High impact polystyrenes are susceptible to solvent crazing at the interface between the rubber particles and the polystyrene phase. The resistance of polystyrene to this crazing is referred to as environmental stress crack resistance.

## 2. OBJECTIVES OF THE STUDY

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.

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

## 3. RESEARCH METHODOLOGY

Ordinary Portland cement (OPC) is by far the most important type of cement. After 1987 higher grade cements were introduced in India. The OPC was classified into three grades, namely 33grade, 43grade and 53grade depending upon the strength of the cement at 28 days when tested as per I.S. 40311988. [5] If the 28 days strength is not less than 33 N/mm2 , it is called 33grade cement, if the strength is not less than 43 N/mm2 , it is called 43grade cement, and if the strength is not less than 53 N/mm2 , it is called 53grade cement. But the actual strength obtained by these cements at the factory is much higher than the BIS specifications. a) Material used

### 3.1 Concrete

A building material made from a mixture of broken aggregate, sand, cement, and water, which can be spread or poured into molds and forms a stone-like mass on hardening.

**Photo. 1 concrete**

**3.1.1 Cement**: The cement and water form a paste that coats the aggregate and sand in the mix. The paste hardens and binds the aggregates and sand together.


**Photo. 2 cement**

**3.1.2 Aggregate:** Sand is the fine aggregate. Gravel or crushed stone is the coarse aggregate in most mixes. Sources for these basic materials can be grouped into three main areas: Mining of mineral aggregate deposits, including sand, gravel, and stone; use of waste slag from the manufacture of iron and steel; and recycling of concrete.

**Photo. 3 aggregate**

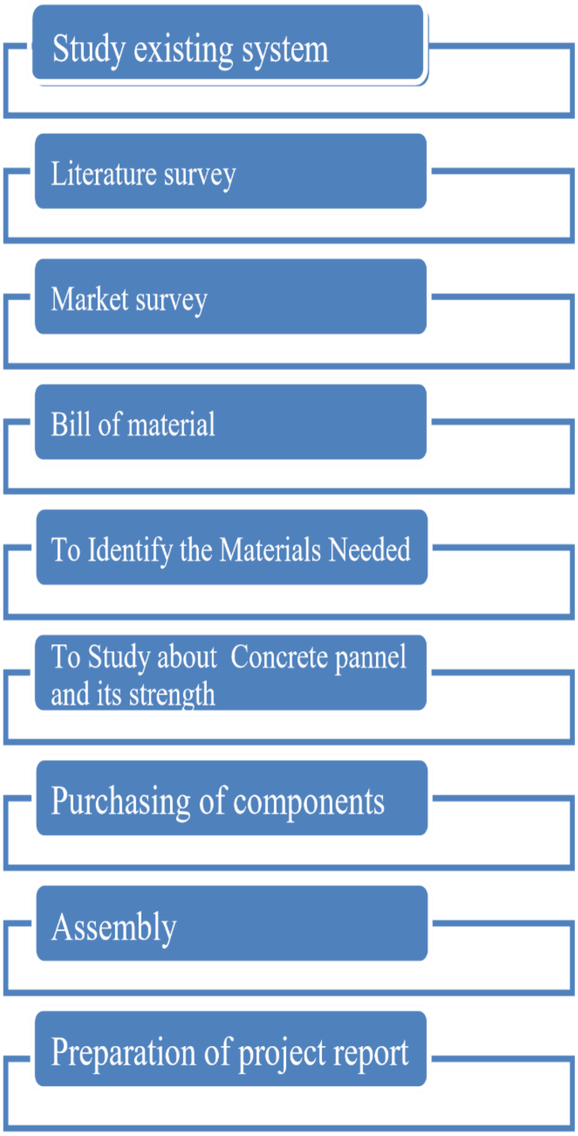


**Fig. 1 Flowchart shows the Methodology**

### 3.1.3 Test procedure

1. A standard plunger, 10 mm diameter, 50 mm long is attached and roughed down to touch the surface of the paste in test block.
2. Release the plunger quickly to sink it into the paste by its own weight.
3. Take the reading by noting the depth of penetration of the plunger.
4. Higher percentage or lower Take about 500 gm of cement.
5. Prepare a paste with a weighed quantity of water for the first trial (say 23 or 24%) the paste must be prepared in standard manner.
6. Fill the paste into vacate mould with 3-5 min, shake the mould well to expel air.
7. Percentage of water as the case may be to find out the depth of penetration.
8. Similarly conduct the trials with different water-cement ratio till the time plunger penetrates for a depth of 33-35 mm from the top.
9. The water content which allows the plunger to penetrate only to a depth of 33- 35 mm from top is known as percentage of water required to produce a cement paste of standard consistency and percentage is usually denoted as p.

