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Investigating Attributions Related to Light Concrete of LECA

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ABSTRACT

Light concrete is of special significance in reinforced concrete structures these days. One production method of light concrete is utilizing light aggregates. LECA is a kind of light concrete which is produced in Iran. This concrete is identified by LECA light aggregates which are expanded clay aggregates. There is no industrial production of structural light concrete in Iran according to great resources of clay. The main reason related to lack of production can be a low resistance of light aggregate concretes.
In this study, it is going to investigate the maximum and necessity of light concrete in structures, unique attributions of LECA concrete such as water absorption, fire control, chemistry and geological qualities, specific gravity and density.
KEYWORDS: Light Concrete of LECA, Compressive Strength and Specific Gravity.

1. INTRODUCTION

LECA means Light Expanded Clay Aggregate. These aggregates can be reached through expanding clay in rotary kilns under a temperature of 1200 centigrade degree.

Some attributions that have led to a wide range of these artificial aggregates' utilization in building, constructive plans, agriculture, environment, road constructions, etc. are their lightness, low thermal conductivity, suitable sound drop, fire resistant, chemical resistant, etc [1-3].

2. General Attributions of LECA

Qualities of aggregates are of high significance because of their utilization volume (3/4 of whole volume) in concrete. Most attributions of concrete before and after solidification such as efficiency, resistance, elasticity, rise and fall and durability are affected by the qualities of building materials.

Main attribution of LECA is porous texture. Quantity and appearance of these aggregates would be different on the basis of production method in tape or rotary smelters. The aggregates of rotary smelter are of spongy texture and black color. The outside coverage color depends on material, method and quality of production which is often in brown color. The thickness of this coverage is 50-199 micron and is of low water absorption in comparison to aggregates of inter-texture.

A vacant space of 73-88% of whole space consist porous and vacant spaces of intra-aggregates. This vacant space between aggregates causes low weight, low thermal conductivity, sound drop and preventing humidity and drainage penetration. The texture of these aggregates and their construction method leads to fire and chemical resistance and durability [2-4].

3. Geological Attributions of LECA

Light aggregates such as expanded clay, Pumice, swollen ---, Perlite and their productions of light concretes are of similar attributions as following:

1. Low specific gravity which decreases weight of dead structure.
2. Fire resistance
3. Neutral (from chemical points)

4. LECA Utilization in Road Constructions

LECA aggregates have useful utilizations in road construction because of high drainage and low thermal conductivity about 0.101-0.09 w/m. k. Its spatial weight is 300-600 kg/m^3 in range of 0-25 mm. In weak and non-compressive sedimentary soils, embankment load is one significant element of soil consolidation in road smoothness, performance and durability furthermore, filling tranches and decreasing underground aquifers lead to subsidence of bed soil. LECA is a significant controlling of embankment subsidence and consolidation because of low spatial weight (light road embankment) and more spatial volume than soil (density decrease). Imposing load on infrastructure which is caused by filling tranches and decreasing underground waters leads to non-monotonous subsidence which can be decreased significantly through utilizing LECA [5-6].

5. Embankment Resistance

Imposed load on infrastructure causes soil layer rupture and embankment failure on weak soils. Embankment load on bed can be decreased by LECA in order to supply soil resistance.

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6.Decrease of Freezing Damage

Infrastructure freezing is caused by heterogeneous infrastructure, stones, high points of frozen stone and water flow. Water resulted from melted ice decreases loading capacity of infrastructure and layers.

The effects of road freezing and its damages and also decrease of loading capacity can be eliminated through LECA insulation of road. LECA insulation is put in layers and increases their resistance against freezing because of higher capacity of thermal insulation in comparison to stone aggregates.

As a result, according to LECA attributions (low spatial weight, drainage, insulation, low capillarity, durability, resistance against deformations and enough loading capacity),buoyance decrease of walls around bridges and gable loafs along suitable performances can solve many road construction problems and guarantee its durability [4].

7. LECA Attributions in Fire Controlling

LECA aggregates are produced in temperature of 1200 centigrade degree therefore they can bear heat shock up to 1100 degree without any flaming. Also, these aggregates are of low thermal conductivity about 0.10-0.17 w/m. k and have effective role on fire controlling.

According to these attributions, other productions of LECA aggregates such as cement mortar, concrete and light concrete would be of suitable fire resistance capacity. Researches and studies showed that the time of constructed LECA wall's resistance depends on wall density and is represented in following formula:

$T=140(M/100)\wedge 1.72$

M: wall weight (m^2) and T: resistance time against fire (min). The related graph is represented in figure 1.

