International Journal of Research in Engineering, Science and Management
Volume-2, Issue-4, April-2019
www.ijresm.com | ISSN (Online): 2581-5792

A Study on Foamed Concrete with Silica Fume and Polypropylene Fibers

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***Abstract*: This paper deals with the study of foamed concrete with silica fume and polypropylene fibers. The increase in demand for structures which are light in weight, the usage of foamed concrete in structural applications are steadily increasing by researcher and industrialist. Lightweight foamed concrete (LFC) is normally created from mixing stable foam to cement paste or mortar. To increase its strength various methods are carrying out. In this the properties and advantage of foamed concrete in addition with silica fume and polypropylene fibers are studied.**

***Keywords*: foamed concrete, fly ash, silica fume, polypropylene fibers.**

1. Introduction

Reducing the self-weight of a structure is undoubtedly considered an advantage in construction if not a necessity in some cases. In order to that using lightweight concrete is one way of the best way of achieving such reduction. Foamed concrete is one type of light weight concrete which created a uniform distribution of air bubbles throughout the mass of concrete. It is mainly produced by combination of preformed foam into cement paste or mortar. The main advantage of this material is the ease of production that makes it possible to produce this concrete at any location with relatively simple and inexpensive materials and equipment.

It is commonly made by two different methods. Method 1 consists of mixing a preformed foam (surfactant) or mix-foaming agents into the cement and water slurry. As the concrete hardens, the bubbles disintegrate, leaving air voids of similar sizes. Method 2, known as autoclaved aerated concrete (AAC), consists of a mix of lime, sand (or fly ash), cement, water, and an expansion agent (aluminum powder) that is poured into a mold. The reaction between the aluminum powder and cement causes microscopic hydrogen bubbles to form, increasing the concrete to about five times its original volume.

The applications of foamed concrete have previously been non-structural and made use of the aesthetic, thermal, fire-resistant and void filling properties. Its properties make lightweight foamed concrete an ideal building material for residential building construction, thus the material is now being developed into a building material for structural applications. Unlike the normal concrete the foamed concrete doesn't need any compaction or vibration. Foam concrete is already demonstrated its superior performances with its greater technical, economic, environmental friendly advantages with its unique characteristics compare to normal concrete and other building materials in many areas of construction and civil engineering applications. Foam concrete can be produced over wide range densities from 400kg/m3 to 1600kg/m3 according to its applications.

A. Advantages of Cellular Lightweight Concrete Blocks:

Cost and Time Effective:

1. Savings in handling and transportation costs.
2. Great savings in foundation and structural costs due to decrease in dead load
3. Possibility of additional floors on old structures
4. CLC blocks are seven times the size of traditional bricks. This result in substantial savings in Cement due to fewer joints compared to brick work and finished plaster work.
5. CLC blocks are factory finished with precise edges & shapes, this result in economical POP or Putty finish and much reduced plaster cost.
6. Due to light weight and low density, overall dead load reduces, thus saving structural steel consumption compared to conventional masonry.
7. There is increase in carpet area by 3 to 5% depending on design.
8. Operating cost savings can be realized through reduction in maintenance, energy bills and insurance.
9. Faster construction using aac blocks gives higher work productivity

High Thermal Insulation:

1. Due to the numerous micropores in CLC, it has a very low thermal conductivity and makes an excellent thermal insulation material.
2. It keeps interiors cooler in summer and warmer in winters.
3. Due to reduced cooling/heating loads, it reduces air conditioning/heating loads by as much as 25-30%.
4. Thus you can use a 2-ton AC in place of a 2.5-ton AC and save on the capital costs of the AC.
5. Due to reduced operational loads, it saves on electricity bills and conserves nation's fuel and environment.
6. Air voids, if smaller than 2mm each, consequently

increase thermal insulation substantially.

7. Normal aggregate concrete has a specific thermal conductivity (Lambda) of 2.1 W/mk.

Fire Resistance:

1. CLC blocks are non-combustible and have a melting point of approximately 1500 degrees Centigrade, much higher than other building materials.
2. No toxic fumes are generated during a fire and thus save precious lives during a fire.

Acoustic Insulation:

1. CLC blocks have natural acoustic insulation due to its aerated structure and have superior sound absorption properties in comparison with other materials. It reduces outdoor noise pollution and also saves costs by reducing costs of noise and echo proofing materials

Environment Friendly:

CLC uses the least amount of energy to produce than any other masonry building material. The manufacturing process is such that negligible gaseous, liquid or solid waste is released into the environment. Moreover, Fly Ash [a waste product during Thermal Power Generation) is the MAJOR raw material consisting 60-70% of the total weight. Thermal Power plant waste is effectively used unlike brick manufacturing which degrades and erodes agricultural land, which is already a precious commodity in a highly populated agro based country like India.

