Use of Foam Concrete in Construction

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***Abstract*: Foamed concrete possesses characteristics such as high strength-to-weight ratio and low density. Using foamed concrete reduces dead loads on the structure and foundation, contributes to energy conservation, and lowers the labor cost during construction. It also reduces the cost of production and transportation of building components compared to normal concrete and has the potential of being used as a structural Material. This paper provides a review of foamed concrete constituents, fabrication techniques, and properties of foamed concrete. This literature review also aims to provide a comprehensive insight into possible applications of foamed concrete in the construction industry today.**

***Keywords*: compressive strength; fly ash; foam concrete; foam stabilizer; foaming agent; porosity; thermal conductivity, aircrete, light weight cellular concrete.**

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Introduction: -

Foam concrete is a type of concrete that is produced by locking air voids in the mortar with the help of a suitable foaming agent and is classified as lightweight concrete. It has low self-weight, minimum aggregate consumption (no coarse aggregate is used), high fluidity, controlled low strength and thermal insulation [1]. The properties of foam concrete are affected by the production method and the materials used. Unlike other porous lightweight concrete, prefabricated foams with foaming agents are added to fresh cement paste and mortar. The air pores brought by the foams constitute 10–90% by volume of the hardened body. This porous structure forms the basis of the mechanical properties, thermal conductivity, acoustic and durability properties of foam concrete [2]. One of the advantages of foam concrete is its weight reduction (up to 80%) compared to conventional concrete [3]. The air bubbles are evenly distributed in the foam concrete body. The pore structure may be affected during the mixing, transportation and placement of fresh concrete, so it should have fixed walls. Air bubbles range in size from approximately 0.1 to 1 mm [4]. The density of foam concrete is mainly affected by the amount of foam and varies between 400 and 1600 kg/m3. It can be used for structural, partitioning, insulation and filling applications with excellent acoustic/thermal insulation, high fire resistance, lower raw material costs, easier pumping and finally no compaction.

Literature Review: To provide basic data for the reasonable mixing design of the alkali-activated (AA) foamed concrete as a thermal insulation material for a floor heating system, 9 concrete mixes with a targeted dry density less than 400 kg/m3 were tested. Ground granulated blast-furnace slag (GGBS) as a source material was activated by the following two types of alkali activators: 10% Ca(OH)2 and 4% Mg(NO3)2, and 2.5% Ca(OH)2 and 6.5% Na2SiO3. The main test parameters were water-to-binder (W/B) ratio and the substitution level (RFA) of fly ash (FA) for GGBS. Test results revealed that the dry density of AA GGBS foamed concrete was independent of the W/B ratio an RFA, whereas the compressive strength increased with the decrease in W/B ratio and with the increase in RFA up to 15%, beyond which it decreased. The largest reduction percentage was found in the photochemical oxidation potential, being more than 99%. The reduction percentage was 87% - 93% for the global warming potential, 81% - 84% for abiotic depletion, 79% - 84% for

acidification potential, 77% - 85% for eutrophication potential, and 73% - 83% for human toxicity potential. Ultimately, this study proved that the developed AA GGBS foamed concrete has a considerable promise as a sustainable construction material for nonstructural element.

Methodology:-

Portland cement is the most common type of cement in general use around the world as a basic ingredient of concrete mortar, stucco, and non-specialty grout.

Sand: - Sand is a granular material composed of finely divided mineral particles. Sand has various compositions but is defined by its grain size.