**Objective of test:**

To check cement is confirming standard requirement of setting time i.e. Initial setting not less than30 minutes

 

- **Initial setting time:** it is defined as the time elapsed between the moments that the water is added to the cement to the moment which cement paste starts losing its plasticity. Normally a minimum 30 minute is given for mixing and handling operation of concrete.
- **Final setting time:** it is defined as the time elapsed between the moment at which water is added to cement and the moment at which cement paste loses its plasticity totally.

### 3.1.4 Procedure of initial setting time

1. Take 500 gm of cement sample.
2. Measure a quantity of water equal to 0.85 times of water required to produce cement paste of standard consistency.
3. Add this water to cement and prepare paste in standard manner.
4. Fill the paste in vacate mould within 3-5 minutes.
5. Start the stop watch the moment water is added to the cement.
6. The temperature of water and that of test room at the time of test shall be within $27^0$ c.± $28^0$ c.
7. Lower the initial setting time needle gently and bring it in contact with the surface of test.
8. Release the needle quickly and allow it to penetrate into the test block.

### 3.1.5 Procedure of final setting time

Prepare the test block of cement paste by using same procedure as used for determination of initial setting.

1. Time replace the initial setting time needle by final.
2. Setting time needle

   Lower the needle gently over the surface of the test block. The needle will make an impression with central point as well as outer circular cutting edge.

   Repeat the step no. 3 step after some time again and again. A moment will come when lowering a needle will make an impression of central needle only and not of outer.
3. Circular edge.
4. Note the time and calculate.
5. the time difference between the moment of addition of water and the moment at which situation stated in step arises. The time difference is final setting time.

**Table No. 3.1: Initial and Final setting time**

| Time | Penetration from bottom |
|---|---|
| 5 min. | 0 mm |
| 10 min. | 1 mm |
| 15 min. | 1 mm |
| 20 min. | 1 mm |
| 25 min. | 1 mm |
| 30 min. | 2 mm |
| 40 min. | 4 mm |

Compressive strength of fly ash brick is three times greater than the normal clay brick. The minimum compressive strength of clay brick is 3.5 N/mm².So as the fly ash brick has compressive strength of 10-12 N/mm². Bricks to be used for different works should not have compressive strength less than as mentioned above. The universal testing machine is used for testing the compressive strength of bricks.

After the curing period gets over bricks are kept for testing. To test the specimens the bricks are placed in the calibrated Compression testing machine of capacity 3000 kN applied a load uniform at the rate of 2.9 kN/min. The load at failure is the maximum load at which specimen fails to produce any further increase in the indicator reading on the testing machine. In that three numbers of bricks were tested for each mix proportion. Each brick may give different strength. Hence, average of three bricks was taken.

**Table No. 3.2: Compressive Strength of Ordinary Portland cement**

| Sr. No. | Observation | Ordinary ($n/mm^2$) |
|---|---|---|
| a | 24 h ± 30 min., not less than | - |
| b | 72 h ± 1 h, not less than | **16** |
| c | 168 ± 2 h, not less than | **22** |
| d | 672 ± 4 h, not less than | - |

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Calculation for the specific gravity and water absorption for the given aggregate sample:

**Polystyrene**

| Proto name | Value |
|---|---|
| Technical Name | Polystyrene (PS) |
| Chemical Formula | (C8H8) N |
| Melt Temperature | 210-249 °C (410-480 °F) |
| Typical Injection Moulding Temperature | 38 - 66 °C (100 - 150 °F) |
| Heat Deflection Temperature (HDT) | 95 °C (284 °F) at 0.46 MPa (66 PSI) |
| Tensile Strength | 53 MPa (7700 PSI) |
| Flexural Strength | 83 MPa (12000 PSI) |

