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LIGHT WEIGHT CONCRETE

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ABSTRACT

Growth in Building Technology has led to the use of Light Weight Concrete (LWC). Its strength is roughly proportional to its weight and its resistance to weathering is about the same as that of ordinary concrete. Given below are the details on Lightweight Concrete. As compared with the usual concrete it has certain advantages as the savings in structural steel supports and decreased foundation sizes because of decreased loads, and better fire resistance and insulation against heat and sound. Its disadvantages include greater cost, need for more care in placing, greater porosity, and more drying shrinkage. LWC may be made by using lightweight aggregates, or by the use of foaming agents, such as aluminum powder, which generates gas while the concrete is still plastic. Natural lightweight aggregates include pumice, scoria, volcanic cinders, tuff, and diatomite. Lightweight aggregate can also be produced by heating clay, shale, slate, diatomaceous shale, perlite, obsidian, and vermiculite, Industrial cinders and blast-furnace slag. Cellular concrete is foam used with either lightweight aggregates and/or admixtures such as fly ash, silica fume, synthetic fiber reinforcement and high range water reducer has produced a new hybrid of concrete called lightweight composite concrete.. Use of light weight concrete is a revolutionary step towards modernizing the construction technology.

Keywords : Light Weight Concrete, Aerated Light Weight Concrete

I. INTRODUCTION

All concrete isn't ugly, hard, cold and difficult to work with. There exists a whole range of light weight concretes which have a density and compressive strength very similar to wood. They are easy to work with can be nailed with ordinary nails, cut with a saw, drilled with wood working tools and easily repaired. We believe that ultra-light weight concrete is one of the most fundamental bulk building materials of the future. Light weight concrete differs from heavy concrete by its use of naturally light weight materials (aggregates) such as pumice (volcanic stone) in place of the sand and gravel used in ordinary structural concrete mixes. It only weighs half as much. Light weight concrete is about one half the weight of hard structural concrete. It can be mixed from a variety of light weight aggregates including vermiculite, perlite, scoria, and pumice. Some form of suitable aggregate is available most everywhere in the world. Typically mix 8:1 or 10:1 (by volume) with cement for walls, and 5:1 for roofs. Most lightweight concrete are good insulator of heat and sound. It has tremendous sculptural possibilities and is ideal for monolithic, wall-roof construction. Industrial waste consisting of fly ash from power plants as a

raw material is used for manufacturing light weight building materials. The large volume of waste has become one of the most significant problems of environmental protection, as its disposal is expensive and non-productive. Experiments show that this waste material can be used for the production of high quality bricks, blocks and other building elements which are less energy intensive than their conventional counterparts.

II. TYPES OF LIGHTWEIGHT CONCRETE

There are basically three ways of making light weight concrete as:

- By replacing the usual mineral aggregates by cellular porous or light weight aggregates.
- By introducing gas or air bubbles in mortar. This is known as aerated concrete.
- By omitting sand fraction from the aggregate. This is called as No-fines concrete

Table 1: Whole range of Light Weight Concrete under three main groups:

No-fines Concrete	**Light Weight Aggregate Concrete**	**Aerated Concrete**	
		Chemical aerating	**Foaming Mixture**
a) Gravel b) Crushed stone c) Coarse clinker d) Sintered pulverized fuel ash e) Expanded clay or shale f) Expanded slate g) Foamed slag	a) Clinker b) Foamed slag b) Expanded clay d) Expanded Shale e) Expanded slate f) Sintered pulverized fuel g) Exfoliated vermiculite h) Expanded perlite i) Pumice	a) Aluminium powder method	a) Preformed foam b) Air-entrained foarn

III.TYPES OF LIGHT WEIGHT AGGREGATES:

Lightweight aggregates can be classified into two categories Viz. Natural Light Weight aggregates and Artificial Light Weight Aggregates.