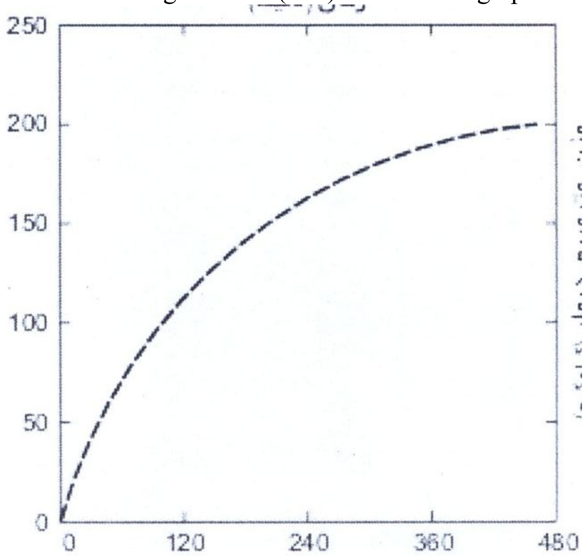

Fig.1. Graph of wall weight relation to resistance time against fire

8. Aggregation

LECA aggregates are ranged 0-25 mm. The aggregates directly depend on the kind of material, the manner of production and at the end, on kiln constants (temperature, rotary velocity, etc.). Also, the considered aggregates can be reached by breaking and screening after production stage. Some common aggregates are 0-3-10-20, 0-2-4-10-20 and 0-4-8-12-20 (mm). The aggregation of LECA accords ASTM C 330 which is based on standard minimum and maximum percentage of sieved aggregates.

According to basic differences of light and common aggregates' weight, sometimes utilizing volume instead of weight is preferred. The weighed amounts should be changed into volume according to mean spatial weight through this method. Table 1 represents aggregation and volume category of LECA along volume percentage. Various sizes have especial utilizations which are shown in table 2. Samples of LECA can be observed in figure 2.

Table1. LECA aggregation percentages

Aggregation (mm)	**Mixture 0-25**	**Small 0-3**	**Middle 3-10**	**Big 10-20**
Volume percentage	1+_99	2+_33	4+_26	**5+_58**

Table2. LECA utilization according to size

Size	**Utilization**
Big 10-20	**Insulation, omitting capillarity, filling light drainage, concrete production and infrastructure**
Middle 3-10	**Concrete production, infrastructure and light filling**
Small 0-3	**Concrete production, mortar and coating**

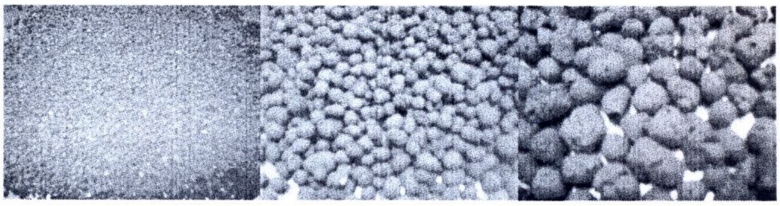

Fig 2. Sample of leca

9. Chemical Qualities

LECA aggregates lack any harmful materials which are in natural aggregates. Experiments show that PH of these aggregates is 7.2 and LECA is chemically neutral. Table 3 shows chemical analysis of LECA.

Table3. Results of chemical analysis related to LECA

Chemical mixture	percentage	Chemical mixture	percentage	Chemical mixture	percentage
Sio_2	66.05	Mgo	1.99	So_3	**0.03**
Al_2o_3	16.75	Tio_2	78.0	Na_2o	**0.69**
Fe_2o3	7.1	P_2o_5	21.0	K_2o	**2.69**
Cao	2.46	Mno	0.09	lo	**20.84**

10. Water Absorption

Time and size of aggregates are 2 important factors in LECA water absorption. Expand and porous is less in small aggregates so water absorption will be less and slow too. Since, the amount of aggregate humidity directly affects other qualification such as weight and thermal conductivity, measuring this quality will be of high significance in identifying effective qualities in application.

Water absorption of LECA accords ASTMC127. Figures 3 and 4 respectively show graphs of LECA aggregates on the basis of aggregate and time. Table 4 represents the mean of water absorption for LECA.

Table4. Mean of water absorption for LECA

Aggregation	Mixture 0-25	Small 0-3	Middle 3-10	Big 10-20
Water absorption after 30 min (%)	18+_2	15+_2	17+_2	**19+_2**
Water absorption after 24 h (%)	30+_2	30 +_2	30+_2	**30+_2**

