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CELLULAR LIGHTWEIGHT CONCRETE

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Abstract: -

Cellular Light weight Concrete (CLWC) is not a new invention in concrete world. It has been known since ancient times. It was made using natural aggregates of volcanic origin such as pumice, scoria, etc. The Greeks and the Romans used pumice in building construction. Lightweight concrete can be defined as a type of concrete which includes an expanding agent in that it increases the volume of the mixture while giving additional qualities such as inability and lessened the dead weight. The usage of Cellular Light-weight Concrete (CLC) blocks gives a prospective solution to building construction industry along with environmental preservation.

I. INTRODUCTION

Concrete is most important construction materials. Concrete is a material used in building construction, consisting of a hard, chemically inert particulate substance, known as an aggregate that is bonded together by cement and water.

In upcoming years there has been an increasing worldwide demand for the construction of buildings, roads and an airfield which has mitigate the raw material in concrete like aggregate. In some ruler areas, the huge quantities of aggregate that have already been used means that local materials are no longer available and the deficit has to be made up by importing materials from other place. Therefore, a new direction towards Cellular Lightweight Concrete in building and civil engineering construction is used [1].

Lightweight concrete maintains its large voids and not forming laitance layers or cement films when placed on the wall. This research was based on the performance of aerated lightweight concrete. However, sufficient water cement ratio is vital to produce adequate cohesion between cement and water. Insufficient water can cause lack of cohesion between particles, thus loss in strength of concrete. Likewise, too much water can cause cement to run off aggregate to form laitance layers, subsequently weakens in strength [2].

Light weight concrete - or foamed concrete - is a versatile material which consists primarily of a cement-based mortar mixed with at least 20% of volume air. It possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties. It can have a range of dry densities, typically from 400 kg/m3 to 1600 kg/m3 and a range of compressive strengths, 1 MPa to 15 MPa [3].

II. Literature Review

P.S.Bhandari and Dr.K.M.Tajne: In this research paper they have concluded that the compressive strength for cellular light weight concrete is low for lower density mixture.The performance of cellular lightweight concrete in term of density and compressive strength are investigated.

HjhKamsiahMohd.Ismail,MohamadShazliFathi and NorpadzlihatunbteManaf: In this study paper the main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages, disadvantages and applications were studied thoroughly.

Satyendra Kumar Meena, Pushpendra Kumar Meena, Rakesh Kumar Meena, Rupayan Roy and Pawan Kumar Meena: It was studied that cellular lightweight concrete possesses high flow ability, low self-weight, minimal consumption of aggregate, controlled low strength and excellent thermal insulation properties.It has excellent resistance to water and frost, and provides a high level of both sound and thermal insulation.

K.KrishnaBhavaniSiram: This paper shows that how the cellular concrete can be used as a replacement of burnt clay bricks. An attempt is made to compare cellular lightweight concrete (CLC) Blocks and Clay Bricks, and recommend a replacement material to red brick in construction industry.

III.Cellular concrete

Foamed concrete has a surprisingly long history and was first patented in 1923, mainly for use as an insulation material. The first comprehensive review on foamed concrete was presented by Valore in 1954 and a detailed treatment by Rudnai and Short and Kinniburgh in 1963, summarising the composition, properties and uses of cellular concrete, irrespective of the method of formation of the cell structure.Significant improvements over the past 20 years in production equipment and better quality surfactants (foaming agents) has enabled the use of foamed concrete on a larger scale[3].

Cellular concrete, sometimes referred to as foam concrete, is a lightweight construction material consisting of Portland cement, water, foaming agent and compressed air. The foam is formulated to provide stability and prevent draining of water. Pozzolans such fly ash and fibers are often added to mix to customize compressive and flexural strengths. Cellular concrete typically contains no sand or aggregate [1].

Cellular lightweight concrete is slurry of cement, sand, water, fly ash and preformed stable foam generated by foam generating machine [2]. By trapping air bubbles within the concrete, a lightweight insulating material is formed. It has fireproofing, insulation, sound attenuation and energy absorbing characteristics. Cellular concrete is either cast-in-place or precast; however, most applications call for a cast-in-place material [1].

IV.Constituents of base mix

Ordinary Portland cement, Rapid hardening Portland cement and, high alumina and Calcium Sulfoaluminate have been used for reducing the setting time and to improve the early strength of foam concrete. Fly ash and ground granulated blast furnace slag have been used in the range of 30–70% and 10–50%, respectively and as cement replacement to reduce the cost, enhance consistence of mix and to reduce heat of hydration while contributing towards long term strength.