3.1 Natural Light Weight Aggregates

Natural light weight aggregates are found in some places and they are not of uniform quality. Pumice is widely used as a natural light weight aggregates.

a) **Pumice**: These rocks of volcanic origin which occurs in many parts of the
Sawdust world. They are light enough due to the escaping of gas from the molten lava when erupted from deep beneath the earth's crest. Pumice is usually light coloured and has fairly even texture of interconnected cells.

b) **Diatomite**. This is hydrated amorphous silica derived from the remains of microscopic aquatic plants called diatoms in deep ocean bed. Its density is 450 kg/m3.

c) **Scoria:** This is also of volcanic origin which is usually dark in colour and contains larger and irregular shaped cells unconnected with each other. It is slightly weaker than Pumice.

d) **Volcanic cinder:** These are loose volcanic product resembling artificial cinder.

e) . Sometimes saw dust is used as a light weight aggregates in flooring, roofing tiles and in the manufacturing of precast products.

f) **Rice husk:** Limited use of the rice husk, ground nut husk and bagasse have been used as light weight aggregates for the manufacture of light weight concrete for special purposes.

3.2 Artificial Light Weight Aggregates

a) **Brick Bats**: These are used where natural aggregates are not available or costly. The aggregates are made from slightly over burnt bricks, which will be hard and absorb less water.

b) **Artificial cinders & coke breeze**. These are residues from high-temperature combustion of coal or coke in industrial furnaces. These are also used for making screeds over flat roofs and for plastering.

c) **Foamed stag**. These are produced by treating blast-furnace slag with water. The molten slag is run into pits containing controlled quantities of water or is broken up by mechanical devices and subjected to sprays or streams of water. The products are fragments that have been vesiculated by steam. The amount of water used has a pronounced influence on the products, which may vary over wide ranges in strength and weight.

d) **Bloated clay.** When certain glass and shales are heated to the point of initial fusion, they expand or what is termed as bloat to many times their original volume on account of the formation of gas within the mass at the fusion temperature. The cellular structure so formed is retained on cooling and the product is used as light weight aggregates.

e) **Expanded shale and slate**. All expanded shale and slate aggregates are made by heating prepared materials to the fusion-point where they become soft and expand because of entrapped expanding gases.

f) **Sintered fly ash**. It is finely divided residue, comprising of spherical glassy particles, resulting from the combustion of powdered coal. By heat treatment these small particles can be made to combine, thus forming porous nodules which have considerable strength.

g) **Exfoliated vermiculite**: Raw vermiculite is a micaceous mineral and has a laminar structure. When heated with certain percentage of water it expands by delamination. This type of expansion is known as exfoliation due to which the vermiculite expands even as much as 30 times and will have density of only 60 to 130 kg/m3.

h) **Expanded perlite**. Perlite is one of the natural glasses like pumice. This when crushed and heated to the point of incipient fusion at a temperature of about 1000° C it expands to form a light cellular material with density of about 30 to 240 kg/ m3.

IV. PROPERTIES OF LIGHT WEIGHT CONCRETE

a) Properties of various light weight aggregates, as reflected by those of the resulting concrete, vary greatly. For example, by using expanded perlite or vermiculite, a concrete of density as low as 300 kg/m3 can be produced, and by use of expanded slag, sintered fly ash, bloated clay etc., a concrete of density 199 kg/m3 can be obtained.

b) The strength of light weight concrete may varies from 0. 3 to 40 N/mm.

c) The strength of concrete made with expanded shale and clay is relatively high and compares favorably with that of ordinary concrete e.g piumice, scoria, and some expanded slags produce a concrete of intermediate strength The insulation properties of the low-strength concretes, however, are better than those of the heavier, stronger concretes. The insulation value of the heaviest material (crushed shale and clay concrete) is about four times that of ordinary concrete.

d) All the lightweight aggregates, with the exception of expanded shales and clays and scoria, produce concretes subject to high shrinkages.

e) most of the lightweight concretes have better nailing and sawing properties than do the heavier and stronger conventional concretes. Table gives the typical properties of light weight aggregate concrete.

f) Perlite, vermiculite, and diatomite produce a concrete of very low strength.

