A Review on Light Weight Concrete using Coal and Fly Ash

Arun Kumar[1] Satya Veer Singh[2]
[1]M. Tech Student [2]Assistant Professor
[1,2]Department of Civil Engineering
[1,2]Faculty of Engineering & Technology, Rama University, Kanpur, India

Abstract— Lightweight concretes can either be lightweight aggregate concrete, foamed concrete or autoclaved aerated concrete (AAC). Such lightweight concrete blocks are often used in house construction. Nearly all LWACs are fire resistant. In addition, depending upon the densities and strength, the concrete can be easily cut, nailed, drilled, and chased with ordinary wood working tools. This paper is a study about Lightweight concrete which are manufactured by composition of Fly ash, cement and sand with requisite quantity of water mixed in proper proportions. These concrete are comparatively lighter in weight and stronger than the ordinary concrete. The Fly ash is one of the major by-product of thermal power plants, 1kg of coal on burning produces about 200 to 500gms of Fly ash. Thus, Fly ash is very easily available which can be used to manufacture light weight concrete as a substitute of ordinary concrete which could lead to reduce the environmental pollution and help in conserving natural resources. I will calculate compressive strength using fly ash and coal.

Keywords: Cement, Compressive Strength, Coal, Aggregate, Sand, Fly Ash

I. INTRODUCTION

Lightweight concrete (brick) as known as AAC (Autoclaved Aerated Concrete) is a well-known constructing material all over the world; it was first invented by a Swedish Architect named Johan Axel Eriksson in 1923.Lightweight concrete contains no aggregate larger than sand, lime, thermal ash, synthetic fiber, cement, aluminum powder and water as binding agent. When AAC is mixed and cast in forms, several chemical reactions take place that give AAC its light weight (20% of the weight of concrete) and thermal properties. Therefore, lightweight concrete is quite light and may suffer extreme pressure as well as insulate the high and low temperatures.

In Japan, lightweight concrete is used to support the building foundation against the earthquakes. Lightweight concrete technology is quite friendly with the environment by reducing five times the amount of carbon dioxide of the production from the raw material process till the recycle wastes process. Since the born of lightweight concrete in building industry, baked bricks (made from natural clays) in developed countries are banded to protect the environment and national resources. On the other hand, lightweight concrete with the gas bubbles structure (up to ⅛ inch in diameter) is applied popularly by developed countries with high technologies such as United States of America, Germany, France, Japan, etc. in handling multiple geography technical issues such as making the foundation for highways, anti-slip subsidence in the mountainous areas or weak land areas to bring back huge economic benefits.

Because of its advantages, lightweight has taken an important part of developed countries such as Europe, North America, and North Asia as well as the attention of some developing countries in replacing its traditional building material which is red brick, regular concrete and clay block.

II. LITERATURE REVIEW

Transparent concrete is concrete based material with light – Trans missive properties due to embedded light optical elements-usually optical fibers. Light is conducted through the stone from one end to the other. Therefore, the fibers have to go through the whole object. This results in certain light pattern on the other surface, depending on the fiber structure. Shadows cast onto one side appear as silhouettes through the material.

Translucent concrete is used in fine architecture as a façade material and for cladding of interior walls. Light – transmitting concrete has also been applied to various design products.

Yasar et al. [2003][1] used basaltic pumice (scoria) as aggregate and fly ash as mineral admixture for making the light weight concrete.

The dry unit weight, compressive strength, elastic modulus and specific gravity of scoria were 1518 kg/m^3, 28.3 MPa, 11.3 GPa, and 2.59, respectively.. The proportions of the control lightweight scoria concrete mixture were 1:2.5:0.55 by mass of NPC, mixed scoria aggregate, and water, respectively. M1 corresponds to control lightweight scoria concrete made with NPC. M2 mixture is lightweight concrete made with 20% fly ash replacement.

Results shows that after the 3 days M2 mixture has less compressive and flexural strength as compare to M1 mixture. However, M2 mixture developed strength comparable to M1 at 7 days. Moreover, it surpassed the of M1 mixture at 28 days and beyond. At 28 days M1 and M2 mix having approximate equal strengths.