## 4. STRENGTH AND WEAKNESS

- Its weight more than concrete by using Polystyrene.
- It required more cost for transportation and handling as compared to light weight concrete.
- It has costlier as compared to polystyrene.
- Vibration is required for compaction.
- Dead load of member is higher than polystyrene concrete member which affect to overall structure.
- When dead load is high then settlement of the structure is happened.
- Standard concrete has high weight so load on foundation is high so reinforcement is required more as compared to light weight concrete.
- Standard concrete plates are costlier because material used in it is costlier as compared to polystyrene concrete. Standard concrete plates only used for toilet block.
- In standard concrete material used is sand and sand is coming from river is affected on environment.
- It is affected to environment.

## 5. BENEFIT COST STUDIES - FEASBILITY STUDIES

- Improved structure efficiency in terms of strength / weight ratio resulting load reaction on the structure and substructure fewer structural components resulting in more usable space in the structure a reduction flexibility in absorbing strains and improved thermal properties minimizing the effects of different cell temperature resulting in building energy conservation as well as improved higher spelling mitigation.
- It is ideally suited for precast concrete product as larger units can be handled with the same handling equipment of manually for same units, resulting in speed and economy in construction. These units in addition to smaller one's cane be lifted or managed by downsizing machinery resulting in reducing site carnage, requirement & mixing the no of

 

concrete element on trucks without exceeding highway load limits reducing transportation cost.

## 6. RESULTS AND DISCUSSIONS

Relationship between the compressive strength development and curing period for all the concrete series that have employed. The designation for each block is.

## 7. CONCLUSIONS

After studying research paper and various books. I conclude that the harmful effects of west polystyrenes on environment is reduced by using west polystyrenes in the construction purposes. 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 get 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 trap 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/mm. 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.

However, comparison between size of polystyrene used, using the pozzolan i.e., PFA gave the more significant influence in term of strength development. It is shown between block 3 with other block using 10 mm gave a difference of strength reduction about 6% compared to block 3 using 10 square mm polystyrene. On the other hand, comparison of PFA replacements shows that block 4 gave lower strength compared to block 5 of 10%.

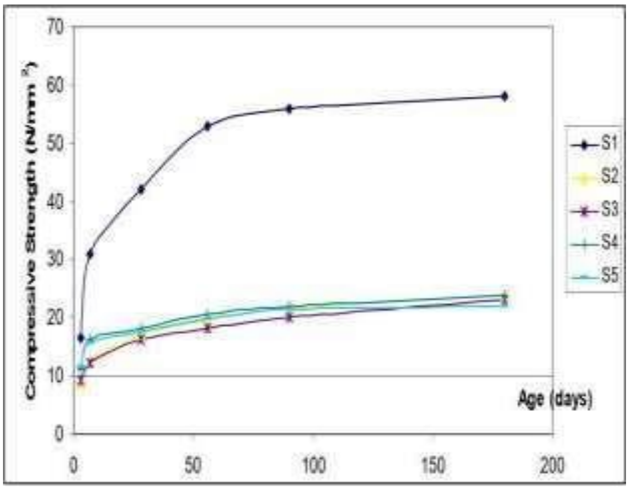


Figure 2: Compressive strength development of different series of

The problem relegated to waste polystyrene can be solved by using of polystyrene in concrete. This polystyrene concrete panels can be used for toilet block, partition wall, compound wall etc. If there is modular concrete of M15 grade it gives 15 N/mm.

Compressive strength but polystyrene concrete gives 6.18 N/mm strength. In modular concrete panel bock of size weight should be 155.0 kg and same of polystyrene concrete panel is 62.50 kg. The total cost of modular concrete block is Rs. 20000/- and that of polystyrene concrete Rs. 7000/ Only. The long-term behavior of polystyrene concrete is about similar to control concrete in any curing period. The light weight concrete concept can be implemented by using this type of precast polystyrene concrete panels and also this type of concrete is eco-friendly.

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