Table 1 : Typical properties of common Light Weight Concretes.

Sr. No.	Type of concrete	Bulk density of aggregates kg/rri3	Bulk density of concrete kg/rri3	Compressive strength of 28 days N/mm²
1.	Sintered fly ash fine Coarse	1050 - 800	1500 - 1540	25 30
2.	Sintered fly ash with natural coarse	800	1700	25
3.	Pumice	500-800	1200	15
4.	Perlite	40-200	400-500	1.2-3.0
5.	Vermiculite	60-200	300-700	0.3-3.0
6.	Cellular (Fly ash)	950	750	3.0

V.STRUCTURAL LIGHT WEIGHT CONCRETE:

The structural light weight concrete is going to be one of the important materials of construction. A concrete which is light in weight and sufficiently strong to be used in conjunction with steel reinforcement will be a material which is more economical than the conventional concrete. Therefore, a concrete which combines strength and lightness will have the unquestionable economic advantage.

Structural light weight aggregate concrete is a concrete having 28 days compressive strength more than 17 MPa and 28 day air dried unit weight not exceeding 1850 kg/m3. The concrete may consist entirely of light weight aggregates or combination of light weight and normal aggregates.

FIG.1 **LWC Column 1**

FIG. 2 LWC Column 2

FIG. 3 LWC Block

VI.AERATED LIGHT WEIGHT CONCRETE:

Aerated concrete is made by introducing air or gas into slurry composed of Portland cement or lime and finely crushed siliceous filler so that when the mix sets and hardens, a uniformly cellular structure is formed. Though it is called aerated concrete is really not a concrete in the correct sense of the word. It is also referred to as gas concrete, foam concrete, cellular concrete.

There are several ways in which aerated concrete can be manufactured:

a) By the formation of gas by chemical reaction within the mass during liquid or plastic state.

b) By mixing preformed stable foam with the slurry.

c) By using finely powdered metal (aluminium or zinc powder) with the slurry and made to react with the calcium hydroxide liberated during the hydration process, to give out large amount of hydrogen gas. This gas when contained in the slurry mix, gives the cellular structure.

Aerated lightweight concrete is created by inclusion of a multitude of micro air bubbles in a cement based mixture. This is achieved by mixing the concentrated foaming chemical with water and compressed air. The Foam Generator is used to inject the foam directly into the concrete mixer which completes the process by mixing it with the sand/ cement/ water slurry. Most conventional ready mix or permanent concrete mixing facilities can be used for this task. Aerated lightweight concrete behaves like ordinary dense weight concrete in most aspects.

VII. NO-FINES CONCRETE

The another method of producing light weight concrete is to omit the fines from conventional concrete. No-fines concrete is a kind of concrete from which the fine aggregate fraction has been omitted. This concrete is made up of only coarse aggregate, cement and water. Very often only single sized coarse aggregate, of size passing through 20 mm retained on 10 mm is used. No-fines concrete is becoming popular because of some of the advantages it possesses over the conventional concrete. The single sized aggregates make a good no-fines concrete, which in addition to having large voids and hence light in weight, also offers architecturally attractive look.

VIII.CONSTRUCTION CONTROL OF LWC

Commercially available lightweight aggregate is usually supplied in three principal sizes fine, medium, and coarse range in size to 20 mm maximum depending upon its application. However, the problem is greater variations in absorption, specific gravity, moisture content, and amount and grading of light weight aggregates. If unit weight and slump tests are made frequently and the cement and water content of the mix are adjusted as necessary to compensate for variations in the aggregate properties and condition, reasonably uniform results can be obtained. To insure material of uniform moisture content at the mixer, lightweight aggregate should be wetted 24 hours before use. This wetting will also reduce segregation during stockpiling and transportation. It is generally necessary to mix lightweight concrete for longer periods than conventional concrete to assure proper mixing and it should be cured by covering it with damp sand or by using a soaker hose. Concretes made with

many of the lightweight aggregates are difficult to place and finish because of the porosity and angularity of the aggregates. The condition can generally be improved by adjusting the grading of the aggregates. This can be done by crushing the larger particles, adding natural sand, or adding filler materials. The place ability can also be improved by adding an air-entraining agent.

