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REVIEW PAPER ON EXPERIMENTAL STUDY OF LIGHT WEIGHT CONCRETE

Rajesh Rathod, Nishant Doijad, Viraj Meshram,

Rutuja Jirapure, Diksha Meshram, Sangharsh Kamble

Civil Engineering Department

Sant Gadage Baba Amravati University, Amravati

***Abstract*— Lightweight concrete has a history of more than two-thousand years and its technical development is still proceeding. This review starts with a retrospective that gives an idea of the wide range of applications covered by lightweight concrete during the last century. Although lightweight concrete is well known and has proven its technical potential in a wide range of applications over the past decades, there are still hesitations and uncertainties in practice. For that reason, lightweight aggregate properties and the various types of lightweight concrete are discussed in detail with a special focus on current standards. The review is based on a background of 25 years of practical and theoretical experience in this field. One of the main challenges in designing lightweight concrete is to adapt most of design, production and execution rules since they often deviate from normal weight concrete. Therefore, aspects are highlighted that often are the cause of misunderstandings, such as nomenclature or the informational value of certain tests. Frequently occurring problems regarding the mix design and production of lightweight concrete are addressed and the unintended consequences are described. A critical view is provided on some information given in existing European concrete standards regarding the mechanical properties of structural lightweight concrete. Finally, the latest stage of development of very light lightweight concretes is presented. Infra-lightweight concrete is introduced as an innovative approach for further extending the range of applications of lightweight concrete by providing background knowledge and experiences from case records.**

***Keywords*— light weight concrete; lightweight aggregate concrete; infra-lightweight concrete; LC; LAC; ILC; lightweight aggregate; LWA; production; mix design**

1. Introduction:

Concrete is one of the most popular construction materials used since hundred years ago. Because of its flexibility in usage it becomes more important and is preferred compared to timber or steel. The combination of cement, coarse aggregate, fine aggregate and water makes up a concrete. It is an acceptable fact now that not only the strength of concrete which plays a main role, in deciding the quality of concrete but what matters most is the durability at services stage. This technological advancement forms a challenge to mankind to look into various ways and means to improve concrete.

Aggregate is one of the important ingredients in term of strength and bonding in concrete. In general, aggregate in concrete can be defined as those having apparent specific gravity of 2.4 or above. Aggregate can be divided further according to their particle shape such as rounded irregular, angular and flaky and according to their surface texture, i.e. glassy, smooth, granular rough, crystalline and honey, combed and porous. By virtue of the aggregate's density, the concrete produce is quite heavy and has a density of about 2400kg/m³.

Reducing concrete density will lead to economical construction because it reduces the cost of transportation, handling and constructability. One of the ideas to make concrete lighter is by the introduction of lightweight aggregate and air entraining agent. Using lightweight aggregate and air entraining agent in the concrete results reduction of dead load, faster construction time and lower haulage and handling cost. It is this true that the application of LWC (Lightweight concrete) is limited to certain purposes compared to normal concrete, but the introduction of LWC gives more alternative to construction industry, which currently focuses on natural resources. Some of the lightweight aggregate are manufactured from waste material such as Lytic, whereby it was produced from pulverized fuel ash (PFA). Study shows that in Malaysia the use of LWC is gaining popularity whereby in the 1994, more than 100,000m² of LWC panel have been produced and it can be said that the demand for the coming year will increase

2. Literature Review:

2.1 T. Parhizkar et.al. Presented experimental investigation on the properties of volcanic pumice lightweight aggregates concretes. To this end, two groups of lightweight concretes (lightweight coarse with natural fine aggregates concrete and lightweight coarse and fine aggregates concrete) are built and the physical/mechanical and durability aspects of them are studied. The results of compressive strength, tensile strength and drying shrinkage show that these lightweight concretes meet the requirements of the structural lightweight concrete.

2.2 Yasar etal. have performed a study on the design of structural lightweight concrete (SL.WC) made with basaltic pumice (scoria) as aggregate and fly ash as mineral admixtures that will provide an advantage of reduction in dead weight of a structure. The compressive and flexural tensile strengths of hardened concrete, the properties of fresh concrete including density and slump workability were measured. Laboratory compressive and tensile strength tests results showed that SLWC can be produced by the use of scoria. SLWC has an advantage of the reduction of the dead weight of the structure at the average of 20% since the dry weight unit of NWC is about 2300 kg/m³

2.3 T. Divya Bhavana and Ropula Kishore Kumar, S. Nikhil, P. Sairamchander had worked on the study of light weight concrete in which they concluded the compressive strength of light weight concrete is lower than the ordinary conventional concrete and from this compressive strength result, it is observed that as the percentage of ECA is increasing the compressive and flexure strength is decreasing since, the density of concrete is reduced by addition of ECA. Also the workability of light weight concrete is good when it is compared to the ordinary conventional concrete and this light weight concrete has low thermal conductivity and has an ability to absorb sound.

