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OPTIMIZATION OF FOAM VOLUME IN FOAM CONCRETE

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Abstract - *Foamed concrete has features like high strength-to-weight ratio and low density. Foamed concrete reduces dead loads on the structure and foundation, and also improves energy conservation, and lowers the labour cost during construction. Ultra-lightweight foam concretes are used to have desirable thermal insulation properties, superior fire-resistant and higher durability, to attain energy efficiency in buildings. Also foamed concrete is considered as an economical solution in fabrication of large scale lightweight construction materials and components such as structural members, partitions, filling grades, and road embankment infills due to its ease in its production process from manufacturing plants to final position of the applications. The cost of production and transportation of building components compared to normal concrete is less and also has the potential of being used as a structural material. This paper finds the optimum foam volume of foamed concrete in which the study is limited to using 0.45 water to cement ratio with 1:2 cement to sand ratio and using coarse aggregate only.*

Key Words: **foamed concrete, foam volume, energy conservation**

1. INTRODUCTION

Foam concrete is a cellular concrete of light weight having a density ranging from 400-1850 kg/m^3. Foam concrete possess distinguished properties for its flowability and functionality like acoustic properties, fire- resistance, and thermal insulating properties. Due to its peculiar features i.e., relatively good strength and easily removable nature when required foam concrete can also be used in filling hollow spaces such as cavities, vaults [7]. It should have sufficient flowability and self- compactability as it cannot be subjected to compaction or vibration [3]. Zhoaming Huang et. al. states that ultra- light weight foam concrete(whose density is between 100- 300kg/m^3) can be made using ordinary Portland cement together with fly ash, hydrogen peroxide and chemical admixtures[4]. As a result for foam concrete of any density, ordinary Portland cement can be used. There are two mixing methods namely prefoaming or mix- foaming. Prefoaming or mix- foaming methods can be used to make foam concrete. When considering prefoaming method, a base mix is first produced to which a stable prefoam aqueous foam prepared separately is thoroughly blended to. While in mix- foaming method, the surface active agents along with the base mix ingredients is mixed together and this process of mixing creates a cellular structure in concrete. The method most preferred is the prefoaming method, where a lower foaming agent is required and, the foaming agent and air content formed is related to each other [3].

The strength and stiffness of foam concrete is largely affected by the quantity of foam as it place a major role in the stability of foam concrete. High strength was found as a result of uniform air- void size distribution [6]. The lower volume of foam provides a uniform air- void distribution than a higher volume [2, 3]. The consistency uniformity and stability of the mix determines its water content. When the water content is low, cement tends to absorb the water from the foam resulting in breakage of the bubble. In case of excess water content, segregation occurs during casting [8]. British Cement Association suggests an optimum water / cement ratio that ranges from 0.5- 0.6. When the target density is of 6.5% to 14% the water to cement ratio can be suggested to have a range from 0.4- 1.25 [1, 3]

2. LITERATURE REVIEW

Density and compressive strength was observed to have a direct relationship i.e., the compressive strength is exponentially influenced when the density is reduced. Moreover the sand content becomes ineffective to compressive strength when the sand to cement ratio ranges from 1.0-2.0 [1]. The density found in two phases is fresh density and dry density. On filling and weighing in a pre-weighed container of known volume the fresh density is calculated. The desired and achieved densities are assessed and the variation can reach up to $\pm$100 kg/m^3 [1]. This method is found in BS EN 12350: Part 6: 2000[1]. Though fresh density is used for casting purpose, a number of physical properties depend on dry density [3]. The properties of foam concrete are affected by the type of filler material. A narrower air- void distribution is created when the filler material is finer thereby increasing the compressive strength. Therefore the type of filler material added and properties depending on it like water/solid ratio, cement content, foam volume mainly influences the compressive strength [6].

The workability and consistency of fresh foam concrete is tested by flow cone or marsh cone test. In order to attain a sufficient mix with self- compaction the flow time should be within 20s in the absence of any external aids. For the stability of the foam concrete mix, a spread flow of 45% was

found to be a suitable value [1]. When fly ash is used as filler the spreadability increases 2.5 times than that of cement-sand mix because of the difference in particle size and shape [3]. Workability and stability of foam concrete can be ensured by the addition of plasticizers. In order to avoid segregation and bleeding, the plasticizers and water to cement ratio must be added appropriately. A combination of superplasticizer and additives has found to have a beneficial influence on void structure of foam concrete

3 RESULTS

3.1 OPTIMIZATION OF FOAM VOLUME IN CONCRETE

The amount of foam that should be added to concrete is optimized by making 3 specimens each with 2.5%, 5%, 7.5%, 10%, 15%,20% foam volume by weight of cement. The results were valued and tabulated.