2. High Thermal Insulation
3. Low thermal conductivity
4. Thermal Performances 5 times better than clay bricks & 10 times better than RCC
5. Interiors remain cool in summer and warm in cold wintry day
6. Ideal material for applications in cold storage rooms
7. Up to 37-42db sound reduction based on thickness
8. It is possible to achieve even higher values depending upon the thickness and the plaster.
9. Savings in recurring energy costs in air-conditioning
10. Can fulfill required STC (Sound Transmission Class) rating
11. 1/3rd the density of clay bricks
12. Economic design: savings in cement and steel
13. Enables faster construction
14. Technology is simple and easy to execute
15. Require minimum skilled workforce and unskilled labour
16. Result in faster execution
17. Finished dwellings are weather-proof, thermally comfortable and durable
18. Suitable for Hurricane/ Earthquake – proof constructions
19. Converting and make productive use of industrial waste products
20. Low Maintenance
21. Resistant to insects & pests

Applications of CLC Blocks

1. Residential Constructions.
2. Commercial Constructions.
3. Institutional Constructions.
4. Hotels and Hospitals.
5. Multi-storeyed Constructions.
6. Industrial Constructions.
7. Insulation Purpose.
8. Add on Floors and Extensions.
9. Crafts and Murals

2. Review

Concrete Structures are very popular and widely used for the construction of the residential and industrial building. The major portions of wealth are spent for the construction of these structures and it becomes a key factor of social development. Researchers are very much interested in developing improved technologies for enhanced strength, safety and economy. The addition of silica fume and polypropylene fibers are helps to increase the compressive strength.

A. Effect of Silica Fume and Polypropylene Fiber

The effects of Silica Fume on the compressive strength of foamed concrete with different silica fume volume fractions. It can be seen that silica fume can significantly increase the compressive strength. The extent of increasing strength increases with an increase in amount of SF. The increase in silica fume increases the strength by 50% by comparing with normal foamed concrete. Silica fume can also reduce the weight of foamed concrete blocks. The effect of polypropylene fiber on the compressive strength of EPS concrete with different EPS volume fractions. For normal concretes, polypropylene fiber decrease the compressive strength a little. While for silica fume added foamed concrete, the strength with polypropylene fiber increases. The main reason is that polypropylene fiber restrains the segregation and increases the homogeneity of mix.

B. Water Absorptions

The absorption characteristics of concrete are related to the porosity and affect the durability of concrete. A limit on the initial (30 min) absorption for assessing the concrete quality was defined by Comite Euro. The initial absorption at 30 min, as well as the final absorption. It is found that the foamed concretes show lower absorptions than the corresponding normal concretes. The effect of polypropylene fiber on the absorption at 30 min and the final absorption. It can be seen that the absorption at 30 min, as well as the final absorption, of sample with polypropylene fiber is much higher than that of sample without polypropylene fiber. It indicates that addition of polypropylene fiber in the mixes introduces air into concrete and increases the water absorption.

3. Conclusion

From the test presented in this paper, the following

conclusions can be drawn:

- The silica fume and fly ash combination provides improvement in both strength and workability of foamed concrete.
- The results for mixes investigated in this study showed that higher compressive strength of foamed concrete is attained in higher replacement of silica fume.
- The replacement of higher amount of silica fume also showed that its compressive strength is attained in early stages itself.

Structural lightweight concretes of density of 1370-950 kg/m3 and the corresponding strengths of about 20-40 MPa are successfully developed. The concretes are fabricated via substituting totally or partially coarse and fine aggregates. All of the concretes containing silica fume show good workability and can be easily compacted and finished. Polypropylene fibers effectively restrain the segregation due to forming a network structure in fresh concrete. The slump and slump values decrease with an increase in Silica Fume percentage. The rate of strength development increases with increasing percentage of Silica Fume. The splitting tensile strength increases with an increase in the compressive strength. For a similar mix proportion, polypropylene fiber improves the splitting tensile strength greatly. All of the concretes show a higher shrinkage than that of normal concrete. For a similar mix proportion, the shrinkage at the same curing age increases with the increase of silica fume volume fraction. Also the shrinkage at the same age increases with the increase of Silica Fume volume fraction. For a similar mix proportion, polypropylene fibers improve remarkably the shrinkage resistance property. Also the water absorption value decreases with the increase of Silica fume for the identical volume fraction. For a similar mix proportion, PP fiber increases the water absorption value.

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