Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 1, No. 2, January : 2024

FLOATING CONCRETE AMENDED WITH EXPANDED POLYSTYRENE BEADS AND PP FIBER

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Abstract

By totally replacing coarse aggregate in concrete with expanded polystyrene (EPS) beads, we produced a novel structural light weight concrete. Since at least the 1950s, expanded polystyrene (EPS) has been employed in technical applications. Light weight non-structural concrete with unit weights ranging from 950 kg/m3 to 1350 kg/m3 is made from expanded polystyrene waste in granular form as light weight aggregate. The findings of an experimental examination of the engineering characteristics of polystyrene aggregate concrete changing in density, such as compressive strength, modulus of elasticity, drying shrinkage, and creep, are presented in this work. Water/cement ratio, polystyrene/cement ratio, cement content, maturity, compaction, fire, and resistance are all factors to consider. A process for creating EPS low weight concrete mixtures is provided at the conclusion of the research.

The goal is to compare the compressive strength of traditional concrete to lightweight concrete containing 30% off flyash and expanded polystyrene, as specified by IS code 10262-2009.

The influence of expanded polystyrene in lightweight concrete on compressive strength was investigated. The EPS in the cube is 0.8 percent, 1.6 percent, and 2.4 percent. According to the results of the experiment, the 2.4 percent EPS beads sample has a higher compressive strength than the other samples, with compressive strengths of 6.6 and 8.8 for 7 and 28 days, respectively.

Keywords: flyash , polystyrene , coarse aggregate , lightweight concrete

Introduction

Since its invention more than a century ago, concrete has been a mainstay of building. For its versatility, it has grown more vital than lumber or steel, and is chosen over the latter. A concrete is formed when cement, coarse aggregate, fine aggregate, and water are mixed together in the right proportions. It is widely accepted that the longevity of concrete in service is more important than its strength when determining the quality of concrete. This progress in technology presents a challenge to humanity to investigate new methods to enhance concrete. In terms of concrete's strength and bonding, aggregate is a key constituent. It is generally accepted that 2.4 or higher apparent specific gravity aggregates are used in concrete. In addition to their particle form, aggregates may be further classified as rounded irregular, angular and flaky and granular rough, crystalline and honey, combed and porous aggregates. The density of the concrete is roughly 2400kg/m3 because of the density of the aggregate. Because of the lower shipping, handling, and constructability costs, reducing the density of the concrete allows for more cost-effective construction. Incorporating a lightweight aggregate and an air entraining agent into concrete is one way to reduce its weight. The use of lightweight aggregate and air entrainment agent in the concrete results in reduced dead weight, quicker construction, and cheaper transportation and handling costs.

Figure 1 Lightweight Exterior wall panel

Objective Of the Study

1. To understand the Lightweight concrete and level of application in construction industry.
2. To compare the strength and density of LWC with normal concrete.
3. To know the effect of PP Fiber on LWC
4. To determine the optimum percentage of EPS Beads.

Advantages of LWC

Because of the massive damage caused by previous earthquakes, many areas of India are clearly seismically susceptible. There has been a lot of concern about the safety of buildings and homes in India because of the dangers posed by earthquakes. A lack of structural integrity caused brick or masonry structures to be rendered uninhabitable by earthquakes of even lesser magnitudes in the past. If you want to build a building that can withstand earthquakes, it has to be lightweight and strong, but it also needs to be flexible. For mass housing demands and occupant safety, novel techniques and materials must be used for advances in manufacturing and construction technology.. Modern steel framing techniques for residential construction make use of cold-formed steel sections and lightweight steel sections. For residential construction in India, steel-concrete composite construction has the ability to improve building performance owing to the complexity of the analysis and design.

The use of fibres in concrete started in highly industrialised nations in the early 1960s. FRC construction and the types of fibres used have developed dramatically over the last five decades, and their employment has risen significantly. Numerous studies have been conducted on how to improve the mechanical characteristics of concrete by adopting random fibre dispersion.

