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A Review Paper on Comparative Study of Lightweight Concrete and Reinforced Concrete

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Abstract- This paper focuses on the comparison between lightweight concrete and reinforced concrete based on their properties, uses, ingredients, characteristics. 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 ability and lessened the dead weight. It is lighter than the conventional concrete. The use of lightweight concrete has been widely spread across countries such as USA, United Kingdom and Sweden. The main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages are that there is a reduction of dead load, faster building rates in construction and lower haulage and handling costs. 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. Therefore, this fundamental research report is prepared to show activities and progress of the lightweight concrete. Focused were on the performance of aerated lightweight concrete such as compressive strength tests, water absorption and density and supplementary tests and comparisons made with other types of lightweight concrete.

Key Words: Light weight aggregate, compressive strength, flexural strength, density, unit weight, modulus of elasticity.

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/m

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.

2. Literature Review:

2.1 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.

2.2 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.

2.3 Yasar et.al. have performed a study on the design of structural lightweight concrete(SLWC) 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/m^3

2.4 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.

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 pcf) 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 e.g., 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 lightweight 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 codes is 1000f'c. 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,

$$Ec = 33w^{1.5}\sqrt{f'c}$$

Where, Ec = elastic modulus, psi

W = unit weight, pcf

F'c = 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. All the concrete beams were de-molded within 24 hours after casting. The demolded test specimens were properly test specimens were properly cured in water available in the laboratory at an age of 7 and 28 days. Flexural test was conducted on a – KN capacity flexural testing machine.

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 Lightweight Concrete

Lightweight concrete can be prepared either by injecting air in its composition or it can be achieved by omitting the finer sizes of the aggregate or even replacing them by a hollow, cellular or porous aggregate. Particularly, lightweight concrete can be categorized into three groups:

i) No-fines concrete

ii) Lightweight aggregate concrete

iii) Aerated/Foamed concrete

9.1) No-Fines Concrete

No-fines concrete can be defined as a lightweight concrete composed of cement and fine aggregate. Uniformly distributed voids are formed throughout its mass. The main characteristics of this type of lightweight concrete is it maintains its large voids and not forming laitance layNo-fines concrete usually used for both load bearing and non-load bearing for external walls and partitions. The strength of no-fines concrete increases as the cement content is increased. However, it is sensitive to the water composition. Insufficient water can cause lack of cohesion between the particles and therefore, subsequent loss in strength of the concrete. Likewise too much water can cause cement film to run off the aggregate to form laitance layers, leaving the bulk of the concrete deficient in cement and thus weakens the strength.

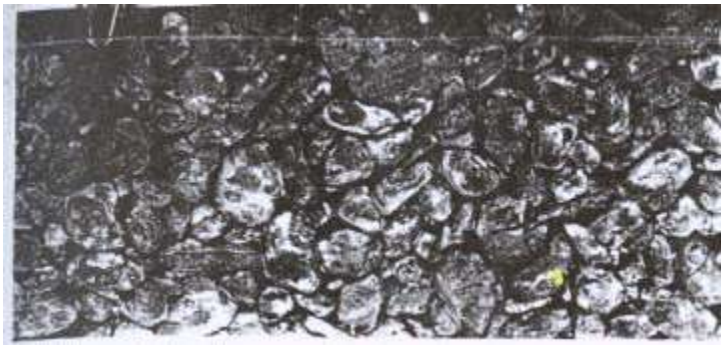

Fig. No-fines concrete

9.2) Lightweight Aggregate Concrete

Porous lightweight aggregate of low specific gravity is used in this lightweight concrete instead of ordinary concrete. The lightweight aggregate can be natural aggregate such as pumice, scoria and all of those of volcanic origin and the artificial aggregate such as expanded blast-furnace slag, vermiculite and clinker aggregate. The main characteristic of this lightweight aggregate is its high porosity which results in a low specific gravity. The lightweight aggregate concrete can be divided into two types according to its application. One is partially compacted lightweight aggregate concrete and the other is the structural lightweight aggregate concrete. The partially compacted lightweight aggregate concrete is mainly used for two purposes that is for precast concrete blocks or panels and cast in-situ roofs and walls. The main requirement for this type of concrete is that it should have adequate strength and a low density to obtain the best thermal insulation. Structurally lightweight aggregate concrete is fully compacted similar to that of the normal reinforced concrete of dense aggregate. It can be used with steel reinforcement as to have a good bond between the steel and the concrete. The concrete should provide adequate protection against the corrosion of the steel. The shape and the texture of the aggregate particles and the coarse nature of the fine aggregate tend to produce harsh concrete mixes. Only the denser varieties of lightweight aggregate are suitable for use in structural concrete. Figure shows the feature of lightweight aggregate concrete.

9.3) Aerated Concrete

Aerated concrete does not contain coarse aggregate, and can be regarded as an aerated mortar. Typically, aerated concrete is made by introducing air or other gas into a cement slurry and fine sand. In commercial practice, the sand is replaced by pulverized fuel ash or other siliceous material, and lime maybe used instead of cement [2]. There are two methods to prepare the aerated concrete. The first method is to inject the gas into the mixing during

its plastic condition by means of a chemical reaction. The second method, air is introduced either by mixing-in stable foam or by whipping-in air, using an air-entraining agent. The first method is usually used in precast concrete factories where the precast units are subsequently autoclaved in order to produce concrete with a reasonable high strength and low drying shrinkage. The second method is mainly used for in-situ concrete, suitable for insulation roof screeds or pipe lagging.

Fig. Aerated Concrete

The differences between the types of lightweight concrete are very much related to its aggregate grading used in the mixes. Table 1 shows the types and grading of aggregate suitable for the different types of lightweight 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 also 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. Result: The lightweight concrete is more times better than normal concrete due to its density, compressive strength, flexural strength and its overall physical/mechanical properties.

Hence LWC is economical than NWC and it definitely use as a best construction material.

13. 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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