3.1.1 Density

The wet density and dry density with different percentages of foam are calculated at 7 and 28 days. Wet and dry densities at 7 and 28 day are tabulated in Table-1.

Table-1: Wet and dry density of foamed concrete with percentage variation of foam

Foam volume	Wet density (kg/m^3)	Dry Density(kg/m^3)	
		7th day	28th day
0%	2281	2195	2152
2.5%	2090	2070	2044
5%	2033	1816	1778
7.5%	1603	1545	1516
10%	1426	1376	1257
15%	1378	1277	1252
20%	1230	1226	1220

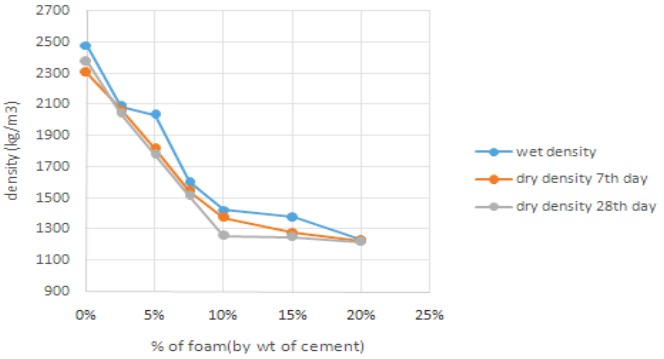

Chart-1: Wet and dry density of foamed concrete with percentage variation of foam

From the observation of Table-1, it can be noticed that, with addition of foam by weight, there is a reduction in density compared to conventional concrete. As the percentage of foam goes on increasing the weight of foam concrete also gets decreased which makes it more light weight.

3.1.2 Compressive strength

The specimen with varying dosage of foam was tested for compressive strength at 7th day and 28th day of curing and results are tabulated in Table-2.

Table-2: Comparison of compressive strength with various percentage of foam

Foam volume	Compressive strength (N/mm^2)	
	7th day	28th day
0%	24.85	31.71
2.5%	12.8	16.66
5%	10.3	13.06
7.5%	7.5	9.53
10%	7.7	8.4
15%	5.7	7.1
20%	5.31	6.9

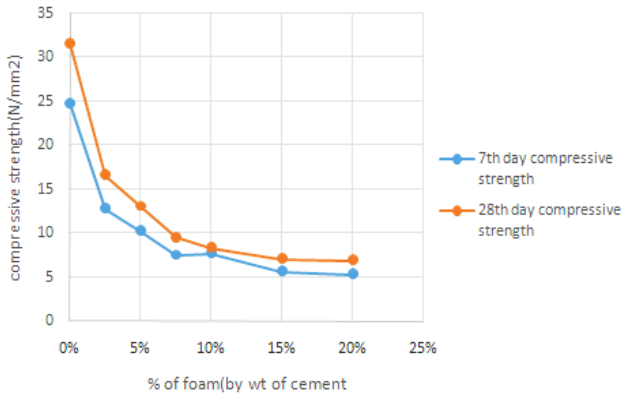

Chart-2: Compressive strength with various percentage of foam

From the observations of Table-2, it can be noticed that with addition of foam by weight of cement, the foam concrete specimen shows significant reduction in compressive strength. Thus reduction increases with increasing percentage of foam and the compressive strength is very low when the percentage of foam reaches about 20% by weight of cement. Thus the optimum weight of foam by weight of cement is taken as 5% and 7.5% taking into consideration the density as well as compressive strength.

4. CONCLUSIONS

- To improve the compressive strength, coarse aggregate is taken to have a good air- void distribution.
- Water- cement ratio was taken as 0.45 as per the referred journals.
- To fix the foam volume accurately cement to sand ratio is taken as 1:2
- The foam volume was obtained as 5% and 7.5%.

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