Ramazan Demirboga et al. [2004][2] used expanded perlite, pumice aggregates (PA), silica fume (SF) and fly ash (FA) on the thermal conductivity of lightweight aggregate concrete (LWAC).

SF and FA were added as replacement for cement by decreasing the cement weights in the ratios of 10%, 20% and 30% by weight.

The highest thermal conductivity of 0.3178 W/mK (watts per meter – kelvin) was observed with the samples containing only PA and plain cement. It decreased with the increase of SF and FA as replacement for cement.

The lowest value of thermal conductivity, which is 0.1472 W/mK, was obtained with the samples prepared with expanded perlite aggregate (EPA) replacement of PA and 70% cement + 30% FA replacement of cement. Both SF and FA had a decreasing effect on thermal conductivity. PA also induced a decrease of 43.5% in thermal conductivity of concrete.

Haque et al. [2002][3] Casted two sand-lightweight concretes (SLWC), using Lytic as a coarse LWA and a dune sand, were made to evaluate their strength and durability

characteristics. The SLWCs were designed for a 28 day cube compressive strength of 50 and 35 MPa.

The bulk specific gravity on oven dried basis and bulk density of the Lytag coarse aggregate were found to be 1.42 and 820 kg/m^3, respectively. The concrete specimens were continuously cured in water for one or 7 days and then exposed to predominantly hot and humid seaside ambient conditions containing air-borne salts.

Results shows that after 7 days of initial curing and on subsequent exposure to hot and humid air both SLWCs attained an almost similar strength to those continuously water cured cubes at an age of 12 months. The depth of carbonation of the two sand lightweight concretes up to an age of 12 months were negligibly small. The results suggest that compressive strength is comparatively less sensitive to the curing regimes investigated. Both the chloride and sulphate penetration after 12 months exposure were found to be within tolerable limits. Also replacement of lightweight fine aggregate with normal weight sand produces a concrete that is somewhat more durable as indicated by their water penetrability and depth of carbonation when concretes are of equal strength.

Awal et al. [2016][4] presents experimental results on some physical and mechanical properties of concrete containing sawdust.

Concrete specimens having various cement to sawdust ratios of 1:1, 1:2 and 1:3 by volume were made and tested for workability, density, water absorption, strength and modulus of elasticity at different curing periods of 7, 14 and 28 days.

It has been found that with the increase in the amount of sawdust, the workability and density of concrete decreased; the water absorption capacity of concrete, however, increased with the increase in volume. Although the strength of sawdust concrete increased with curing period, the strength and the corresponding modulus of elasticity decreased with the increasing amount of sawdust in the mix. The results obtained and the observation made in the short-term investigation suggests that sawdust can suitably be used as a building material for making of light weight concrete.

Serkan Subasi [2009][5] The effect of using fly ash in high strength lightweight aggregate concrete produced with expanded clay aggregate on physical and mechanical properties of the concrete was investigated. For this purpose, lightweight concrete mixtures with 350, 400 and 450 kg/m3 cement content were prepared using expanded clay aggregate. Besides, concretes with 0, 10, 20 and 30% fly ash replacement were produced out of the mixtures with different cement contents. Concrete density, porosity, ultrasonic pulse velocity, compressive and split tensile strength experiments were performed on the prepared samples. As a result, it was seen that it is possible to produce high strength lightweight concrete using expanded clay aggregate; the cement content with 450 kg/m3 among concrete mixtures had the highest strength values; mechanical properties of concrete could be enhanced by using 10% fly ash; thus a saving in cement amount could be achieved.

Ravi Kumar, Vandana Patyal [2014][6] Efforts has been made to study the behaviour of fly ash bricks by taking different proportions of fly ash, cement, lime, gypsum and sand. Three types of fly ash bricks in the different percentage of cement such as 3%, 5% and without cement are designed and then various tests such as compressive strength test, water absorption test, efflorescence, weight test, structural test were performed in order to have comparison with conventional bricks. In the experimental study it is found that the compressive strength of fly ash brick containing 5% cement is 152.1 kg/cm2 which is more than that of class I conventional bricks by 40% approximately.