Water: - Water is an inorganic compound with the chemical formula H 2O. It is a transparent, tasteless, odorless, and nearly colorless chemical substance

Foaming agent: - Foaming Agent for CLC Bricks is to be diluted in water and then foam is produced in a concrete foam generator with compressed air. Foam produced has very fine and stable high-quality foam. Foaming Agent for CLC Blocks is high quality, produces fine and durable air bubbles

Manufacturing process:-

For manufacturing 1 Cum of CLC bricks approximately 5 Bags of OPC 53 Grade Cement and 500 Keg's of Fly ash is added into a mixer.
Around 1.2 keg's of foaming agent diluted with 30 Liters of water is added and mixed thoroughly
Foaming agent allows airs to entrain the mixture making the slurry light weighted
One liter of slurry is collected from the mixer and weighed for density. If the required density is achieved, then the slurry is drained into trollies.
The slurry is then poured into assembled moulds of bricks of required dimension and is allowed to set for 18 to 24 hours.
Finished CLC bricks are taken to the curing area and are allowed to cure for 28 days. Good curing gives strength and dimensional stability to bricks.
The mixture is pore into assemble moulds of blocks. The foam creates a ball bearing effect due to which the concrete flows easily into all corners of the mould& compacts itself, Does not require any kind of vibration & compaction, Blocks are cured by water curing procedure for 14-28 days.One of the objectives of this paper is to evaluate the effect of replacing the river sand by using m-sand used in foam concrete and to study the flexural strength and structural performances of welded square mesh ferro foam panel. The following are quantity of materials is followed and thus exposed to a series of experiments. 1:1 ratio of cement mortar is selected, and the river sand is replaced by 40% by m-sand based on experiments to get maximum compressive strength.

a) Cement = 784.313 kg
b) River sand = 470.5878 kg
c) cm-sand = 313.7252 kg
d) Water = 313.7252 kg and
e) Foam agent = 117.646kg

Applications of foamed concrete:-

- Due to low density, it is used as filling material for cavities in slabs, concrete pits, etc.
- Light weight foundation can be constructed.
- Wall panels, floor, roofs can be constructed for thermal insulation.
- Employing tilt up construction.

- Production of light weight blocks and precast panels.
- Trench reinstatement.
- Soil stabilization, Earthquake adverse effect resistances, Temperature change negative effects, floor heating systems are some of geotechnical applications.
- It can be effectively used to fill voids of old sewers, water storage tanks, basement ducts.
- Culvert filling, subway infill, tunnel grouting.
- For road sub bases, foam concrete is also used for frost heave in roads, to fill voids in roadways due to heavy rains.
- Acts as shock absorbing barriers for airport and regular traffic.
- Prevention of frost heave in pile caps, shallow piles
- Fire insulation for any structure.

Test Perform: -

Foam concrete, when made with high-quality materials and with appropriate proportioning yields strong structural and service bearing capacity along with enhanced durability, thereby making it necessary to evaluate the hardened properties of concrete. Following are the series of tests carried out:

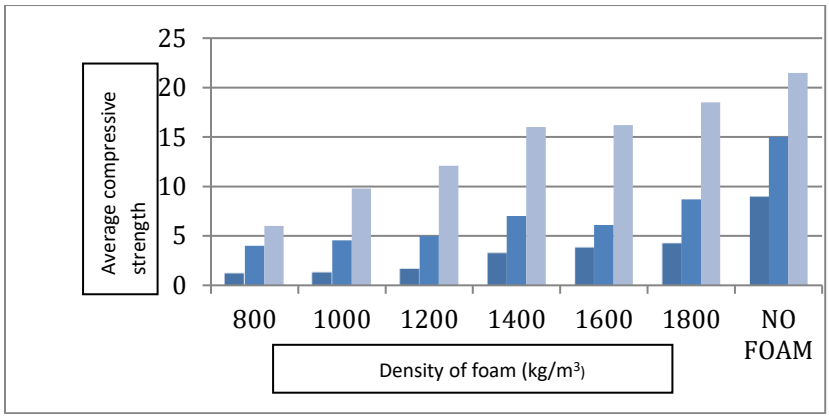
- Compressive strength test on foam concrete
- Water Absorbtion test on foam concrete
- Split tensile strength test on foam concrete
- Flexural strength test on foam concrete
- Flexural strength of beam
- Flexural strength of panel

Results:-

Compressive Strength test:-

Compressive strength is one of the important qualitative characteristic of concrete in relation to its strength. Cube of size 150*150*150 mm are used and tested at 3,7,14, and 28 days of curing in water under controlled laboratory conditions. The samples were tested using hydraulic compression machine. The results thus obtained were

Foam density	Average compressive strength (mpa)		
	3 days	7days	28 days
800	1.2	4	6
1000	1.32	4.56	9.8
1200	1.67	5	12.1
1400	3.25	7	16
1600	3.8	6.1	16.2
1800	4.23	8.7	18.5
NO FOAM	8.91	15	21.5



Compression strength of foam at different ages

From the above results, it is observed that the compressive strength increased by 30% in comparison with control concrete for different ages such as 3,7,14 and 28 days.