2.4 Miss Akshata A Mulgund and Dr. Dilip K Kulkarni had worked on the light weight concrete in which they shown the comparison of both the densities of normal concrete as well as light weight concrete. As per the density of light weight concrete is much more lesser than normal concrete, so the lesser density of light weight concrete is helps to reduce dead load of structure, increases the progress of building and it maintain the economy of structure.

3. Light Weight Aggregate: There are many types of lightweight aggregates available, but not all are structurally suitable. Low density concretes are mainly used for insulation purposes. They have a low unit weight (around 50 pct) and low compressive strength (ranging from 100 to 1000 psi).Fig. shows a spectrum of lightweight concretes.

Structural lightweight concrete as defined by the American concrete Institute shall have a 28-day compressive. strength in excess of 2500 psi and a 28-day unit weight not exceeding 115 pcf. Raw materials used in commercial production of structural lightweight aggregates are generally

(a) Suitable natural deposits of shales, clays or slates.
(b) By-products of other industries, such as iron blast furnace slag or fly ash.

There are several methods of producing structural lightweight aggregates eg, rotary kiln process, sintering process and machine process.

4. Compressive Strength: Compressive strength comparable to that of normal weight concrete is obtained by the use of lightweight concrete. High compressive strengths of up to 7000 psi are used in the production of structural precast members. However, generally more sacks of cement per cubic yard of concrete are required when manufacturing light weight concrete instead of normal concrete.

5. Unit Weight: The unit weight of lightweight concrete is significantly lower than that of normal weight concrete, due to the cellular structure of the aggregate. The unit weight of lightweight concrete, depending on the type of fine and coarse aggregate used, various from 90 to 120 pcf. The unit weight is also greatly affected by graduation and particle shape. Higher strength lightweight concrete has a somewhat higher unit weight since more sacks of cement per cubic yard of concrete are used.

6. Modulus of Elasticity: Statics modulus of elasticity is taken as the slope of the secant to the stress-strain curve, Over the years several expressions for modulus of elasticity of concrete have been developed. One that has appeared frequently in cades is 1000re. This formula and others are reasonably accurate for concretes of usual strength made of normal weight aggregates.

However, the increased use of lightweight aggregates and also higher strength concretes created the need for a more accurate expression.

Adrian Pauw analysed a large number of test data for concrete of different densities and arrived at the following empirical equation,

$Ec=33w15\sqrt{f'c}$

Where, Ec = elastic modulus, psi

W = unit weight, pef

Fc = concrete compressive strength, psi

The above formula gives the values of modulus of elasticity for both lightweight and normal weight concrete and is adopted by the current American Concrete Institute Code.

7. Flexural Strength: In the investigation, different concrete mix of ECA replacements as mentioned above is considered to perform the test by-weight basis with 10% of cement replaced by silica fume and 1.6% PVA solution. A 700mm x 150mm x 150mmconcrete beam was used as test specimens to determine the flexural strength of concrete beams. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The beams are properly compacted

8. Density: Mass of a unit volume of a material substance. The formula for density is d=M / V, where d is density, M is mass and V is volume.

The density of lightweight concrete in the range between 300 to 1850 kg / cum and normal concrete density 2200 to 2500 kg / cum. Lightweight concrete has low density and it helps to reduce dead load of structure as compare of normal concrete.

9. TYPES OF LIGHT WEIGHT CONCRETE

9.1 Light weight aggregate concrete: The lightweight porous aggregate such as pumice, thermally treated shale, diatomite, scoria, volcanic cinder etc. is used for decreasing the density of concrete. The specific gravity of such concrete is generally less than 2. The structural strength difference in concrete form by using normal aggregate and such aggregate keeping all other material as in the same quality and proportional is only 30%.

Thus due to these reasons, the concrete using lightweight are also subjected to structural strength design along with the purpose of decreasing its density. The density of such concrete varies from 1400 kg/m3-1800 kg/m3 and the strength of such concrete generally starts with the 17MPa and more which depends upon their design mix.

Fig. LIGHT WEIGHT AGGREGATE

9.2 No fine concrete: In this, the fine aggregate is completely omitted from the mix to create the interstitial voids. This concrete is prone to internal cracks formation and are not well compacted due to which there is a decrease in density. The gap graded aggregate is preferred in order to prevent the interstitial bonding or compaction. They are useful for damp proof coursing, temporary structures, and external load-bearing walls. The density of this concrete is also 25%-30% less than normal concrete.