Silica fume up to 10% by mass of cement has been added to intensify the strength of cement. Alternate fine aggregates, viz., fly ash and lime, chalk and crushed concrete, recycled glass, foundry sand and were used either to reduce the density of foam concrete.

1. Making of cellular lightweight concrete

The components of foam concrete mix should be set by their functional role in order as follows:

a. Foaming agent
b. Binding agent

c. Water
d. Aggregate
e. Admixtures

V. Properties of foam concrete

Fresh state properties: As foam concrete cannot be subjected to compaction or vibration the foam concrete should have flow ability and self-compact ability. These two properties are evaluated in terms of consistency and stability of foam concrete.

1. **Consistency:** Flow time using marsh cone and flow cone spread tests are adopted to assess the consistency of foam concrete. The consistency reduces with an increase in volume of foam in the mix, which may be attributed to the (1) reduced self-weight and greater cohesion resulting from higher air content. (2) Adhesion between the bubbles and solid particles in the mix increases the stiffness of the mix.
2. **Stability:** The stability of foam concrete is the consistency at which the density ratio is nearly one (the measured fresh density/design density), without any segregation and bleeding.

VI. Physical properties

1) Drying shrinkage:Foam concrete possesses high drying shrinkage due to the absence of aggregates, i.e., up to 10 times greater than those observed on normal weight concrete. Autoclaving is reported to reduce the drying shrinkage significantly by 12–50% of that of moist-cured concrete due to a change in mineralogical compositions. The shrinkage of foam concrete reduces with density which is attributed to the lower paste content affecting the shrinkage in lowdensity mixes.
2) Low Density and High Strength: Due to its low density, foam concrete imposes little vertical stress on the substructure - a particularly important attribute in areas sensitive to settlement. Heavier density (1000 kg/m^3+) foam concrete is mainly used for applications where water ingress would be an issue - infilling cellars, or in the construction of roof slabs for example.
3) Compressive strength: The compressive strength decreases exponentially with a reduction in density of foam concrete. The parameters affecting the strength of foam concrete are cement–sand and water–cement ratios, curing regime, type and particle size distribution of sand and type of foaming agent used.For dry density of foam concrete between 500 and 1000 kg/m^3, the compressive strength decreases with an increase in void diameter. For densities higher than 1000 kg/m^3, as the air-voids are far apart to have an influence on the compressive strength, the composition of the paste determines the compressive strength.
4) Flexural and tensile strengths:Splitting tensile strengths of foam concrete are lower than those of equivalent normal weight and lightweight aggregate concrete with higher values observed for mixes with sand than those with fly ash.Use of Polypropylene fibres has been reported to enhance the performance with respect to tensile and flexural strength of foam concrete.

VII. Functional characteristics

1) Fire resistance**:**Foam concrete is extremely fire resistant and well suited to applications where fire is a risk. Test have shown that in addition to prolonged fire protection, the application of intense heat, such as a high energy flame held close to the surface, does not cause the concrete to spall or explode as is the case with normal dense weight concrete.
2) Thermal insulation:Foam concrete has excellent thermal insulating properties due to its cellular microstructure. The thermal conductivity of foam concrete of density 1000 kg/m^3 is reported to be one-sixth the value of typical cement–sand mortar.

VIII. Advantages of Cellular Lightweight Concrete

1) Cellular lightweight concrete does not settle, therefore no compaction.
2) It does not impose large loadings.
3) It is free flowing so spreads to fill all voids.
4) It has excellent load spreading characteristics.

IX. Applications of Cellular Lightweight Concrete

1) Building Blocks : Blocks and panels can be made for partition and load bearing walls. They can be made with almost any dimensions.
2) Floor Screed: Foamed concrete can be used for floor screeds, creating a flat surface on uneven ground and raising floor levels.
3) Roof Insulation**:** Foamed Concrete is used extensively for roof insulation and for making a slope on flat roofs. It has good thermal insulation properties and because it is lightweight foamed concrete does not impose a large loading on the building.
4) Road Sub-Base**:** Foamed Concrete is being used road sub base on a bridge. Foamed concrete is lightweight so that the loading imposed on the bridge is minimised.

X. Conclusion:

It can be concluded that the lightweight concrete has a desirable strength to be an alternative construction material for the industrialized building system. This study has shown that the use of fly ash in foamed concrete, either can greatly improve its properties. The properties of cellular lightweight concrete its advantages, disadvantages and applications were studied thoroughly.

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