Literature

Roshan Peter et al. (2016) conducted various experimental studies on lightweight aggregates for floating concrete structures. In this experiment, they attempted to investigate the mechanical properties of an M20 lightweight concrete using pumice stone as a partial replacement for coarse aggregates and mineral additives such as silica fume with as a control mixture, the compression strength study was prepared for six series. Each set consists of 3 cubes. The optimal 7 days Compressive strength was

obtained in the range of 5% silica powder for different replacement of coarse aggregate with pumice Stone for 10%, 20%, 30%, 40% and 50%. A comparison of the compressive strength can lead to the conclusion that any structure can be built with 50% pumice coarse aggregate replacement with the addition of 5% silica vapor.
Jay Bankim Shah et al. (2015) concluded that the costs, compressive strength and tensile strength gradually decrease with the increase of BPA in concrete blocks. Adding plastic balls to concrete blocks with EPS increases compressive strength, but it also gradually increases costs. The use of EPS and plastic beads in appropriate amounts leads to good compression strength and rising costs are not important. This can be an effective form of eliminating and using EPS Plastic beads which are waste from many ndustries.
Hemant k. Sarje et al. (2014) studied the technique of growing lightweight concrete. His study focuses on demonstration on compression, water absorption. Low thermal conductivity and low density are the main advantages of lightness. Concrete, which minimizes the permanent load and the construction costs by mixing fly ash and air entraining agents such Protein-based Kemelit foaming agent.
Thomas Tamut et al. (2014) studied the partial replacement of polystyrene spheres in concrete and also examined this properties of lightweight concrete containing EPS spheres, such as compressive and tensile strength & its properties. They have been compared to traditional concrete properties. In 28 days, the compressive strength was 5%, 10%, 15%, 20%, 25% and 30% of the strength of the EPS-based concrete were 91%, 77%, 57% and 45% respectively with normal cement. On this basis, they were stretched by increasing the pearl content of EPS in concrete mixes, the compressive and tensile strength of concrete. Without fasteners, EPS concrete has good workability and can be light compacted and improved processing by increasing the content of EPS accounts. The replacement with EPS had a positive impact. The use in the construction of non-structural elements as an alternative material and is also the solution for the elimination of EPS.
Abhijit Mandlik et al. (2013) used EPS beads to examine lightweight concrete. It is suitable for different areas like bridges, low temperature walls, repairs to wooden floors of old buildings, floating docks etc. So we can see that the EPS concrete costs are lower than with conventional concrete. Increased EPS pearl content in concrete mixes decreases the tensile strength of concrete. He noted that the exchange of EPS was a good use in building non-structural structures. The Elements as an alternative material serves as a solution for the best EPS layout. EPS concrete can be made without binder and can be easily compacted.
Roshan Gawale et al. (2016) examined some of the problematic claims that currently produce millions of tons of polystyrene waste around the world. This ultimately leads to pollution and damage to the ecosystem. In a day to day there is an increase in nationally and internationally
environmental regulations that Rayees Ahmad Ganie (2017) studied the production of floating concrete with pumice, foaming agent and thermacol. He It also examined the influence of aggregate types and amounts on the compressive strength of concrete. It was also produced strength which was determined by using five light-weight concrete.

Materials Used

1) Cement

Using cement as a binder is an essential part of every building project, since it hardens, sets, and bonds with other materials. Sand and gravel (aggregate) are usually bound together with cement, rather than cement being used on its own. "Mortar for masonry is made from cement mixed with fine aggregate, whereas concrete is made from cement mixed with sand and gravel."
Portland Cement 53 Grade from Ultra Tech Company was used in the research since it is readily available in the local market.

For physical and chemical criteria, the cement bought was tested in accordance with IS: 169-1989 and IS: 4032-1988, respectively. Table 1 lists the cement's physical qualities.

Figure 2 Stacking of Ultratech Cement in warehouse

Table-1 Properties of cement

S.NO.	Properties	Test result	IS:169-1989
1	Normal consistency	0.32	
2	Initial setting time	50min	Minimum of 30min
3	Final setting time	320min	Maximum of 600min
4	Specific gravity	3.14	
5	Compressive strength		
	3days strength	29.2 Mpa	Minimum of 27Mpa
	7days strength	44.6 Mpa	Minimum of 40Mpa
	28days strength	56.6 Mpa	Minimum of 53Mpa

2) Coarse Sand

Fine Washed Sand is our concrete sand that is finer than Coarse Sand, which is washed and screened to a greater grit size (masonry sand). Ready-mixed concrete is made by mixing coarse sand with other ingredients including aggregate, water, and cement. In terms of particle size, the fineness modulus ranges from 3.7-9.1 m. Concrete is not strengthened by sand. It aids in the re-calibration of one's strength. The porosity of concrete may be reduced by adding sand to the mix. This reduces the concrete's void volume. As a result, the likelihood of it developing fractures is decreased. Adding sand to concrete enhances the permeability of the material. To prevent fractures from forming, it allows the concrete's gases and heat to exit equally and without building up pressure.