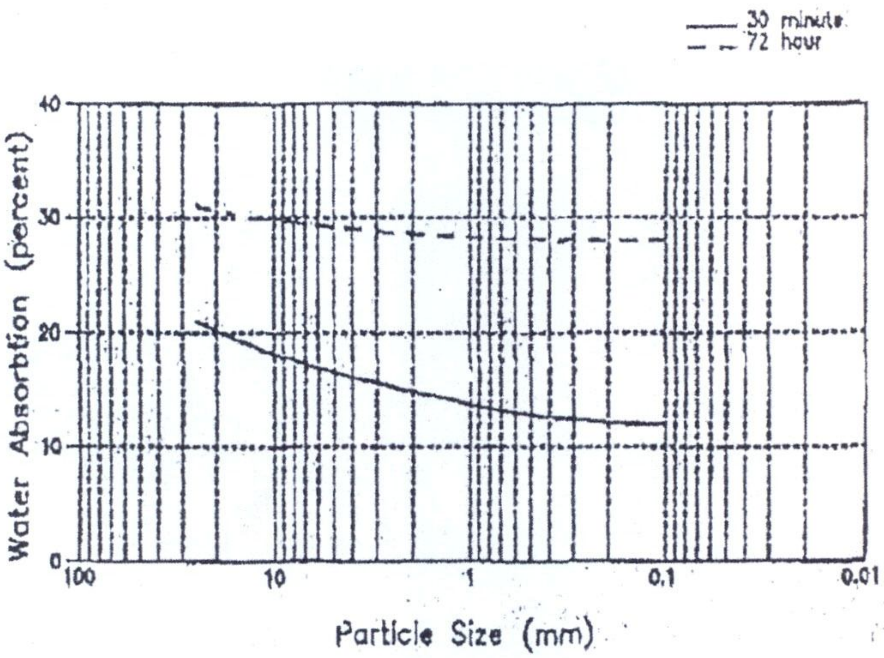

Fig3. Graph of water absorption for LECA (aggregation diameter)

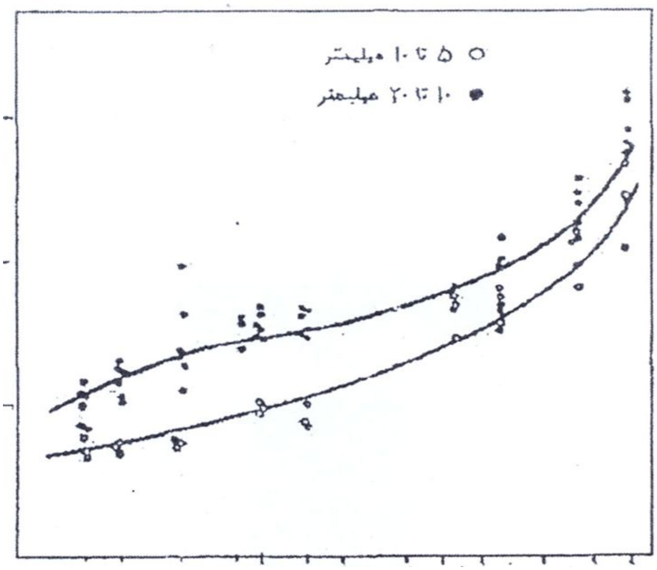

Fig4. Graph of water absorption for LECA (time)

10.1. Spatial Weight and Aggregate Mass

One important identification and classification factor of light aggregates is their spatial weight which directly is depended on production circumstance and materials. The more the size of LECA is, the less the spatial weight will be. This is a common and logical rule of volume expansion.

There is a wide range of difference between dry, saturated and massive aggregate density. As graph shows, the less the aggregate diameter is, the more the density will be. This is verified for spatial weight too. The density of big aggregate is based on ASTMC127 and the small one is ASTMC128. Table 5 shows the mean of density and spatial weight for LECA. If LECA aggregate is utilized in light concrete structures, the aggregate density should not exceed the amounts of table 6.

Table5. Weight and volume density of LECA

Aggregation	Mixture 0-25	Small 0-3	Middle 1-3	Big 1-20
Volume density (kg/m^2)	380+30	485+30	485+30	**335+30**

Table6. Maximum density of aggregates

Aggregate size	Maximum especial weight of aggregates
Small aggregate	**1120**
Big aggregate	**880**
Mixture of big and small	**1040**

10.2. Material Resistance

Resistance is an important factor of selecting light materials. Generally, compressive resistance of concrete is not more than compressive resistance of utilized aggregates. Calculating compressive resistance of aggregates is problematic and the necessary information should be gathered through indirect experiments such as compressive resistance of stone fragment samples, fragment coefficient of aggregates and aggregate performance. Aggregate resistance can result from composed weakness, material texture or adhesive weakness.
LECA is of great resistance with spatial weight of 750-1500 kg/m^3. A LECA concrete of 15×15×15cm and spatial weight of 1500 kg/m^3 (dry weight) was under compressive resistance experiment in construction research center of Iran and a resistance of 28 days equaled 208 kg/m^3. There is no standard method for identifying aggregate resistance. Some common experiments for calculating aggregate resistance are fragment valence experiment for usual aggregates and 10% valence experiment for low resistance materials. 3 kinds of concretes are produced according to European committee forms which are listed below:
S type with spatial weight of 1600-1900 kg/m^3
I.S type with spatial weight of 1450-1600 kg/m^3
I type with spatial weight less than 1450 kg/m^3

11. Acknowledgment

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