Pouring of concrete

IX. MIXING OF LIGHT WEIGHT CONCRETE:

Two main mixtures account for the majority of aerated lightweight concrete construction.

a) Cement + Foam:

b) Cement + Sand + Foam:

c) Cement + Light Weight Aggregates + Foam:

d) Dense Weight Concrete + Foam:

Curing:

Since many of the properties of aerated lightweight concrete depend upon the successful process of curing, outlined below are some of the methods whereby its strength can be increased.

Air Curing

X. ADVANTAGES

1) Reduced weight, with a wide range of possible densities and strength. Compared with dense weight concrete, reduction in weight from 10% to 87% can be achieved.
2) The cost advantage would be typically around 15 to 20% compared with dense weight concrete.
3) Additional, substantial savings are achieved due to a lower deadweight of the building. Structural components and foundation cost are greatly reduced, in particular on high-rise projects
4) It is possible to add other products to the foam Mix to obtain lightweight composite concrete. Notably the use of various fibers increases the strength of the product and prevents cracking in adverse conditions.
5) Fire rated to a minimum of 2 hours for a 75 mm (3") thick panel.
6) No obnoxious or toxic fume emission - no health hazards both in the manufacturing process and if product is subjected to heat (such as in case of fire).
7) Ongoing savings on power / energy costs (for air-conditioning and heating) are very substantial because of its thermal insulation qualities.
8) Aerated Lightweight Concrete can be sawn, sculptured with hand or common power tools and be penetrated by normal building nails and screws.
9) Compressive strength can be varied according to requirements. This is a function of density, moisture, mix proportion, chemical and physical characteristics of components materials and curing method.
10) Low water absorption because of its closed cellular structure.
11) Acoustic properties are such that sound is being absorbed, not reflected as is the case with dense weight concrete or brick walls.
12) The reduced weight facilitates cartage and handling and reduces transport cost.

XI. APPLICATIONS

1) Aerated Lightweight Concrete is widely used in the manufacture of single skin lightweight concrete wall panels, employing tilt-up construction. This is an ideal situation for the manufacture of light commercial structures and factories as well as residential housing.
2) Aerated Lightweight Concrete can be used as a filling material between dense weight concrete or other material to provide insulation. This is ideal for use in fire rated structures, such as solvent store, munitions storage facilities etc.
3) Sandwich panels with various surface materials, using Lightweight Concrete as columns & filler, are gaining increased acceptance for partition walls in office complexes, commercial walling, shopping centers and internal walls of residential houses and flats.
4) Lightweight Concrete is often specified for use as a lightweight filling material, or used to provide graded insulation on roof projects beneath waterproofing membranes.
5) Lightweight Concrete is also recognized as a cost effective way to rehabilitate old floors (i.e. multi-storey buildings that have wooden floors) which require a lightweight self leveling compound.

6) Currently used in the mining industry and applications in sewage lining grouting, this market has enormous potential.

7) Typical applications are void filling in mines, after excavation work or disused trenches and shafts. This is just one example of how this market can be developed.

8) Its applications as decorative facades, lightweight garden ornaments, lightweight blocks and reconstituted stone tiles etc.

LWC Roof Tile

XI.CONCLUSION

Most lightweight concrete are good insulator of heat and sound. It has tremendous sculptural possibilities and is ideal for monolithic, wall-roof construction. Light weight concrete differs from heavy concrete by its use of naturally light weight materials (aggregates) such as vermiculite, perlite, scoria, and pumice (volcanic stone) in place of the sand and gravel used in ordinary structural concrete mixes. It only weighs half as much. LWC construction can be a partial solution for several environmental problems. Light weight concrete is one of the most fundamental bulk building materials of the future.

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