Minerals and finely split stony debris make up the majority of natural sand's composition. Because of its chemical inertness and high hardness, quartz is the most prevalent type of silica (silicon dioxide, or SiO2) and hence the most frequent sand ingredient. Since it is a fine aggregate in concrete, it is employed The experiment employed river sand that was readily accessible in the local market. In compliance with IS: 2386-1963, the aggregate was evaluated for physical specifications such as gradation, fineness modulus, and specific gravity.The sand was surface dried before use

Figure 3 Coarse sand of Zone II

3) Poly Propylene Fiber

There are a wide variety of fibres available for use in the building sector. Steel fibres, glass fibres, and polypropylene fibres are the most prevalent forms of fibres. Concrete may vary these usages for a variety of reasons. Fibers are chosen based on factors such as cost, availability, and efficacy. The employment of special fibres such as carbon and Kevlar as well as natural fibres, mineral fibres, and asbestos fibres in hostile environments is possible. In order to get the desired behaviour and qualities for a concrete, fibres are used in a variety of ways, depending on what the concrete needs. In terms of fibre shape, there are a plethora of options ranging from hooked ends to deformed fibres and wires to fibre mesh and wave-cut fibres to giant end fibres, among others. For example, various fibres are utilised in the building of various constructions, including as

1. Steel fiber.
2. Glass fiber.
3. Polypropylene fiber.

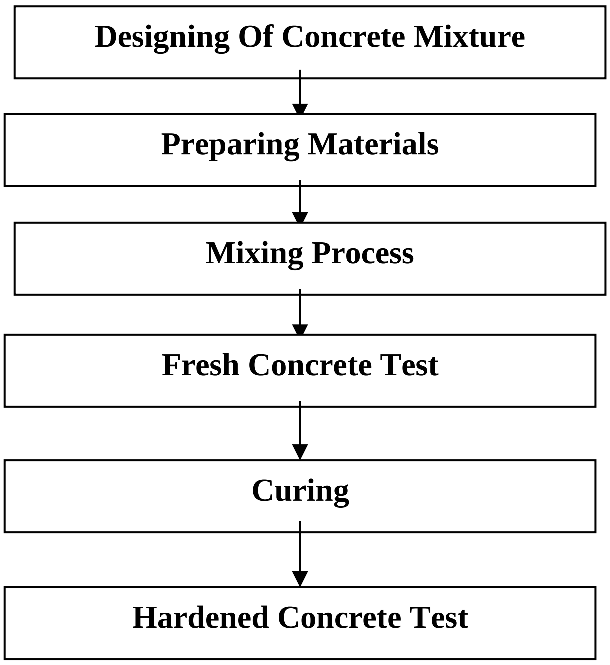
Figure 4 Poly Propylene fiber of dia 24 mm

4) Expanded polystyrene foam (EPS Beads)

Lightweight EPS concrete is available. EPS beads of various sizes and polyamide-66 threads were used to create a novel lightweight concrete in this research. From our prior research, which was touted as a unique lightweight concrete, we acquired some of the outcomes. Researchers found that the strongest adhesion is reduced when the biggest EPS beads dissolve along the contact zone of the surface being tested.

Figure 5 EPS Beads Used in concrete

Methodology



Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 1, No. 2, January : 2024

Test Results

Mix Group	Mix Id	Mix Specification	Initial Flow in mm	60 min	120 Min	180 Min
M1	**T_1**	**C300FA200EPS4PP0.9**	**650**	**610**	**580**	**500**
M2	**T_2**	**C300FA200EPS8PP0.9**	**710**	**670**	**620**	**580**
M3	**T_3**	**C270FA150EPS12PP0.9**	**760**	**715**	**670**	**610**
M4	**T_4**	**C270FA150EPS12PP0**	**780**	**730**	**700**	**640**

