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Full Length Research Paper

The effect of zeolit rate on the thermo-mechanical properties of concrete

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Zeolite (clinoptilolite) is mainly natural volcanic porous tuff and it has strong absorption ability, large specific surface area and lightness. The concrete has been produced using in the rate of 0, 5, 10 and 15% zeolite as an aggregate in the concrete. In the mixing, water to cement ratio was kept at 0.50. The thermo-mechanical properties of the concrete have been measured. It has been found that thermal conductivity has decreased with the zeolite in concrete but compressive strength increased with the increasing zeolite rate in the concrete.

Key words: Zeolite, Thermo-mechanical properties, lightweight concrete.

INTRODUCTION

Lightweight concrete (LWC) is a vital material for construction as it offers a range of technical, economic and environment-enhancing and preserving advantages. Since the mechanical properties of LWC are considerably lower than normal weight concrete (NWC), the structural usage is limited. In order to use LWC for structural purpose, the material must be engineered to show adequate strength, ductility or both of them (Arisoy and Wu, 2006). Zeolite is aluminosilicate materials characterized by its upon structure which has interconnected cavities that can be accessed by molecular, atomic and ionic species. Their structure allows unique adsorptive properties, which provide catalytic abilities. Natural zeolite contains large quantities of reactive SiO_2 and Al_2O_3. Similar to other pozzolanic material such as silica fumes and fly ash, zeolite substitution can improve the strength of concrete by the pozzolanic reaction with $Ca(OH)_2$ (Couves et al., 1993). It can prevent bleeding, segregation and delamimition of fresh concrete so as to make pumping process easier, decrease permeability of hardened concrete, enhance durability especially the resistance to alkali-aggregate reaction, increase concrete strength and minimize cracking caused by self-shrinkage in concrete (Feng and Yang, 1987). Although, Turkey has large zeolite source, it has not been used in industrial field while it is being used in some fields such as agriculture and purification of waste water (Urhan, 1987). Thermal conductivity is an important parameter for a material and it depends on its structure and temperature. Concrete produced using different types of aggregate can have different density and the effective thermal conductivity arise from differences in their porosity. Thermal behavior of concrete is relevant to any use of concrete, especially in relation to structures where it is desirable to have low thermal conductivity, dimensional stability, high specific heat and little or no decrease of stiffness upon heating. A few works have been performed on thermal conductivity and some studies have been done on the effect of admixture and the mechanical properties of concrete (Gül and Uysal, 1997). In this work, the experimental results of the thermo mechanical properties of concrete contains different rate of zeolite will be presented.

EXPERIMENTAL DETAILS

The concrete has been produced using zeolite as an aggregate in the rate of 0, 5, 10 and 15 in the concrete. The zeolite was obtained from Enli Mining Company in Manisa-Gördes. The other type of aggregate used in concrete production was the natural aggregate and it has been obtained from Isparta-Atabey. The cement was Portland Cement (42.5 N/mm^2) and the chemical compound of cement and zeolite are given in Table 1 and some properties of PC 42.5 are listed in Table 2.

In order to investigate the effect of zeolite rate on thermo-mechanical properties of concrete, three different mixing designs were prepared. The water to cement ratio of all mixtures was kept at 0.50 and the cement was used 350 kg/m^3. Mixtures proportions are given in Table 3. 10 × 10 × 10 cm cube samples and cylindrical sample with 150 mm diameter and 300 mm length were prepared with these mixing designs. These samples were cured for

Table 1. The percentage of chemical composition of cement and zeolite.

Compounds	Porland cement	Zeolite
CaO	61	1.91
MgO	3.56	1.10
K_2O	0.11	3.40
Fe_2O_3	3.81	1.84
SiO_2	22.56	68.82
Al_2O_3	7.11	14.16
SO_2	2.70	0.13
H_2O		7.38

Table 2. Physical and mechanical properties of cement PC42.5.

Fineness 90 μ	Blaine (cm^2/g)	Specific gravity (gr/cm^3)	Flexural strength E28(MPa)	Compressive strength E28 (MPa)
0.1	2919	3.12	7.88	55.8

Table 3. Mixture proportions (kg/m^3).

