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Review

Lightweight expanded clay aggregate as a building material – An overview

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HIGHLIGHTS

- LECA decreased density, shrinkage and mechanical strength, but increased workability.
- LECA decreased chloride penetration, but increased thermal and sound insulation.
- LECA increased fire resistance, but decreased freeze/thaw resistance.
- LECA could be employed into geopolymers.
- Various materials could be added to improve special properties of LECA media.

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ABSTRACT

LECA is the abbreviation of lightweight expanded clay aggregate. LECA is produced from special plastic clay with no or very little content of lime. The clay is dried, heated and burned in rotary kilns at 1100–1300 °C. LECA is porous ceramic product with a uniform pore structure with almost potato shape or round shape due to the kiln circular movement. The abundant numbers of small, air-filled cavities in LECA give its lightweight, thermal as well as sound isolation characterizes. In this article, the earlier studies which focused on using LECA as a part of building materials in traditional cementitious materials, as well as inorganic polymers (geopolymers), have been briefed. Furthermore, various materials which added to modify some properties of LECA concrete and mortar have been briefed and reported. The main findings of this review are the incorporation of LECA in the matrix increased its workability, decreased density, decreased mechanical strength, decreased freeze/thaw resistance, increased water absorption, decreased chloride penetration resistance, but increased thermal insulation and fire resistance.

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1. Introduction

LECA is an acronym term of lightweight expanded clay aggregate. It is also known as LIAPOR (porous lias clay), grow rocks or hydrocorns [1]. LECA is produced in many countries (more than twenty countries) with various products name. Particular countries produce LECA with approximately similar method such as UK, Iran, Portugal, Finland, Germany, Italy, Denmark and Switzerland branded it as "leca", whilst Sweden, China, Poland and Russia branded it as "Keramzite". Spain branded it as "liapour", whilst South Africa branded it as "Argex". Whatever, LECA is produced from special plastic clay with no or very little content of lime. The clay is dried, heated and burned in rotary kilns at very high temperatures of approximately 1100–1300 °C [2]. During heating, gas is released inside the pellets and entrapped in it during cooling, whilst the organic compounds burnt off forcing the pellets to expand (or bloated) producing ceramic pellets with porous, lightweight and high crushing resistance material (Fig. 1). LECA pellet may expand up to 5–6-fold, by volume [3]. LECA has almost potato shape or round shape due to the kiln circular movement. Inside LECA particles, there are holes of different sizes which are mostly interconnected (Fig. 2). Other types have different structures and geometries. This depends on the manufacturer process, of which increasing temperature during sintering led to an increase in the total porosity and producing continuous pores. Further increase temperature above the pyro-plasticity range let to a reduction in the pore size and porosity [4].

LECA consists of rounded pellets which when broken open shows a vesicular texture [5]. In most cases, LECA is a dark brown or reddish or brown-red or gray colours. Yellow or black colours are also available. These differences in colours could be associated to the varieties in LECA chemical composition and its manufacture method. It is an inert lightness substance and does not contain harmful materials with natural pH value (nearly 7), it does not damage in water, moisture impermeable, non-combustible, non-biodegradable, non-decomposition against severe conditions, excellent thermal insulation, fire resistance, soundproofing by its high acoustic resistance. LECA may have different sizes (from 0.1 to 25 mm) which suitable for fine aggregate, coarse aggregate and both of them (Fig. 3). The lightness of LECA could be associated to the multi-separated air spaces which exist inside and among the aggregates. LECA has many loose bulk densities fluctuated from 250 to 710 kg/m^3 [1] which mainly depends on its size.

The chemical composition of LECA consists mainly of SiO_2, Al_2O_3, Fe_2O_3, CaO and some alkalis such as Na_2O and K_2O [2]. Table 1 presents the chemical composition of LECA for various studies. It can be noted that the content of SiO_2 in the total composition fluctuated from 53.3% to 70%, Al_2O_3 fluctuated from 15.05% to 27%, Fe_2O_3 fluctuated from 1% to 14.3% and CaO fluctuated from 0.2% to 3.92%. LECA has many interesting physical properties. Its thermal conductivity in the range of 0.097 to 0.123 W/m K [6]. Ardakani and Yazdani [7] found a wide range of the crushing resistance, dry density, 24 h water absorption, loose bulk density of LECA. Table 2 briefs some of the physical properties of LECA of different studies. The numerous densities of LECA can be considered as one advantage of using this type of aggregate, of which these make it suitable for both structural and nun-structural lightweight concretes.

LECA is an impressive versatile material which is used in a various number of applications. For example, in the construction field, it can be used widely in the production of lightweight blocks, concrete, precast as well as in structural backfill against foundations. In

Fig. 1. The flowchart of LECA production (http://www.ftmmachinery.com).