Lakshmi Kumar Minapu [2014][7] Design of concrete structures, light weight concrete plays a prominent role in reducing the density and To increase the thermal insulation. These may relate of both structural integrity & serviceability. More environmental And economic benefits can be achieved if waste materials can be used to replace the fine light weight aggregate. The New sources of Structural aggregate which is produced from environmental waste is Natural aggregates, synthetic light weight aggregate The use of structural grade light weight concrete reduces the self-weight and helps to construct larger precast units. In this study, an attempt has been made to study the Mechanical Properties of a structural grade light Weight concrete M30 using the light weight aggregate pumice stone as a partial replacement to coarse aggregate and Mineral admixture materials like Fly Ash and Silica Fume. For this purpose along with a Control Mix, 12 sets were Prepared to study the compressive strength, tensile strength and flexural strength. Each set comprises of 4 cubes, 2 Cylinders and 2 prisms. Slump test were carried out for each mix in the fresh state. 28-days Compressive test, Tensile Strength and Flexural Strength tests were performed in the hardened state. The study is also extended for blending of Concrete with different types of mineral admixtures. The test results showed an overall strength & weight reduction in various trails. Therefore, the light weight concrete is no way inferior for construction purpose.

V. Bhaskar Desai[2014][8] experimental investigation an attempt is to be made to study the strength properties of light weight cinder aggregate cement concrete in different percentage proportions of 0, 25, 50, 75 and 100 by volume of light weight aggregate concrete can be prepared. By using this the properties such as compressive strength, split tensile strength, modulus of elasticity, density and shear stress etc., are studied by casting and testing around 105 samples consisting 15 no of plain cube specimens of size 150 x 150 x 150mm, 60 no of (Double Centered Notch) DCN specimens of size 150x150x150mm and 30 no of cylinders of size 150mm dia. and 300mm height Cost of this brick is high but if we use this brick mix for the replace as PCC (Plain Cement Concrete, BBCC (Brick Bat Cement Concrete), RCC (Reinforced Cement Concrete) at plinth level and also it can be used in compressive element so the cost of the PCC, BBCC and RCC is decreases.

M.N. Akhtar [2013][9] In the present study, the effect of fly ash with high replacement, and different properties of bricks combination were studied. It was found that the compressive strength of Plain Fly Ash and Treated Fly Ash Bricks (FAB, FALB) increases linearly and maximum with 5% coarse sand and 15% sand combination at 10% cement. This increase of compressive strength continues with the addition of 0.25% Plastic fibre in FAB and FALB.

The addition of lime to the fly ash increases the cementations properties of Fly ash and it was found that at 1.5% of lime, the OMC is minimum and dry density is maximum.

The compressive strength of Plain Fly Ash Brick and Treated Fly Ash Brick is increases linearly and maximum with 5% coarse sand and 15% sand combination at 10% cement.

Akshata A Mulgund [2018][10] Density of the normal concrete is 2200 to 2600 kg/m3. This weight will make it an uneconomical structural material. Attempts have been made in the past to reduce the self-weight of concrete to increase the efficiency of concrete as astructural material. The light-weight concrete is a concrete which has a density of 300 to 1850 kg/m3 .There are many advantages of having low density. It helps in reduction of dead load, increases the progress of building. The weight of a building on the foundation is an important factor, in case of weak soil . Floors and walls if made up of LWC will result in economy. It has low thermal conductivity, which improves with decreasing density. Buildings where air-conditioning is required the use of LWC with low thermal conductivity will be appropriate. The use of LWC uses industrial wastes such as clinker, fly ash, slag etc. There is only one method for making LWC i.e., by the inclusion of air in concrete. It can be done by three different ways.

III. Conclusion

On the study of above mentioned Review paper, following conclusion are obtained regarding Light weight Concrete:

- Comparatively lighter in weight and stronger than the ordinary clay bricks.
- The lightweight concrete can be used in the earthquake prone zone.
- For different mix proportions, at different curing ages are required.
- Research papers shows that lightweight concrete is also an alternative option for construction of building in normal as well as aggressive environment.
- There are several new opportunities and challenges in the field of lightweight aggregate building industry.
- Due to use of waste material in the making of lightweight concrete also reduce the cost of construction and make the environment ecofriendly.
- The dead load of structure is reduce due to use of lightweight concrete, cut the cost of construction due to decrement in the size of section and quantity of reinforcement.

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