Water absorption:

Three full size blocks shall be completely immersed in clean water at room temperature for 24 hours. The blocks shall then be removed from the water and allowed to drain for one minute by placing them on a 10 mm or coarser wire mesh, visible surface water being removed with a damp cloth, the saturated and surface dry blocks immediately weighed. After weighing all blocks shall be dried in a ventilated oven at 100 to 1150C for not less than 24 hours and until two successive weighing at intervals of 2 hours show an increment of loss not greater than 0.2 percent of the last previously determined mass of the specimen.
The water absorption calculates as given below:
Absorption, percent =(A-B)/B * 100
Where,
A=wet mass of unit in kg.
B = dry mass of unit in kg.

Density of foam (kg/m^3)	% of water absorbtion
800	11.87
1000	11.51
1200	11.37
1400	10.96
1600	9.98
1800	8.91
No foam	8.21

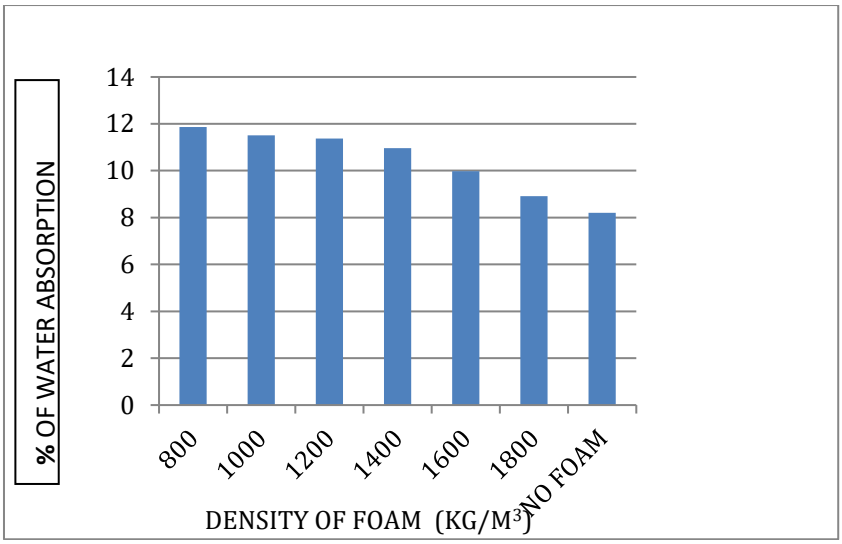


Fig. Variation of water absorbtion with different densities of foam

Conclusion: -

- Based on the test results of the present investigation, the following conclusions are drawn.
- As no coarse aggregate is used it can be used as precast in-situ elements.
- From the test results it can be arrived that at 1200 kg/m3 density, compressive strength, split tensile strength, flexural strength and water absorption is taken as optimum with strengths 12.4 MPa,1.85MPa,2.54MPa and11.37%
- Brick has compressive strength of 3-7Mpa at 1900kg/m3, compared to our results at 1200kg/m3 the strength is 12.36 Mpa which is 50% more than that.
- The water absorption for 1st class brick is 20% but in case of foam concrete at 1200kg/m3 the water absorption is 11.37%.
- By selecting 1200kg/m3 as optimum density we can reduce the density by 40%
- Using the test results, it can be concluded that the percentage of cement content will be reduced to half by using quarry dust so that CO2 emissions from the cement will be reduced .
- Per unit quantity of work,foam concrete is more cost effective besides eco friendly.

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