INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact Factor: 6.078
(Volume 7, Issue 3 - V7I3-1311)
Available online at: https://www.ijariit.com

Sustainable toilets by using lightweight precast concrete panels

Shinde Bhagyashri Vasant
bvshinde93@gmail.com
Imperial College of Engineering and Research, Pune, Maharashtra

N. V. Khadake
drnvk1960@gmail.com
Imperial College of Engineering and Research, Pune, Maharashtra

ABSTRACT

The objective of this project is to designing and managing a self-sustaining toilet for implementation in rural areas of India, the toilet will be built out of low cost and readily accessible materials and require little to no water, no electricity, and minimum maintenance cost and management. I work for reducing the total cost of the toilet and making the proper management of sanitization in rural area. Cast in-situ construction is time taking process as comparing to precast concrete panel construction so precast concrete panels are very useful for time saving and overall cost reduction of toilet construction.

Keywords— *Precast Concrete Panel, Light Weight Concrete, Cost Reduction, Setting Time, Time Management*

1. INTRODUCTION

This case study of the sustainability of rural sanitation marketing is part of a wider activity entitled "Total Sanitation and Sanitation management (TSSM): New Approaches to Stimulate and Scale Up Sanitation Demand and Supply Project," also known as the Global Scaling Up Sanitation Project. Th e long-term vision for this eff ort is to help a number of developing countries meet the basic sanitation needs of the rural poor who do not currently have access to safe and hygienic sanitation. TSSM tests proven and promising approaches to create demand for sanitation and improve the supply of sanitation-related products and services to increase household access to safe and sustainable sanitation; create open-defecation free communities; and promote improved hygiene practices.

Conventional in-situ method in construction industry is one of the contributing factors to the deterioration on the quality of surrounding environment. Construction waste and debris pollute the environment with the emission of dust particle in the air, soil waste silting into drainage system, and disposal of large volume of waste product. Off-site method which produce less wastage of material, reduce site activities and shorter construction period is seen as a greener and environmentally sustainable approach to the construction industry.

According to IBS One Stop Centre of CIDB, in-situ concrete is preferred compared to pre-cast concrete for toilet construction due to its rigidity and monolithic casting. Unlike in-situ reinforced concrete, pre-cast concrete structure is not rigid and not monolithically cast. The joints between pre-cast concrete components and the cold joints between pre-cast concrete and in-situ concrete topping are prone to cracks due to the building movement from the live load, dead load and lateral force.

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.

- For making a proper management of construction and cost reduction of precast concrete panel.
- Reduce the total cost and time of construction of toilet.
- To make the designing and fabrication of toilet easy and accessible in the village.

3. RESEARCH METHODOLOGY

3.1 Introduction of material used:

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.

3.1.1 Cement Concrete: 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.

3.1.2 Composition of Portland cement: The principal raw materials used in the manufacturing of cement are:

- Argillaceous or silicates of alumina in the form of clays and shale.
- Calcareous or calcium carbonate.

Table 1: Chemical Constituents of Portland cement

Chemical constituents	Percentage
Lime (CaO)	60 to 67%
Silica (SiO_2)	17 to 25%
Alumina (Al_2O_3)	3 to 8%
Iron oxide (Fe_2O_3)	0.5 to 6%
Magnesia (MgO)	0.1 to 4%
Sulphur trioxide (SO_3)	1 to 3%
Soda and/or potash ($Na_2O + K_2O$)	0.5 to 1.3%

Ref: International Journal of Research in Advent Technology, Vishwa on 16, 19 March 2016

3.1.3 Ordinary Portland cement: 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. 4031-1988. [5] If the 28 days strength is not less than 33 N/mm^2 it is called 33grade cement, if the strength is not less than 43N/mm^2 it is called 43grade cement, and if the strength is not less than 53 N/mm^2, it is called 53 grade cement. But the actual strength obtained by these cements at the factory is much higher than the BIS specifications.

3.2 Test on Cement

3.2.1 Standard Consistency: Objective of test: To ascertain % of water content to have sufficient consistency is within standard limits. (30-33%)

3.2.2 Setting Time: The setting time of the cements, when tested by vacate apparatus method shall conform to the following requirement are given in table 3.2 [7]

Table 2: Setting time of ordinary Portland cement

Sr. No.	Observation	Ordinary
(a)	Initial setting time in minutes, not less than	30
(b)	Final setting time in minutes, Not more than	600

Ref: International Journal of Scientific Engineering and Technology Research, Vol.05 Issue 07, March – 2016

Objective of test: To check cement is confirming standard requirement of setting time i.e. Initial setting not less than 30 minutes Final setting not greater than 600 minutes.