Table 2 Results of Flow Test of lightweight concrete at different intervals

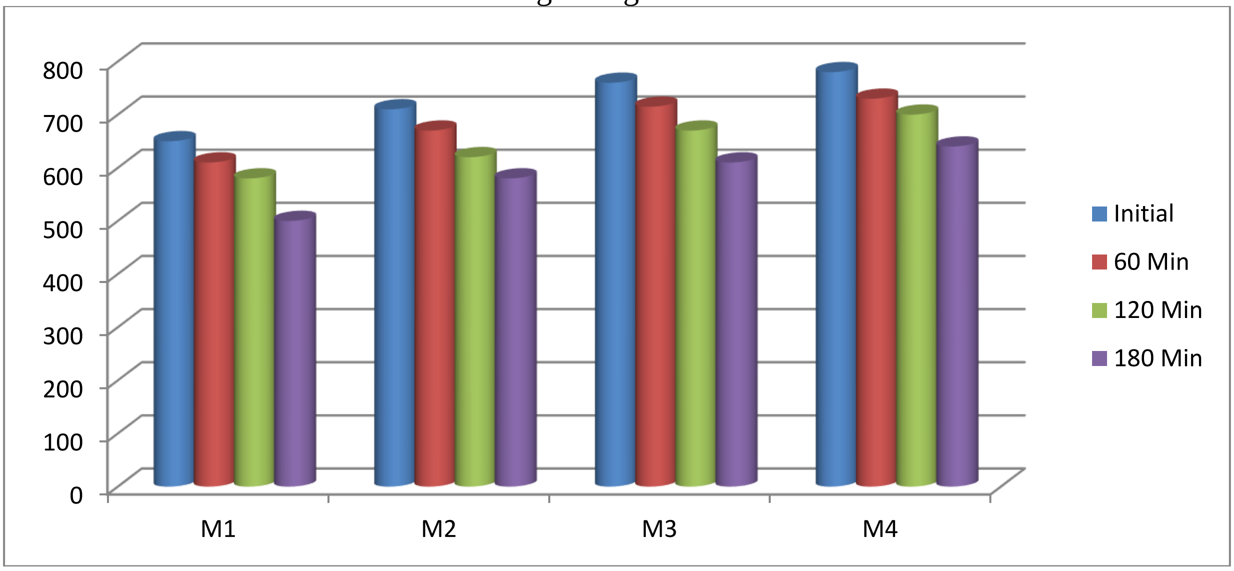


Figure 6 Comparison graph between all three trial mixes

Conclusion

It has been shown that the EPS beads-based lightweight concrete may be used to build partition walls, footpaths and parapet walls as an alternative building material.

Poor-density mixtures have low strength from lightweight concrete made with EPS beads. The Air entraining additive generated an increase in voids throughout the sample. As a result, concrete's compressive strength is decreasing.

Concrete's compressive strength and density rise in direct proportion to the amount of coarse sand and EPS beads in the mix, and vice versa.

Adding 1.5 percent Polypropylene fibre to concrete results in an increase in the concrete's tensile strength.

The flow of concrete rises and the density falls with the use of EPS Beads.
In light-weight concrete, polypropylene fibre (PP) reduces flow.

References

[1] Okamura H., and Ouchi M., (2003), 'Self-Compacting Concrete', Journal of Advanced Concrete Technology, Vol.1, No. 1, pp.(5-15). American Journal of Civil Engineering 2013; 1(3): 102-110 109
[2] European Project Group, (2005), 'The European Guidelines for Self-Compacting Concrete: Specification, Production and Use', pp.63.
[3] Hodws D.W., Sheinn A.M., Ng C.C., lim W.B., and Tam C.T., (2001), 'Self-compaction concrete for Singapore', 26th Conference on Our World in Concrete and Structures., 26-28 August, 2001, Singapore.
[4] Collepardi M., (2006), 'Main ingredients and basic principles for SCC production', Department of Applied Physical Chemistry, Politecnico of Milan, Italy.
[5] Okamura H., and Ozawa K., (1995), 'Mix design for self-compacting concrete', Concrete Library of JSCE, No.25, pp.(107-120).
[6] Grunewald S., and Walraven J.C., (2009), 'Transporting fibers as reinforcement in self-compacting concrete', HERON, Vol. 54, No. 2/3, pp.(101-126).
[7] Gencel O., Brostow W., Datashvili T., and Thedford M., (2011), 'Workability and mechanical performance of steel fiber-reinforced self-compacting concrete with fly ash', Bartin University, Turkey
[8] Tadepalli P., Mo Y., Hsu T., and Vogel J., (2009), 'Mechanical properties of steel fiber reinforced concrete beams', ASCE Structures Congress, pp.(1039-1048).
[9] Vikan H., (2007), 'State of the art report on Concrete workability and fiber content', SINTEF Building and Infrastructure ,COIN – Concrete Innovation Centre, Norway, pp.(1-38), www.sintef.no./coin
[10] ACI Committee 544.5R, (2010), 'Report on the Physical Properties and Durability of Fiber-Reinforced Concrete', American Concrete Institute.