There density can ranges from 700kg/m3 (using lightweight aggregate) -1600/1900kg/m3 (using normal aggregate). And their strength lies within 4MPa-14MPa. They exhibit low shrinkage on drying and tend to segregate less. But it must be noted that compaction via vibrating machines is prohibited however simple compaction through rod are allowed.

Fig. NO FINE CONCRETE

9.3 Aerated concrete: The microscopic pores of evenly well-distributed form in concrete is achieved by using the additional foam-forming materials like aluminium in the concrete mix. The aluminium powder reacts with the calcium hydroxide to give hydrogen gas, which forms the bubble of the air entrains gas within the concrete while setting.

Also, sometimes foam-forming materials (hydrolysed protein or resin soaps) are used to form the foams. The air entrainment makes the concrete spongy or cellular in structure. The concrete along with a comparison of its equivalent density with other material, it can be said it has comparative high strength. This concrete can decrease the load up to 80% but are not good for structural strength. Thus this concrete is also precast in the forms of blocks which can easily lift and placed as masonry units. Moreover, these long precast blocks are also used as a slab for the steel structures.

Due to high air entrainment voids, it can facilities the internal curing to concrete. They have extremely less density ranges from 550kg/m3 – 990kg /m3, so that can even float on water. The help of using both light aggregate, aluminium, and other admixture can make this.

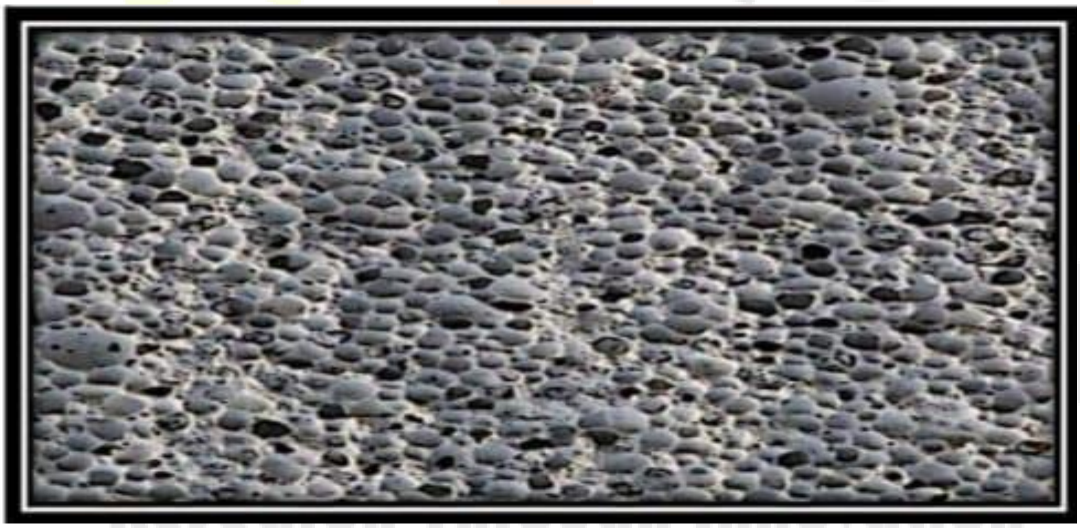

Fig. Aerated concrete

10. Objective of the Study:

1. To understand the Lightweight concrete and level of application in construction industry mainly Malaysia.

2. To compare the strength and density of LWC with normal concrete.

3. To know that the different types of LWC and application in construction industry.

11. Scope and Limitation of the Study:

The main purpose of this research is to know what is the lightweight concrete and used level in construction Industry at Malaysia. Any factor will be included in this research as a recommendation. This research methodology selected for this research is interview and get information from developer or local authorities, get information from oversea such as UK and other countries about the lightweight concrete and alsu from reference books so that related the lightweight concrete and application in construction industry at Malaysia.

Our study also using 3 sites to research about the lightweight concrete in Malaysia and choice the site at around Selangor state, it is because the Selangor state is develop state in Malaysia and attempt to develop the lightweight concrete in our country. It also suitable with Rancangan Malaysia ke-9 when the Malaysia government wants at each government project must use the lightweight concrete although small amount.

12. CONCLUSION:

The initial findings have shown that the lightweight concrete has a desirable strength to be an alternative construction material for the industrialized building. System. The strength of aerated lightweight concrete are low for lower density mixture. This resulted in the increment of voids throughout the sample caused by the foam. Thus the decrease in the compressive strength of the concrete. The foamed lightweight concrete is not suitable to be used as non-load bearing wall as the compressive strength is 27% less than recommended. Nevertheless the compressive strength is accepted to be produced as non- load bearing structure.

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