3.3 Mix Design

M_{15} standard concrete mix design

(a) Type of cement- OPC 53 grade
(b) Max. size of aggregate- 10MM
(c) Exposure condition sever- mild
(d) Workability – 0.90 C.F.
(e) Min. cement content- 220 kg/m^3
(f) Max. cement & water ratio- 0.60
(g) Degree of saturation- good
(h) Type of aggregate- crushed angular aggregate
(i) Specific gravity of course aggregate- 2.76
(j) Specific gravity of fine aggregate- 2.79
(k) Water absorption of course aggregate & fine aggregate - 0.5% &1%
(l) Free surface moisture of course aggregate & fine aggregate – Nil
(m) Gravity of fine aggregate confirming the grading zone

Target Strength = 15 + 1.65 x 3.5 = 20.77 N/MM^2

3.4 Proposed Design, Modification, Development and the Optimization:

- Generally, the precast concrete panel are manufactured by using cement, sand and aggregate.
- In our project we are constructing the precast light weight concrete panel using polystyrene of M^{15}
- In this concrete we are replace the course aggregate 70% by polystyrene and natural sand by crush sand.
- This proportion of concrete gives the good strength at lowest cost as compared to standard concrete.
- The different proportion of concrete are taken and strength of that particular perpetration of concrete are taken using CTM machine.

4. ADVANTAGES AND DISADVANTAGES

In-situ Toilet-Advantages	Pre-fab Toilet-Advantages
• Monolithic casting of concrete and pipe penetration. • Flexible design. • Rely on readily available trades. • Suitable for any size and shape of toilet. • Easy to renovate. • Open system and competitive tendering.	• Standard modular design. Works are done in factory. Reduce site activities and construction period. • Less trade involves. • Better quality control. • Better testing method in factory. Sustainable construction, • improved material management and reduces wastages. Coordinated design and services in factory. • Reduced error.
In-situ toilet: Disadvantages	**Pre-fab Toilet-Disadvantages**
• All works are done on site. Involves many trades Quality of work depends on workmanship. • Need proper supervision to reduce error. • Longer construction period to follow work sequence. Accessible for maintenance. Testing on site. • Wastage of material	• Rigid design and inflexible for renovation. • Restriction in size to suit manufacturing and transportation. • Proprietary system, less competitive during tendering. Costly repair work. • Preformed opening for services. Not monolithic.

5. 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 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.

6. CONCLUSIONS

The problem relegated to waste polystyrene can be solved by using of polystyrene in concrete. This polystyrene concrete panel can be used for toilet block, partition wall, compound wall etc. If there is modular concrete of M15 grade it gives 15 N/mm^2 compressive strength but polystyrene concrete gives 6.18 N/mm^2 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.

7. REFERENCES

[1] Aman Mulla[1], Amol Shelake[2] "Lightweight Expanded Polystyrene Beads Concrete" International Journal of Research in Advent Technology, Vishwa on 16, 19 March 2016.

[2] A.M. Neville properties of cement the pitman London (1981)

[3] Ben Saba and Rashia Sri Ravindra rajah "Engineering Properties of Lightweight Concrete Containing Crushed Expanded.

[4] "Polystyrene-waste" Materials Research Society, 1997 Fall Meeting Symposium MM: Advances in Materials for Cementitious Composites December 1-3, 1997, Boston, USA.

[5] BS EN 12504-4. 2004. Testing concrete. Part 4: Determination of ultrasonic pulse velocity.

[6] Cement and Concrete Association curing concrete London (1978)

[7] Dr. G. Elangovan Dean "Experimental Study on Light Weight Concrete by Partial Replacement of Fine Aggregate Using Fly Ash and Adding Thermocol" International Journal on Engineering Technology and Sciences, Volume II, Issue IX, September.

[8] MD. SUBHAN "Experimental Study of Light Weight Aggregate Concrete" International Journal of Scientific Engineering and Technology Research, Vol.05 Issue 07, March – 2016.

[9] M. H. Ahmad*, L. Y. Loon, R. C. Omar, "Mix Design of Styrofoam Concrete" ICCBT, June 2008.

[10] Roshan Gawale[1] , Shubham Mishra[2] , Harshal Sambare[3] , Jidhnesh Kothari[4] , Assistant Prof. Mohali Patil[5] "LIGHT WEIGHT COCRETE BY USING EPS BEADS" International Journal of Innovative Research in Science and Engineering, Vol.02 Issue 03, March – 2016.

[11] Sabaa, B. and R. S. Ravindra rajah, 1997. Engineering properties of lightweight concrete containing crushed expanded polystyrene waste.

[12] Zaher Kuhail "Polystyrene Lightweight Concrete (Polyconcrete)" An-Najah Univ. J. Res.,Vol. 15, 18/7/2001

[13] https://www.youtube.com/watch?v=j3j6azOz6x0https://www.youtube.com/watch?v=JgrlEiGK0DM, www.sciencedirect.com

