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Discussion

A discussion of the paper "The effects of expanded perlite aggregate, silica fume and fly ash on the thermal conductivity of lightweight concrete" by Ramazan Demirboğa and Rüstem Gül☆

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Drs. Demirboğa and Gül have studied the effects of expanded perlite aggregate, silica fume and fly ash on the thermal conductivity of lightweight concrete (LC). The authors did not clarify the relationship between density and thermal conductivity (TC) of LC used for their study. The TC of a material is the rate at which it transmits heat and is defined as the ratio of the flux of heat to the temperature gradient. Surely, the density of LC is a most important factor but water content and loading temperature significantly influence the TC of the LC. Typical values of density and TC for different cementitious materials are given in Table 1.

From the point of view of structural changes in the cement gel, for the temperature range up to 1275 K three processes are the most important, namely, the decomposition of $Ca(OH)_2$ at about 735 K, decomposition of calcium silicate hydrates at about 975 K and decomposition of calcium carbonate at about 1175 K. During these processes, gaseous substances (H_2O and CO_2) are released. Since the thermal conductivity of gaseous substances are quite different than that of the hydration product, it is expected that the thermal conductivity will change during the early period of hydration. The water–cement ratio of the LC strongly influences the conductivity at a very early age. Due to the fast generation of the mentioned gaseous substances, the local overpressure in some parts of the porous system may lead to crack appearance, and consequently to the opening of preferential paths for the pore water flow. The increasing of porosity in a cementitious material leads to a decrease of density. The increasing amount of bigger pores then logically leads to a decrease of thermal conductivity because of the increasing amount of the air void in the material.

Table 1
Typical values of density and thermal conductivity for different cementitious materials

	Density, ρ (kg/m^3)	Thermal conductivity, λ (W/mK)
Gypsum	800	0.153
Cement mortar	1,860	0.321
Lightweight aggregate	1,674	0.189
Pumice	1,613	0.178
Perlite	784	0.098
Fly ash	2,431	0.467
Natural zeolite	2,190	0.426
Sand (dry)	2,360	0.448
Stone	3,120	1.045
Air	1.293	0.026
CO_2	1.964	0.017

Source: Refs. [1–3].

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