Zeolite rate	Water	Cement	Zeolite	Fine normal aggregate	Coarse normal aggregate
0	175	350	0	704.91	1128.97
5	175	332.5	17.5		
10	175	315	35		
15	175	297.5	52.5		

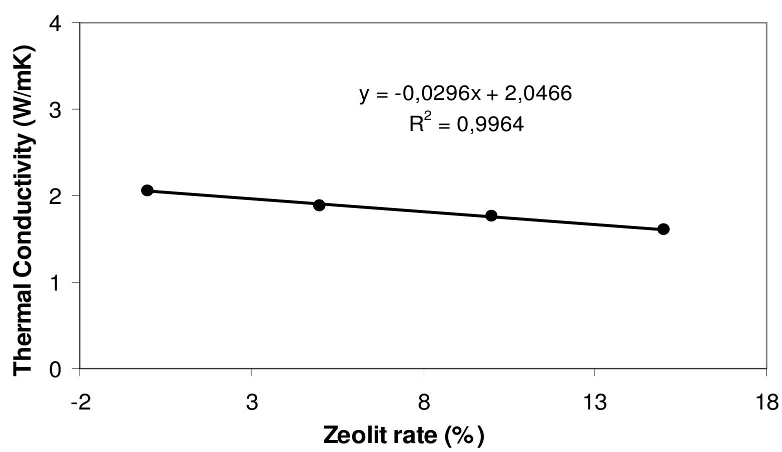

Figure 1. Thermal conductivity of concrete as a function of the zeolite rate in the concrete.

28 and 90 days in water at 22°C until the time of testing. After curing, the samples were tested for compressive strength.

RESULTS AND CONCLUSIONS

The zeolite rate, besides the thermal conductivity and the physical and mechanical properties of the concrete has also been investigated. In Figure 1 the thermal conductivity of the concrete as a function of the zeolit rate has been displayed. It can be seen from this figure that the thermal conductivity decreases with the increasing zeolite rate in the concrete. On the other hand the compressive strength increases with the increasing zeolite rate in the concrete. This is displayed in Figure 2. Thermal conductivity has been displayed against compressive strength in Figure 3 where it can clearly be seen those of non linearity for both period. The unit

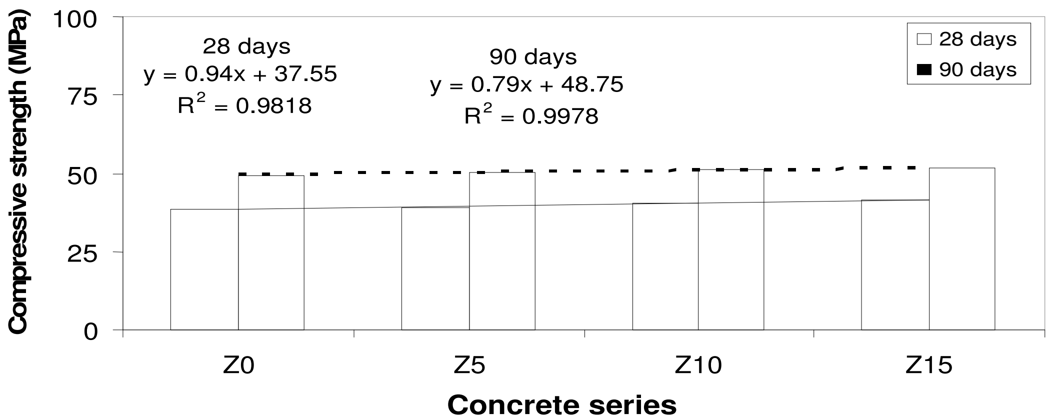

Figure 2. Variation of compressive strength for 28 and 90 days with the zeolit rate in the concrete.

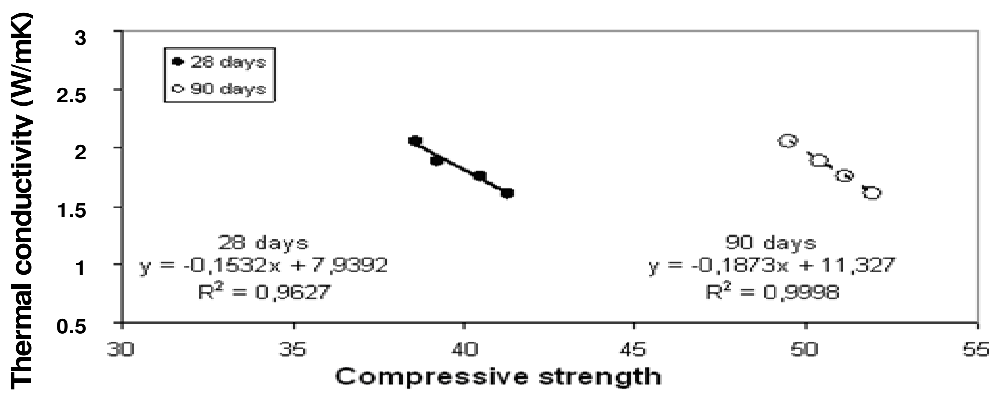

Figure 3. Thermal conductivity versus compressive strength for 28 and 90 days.

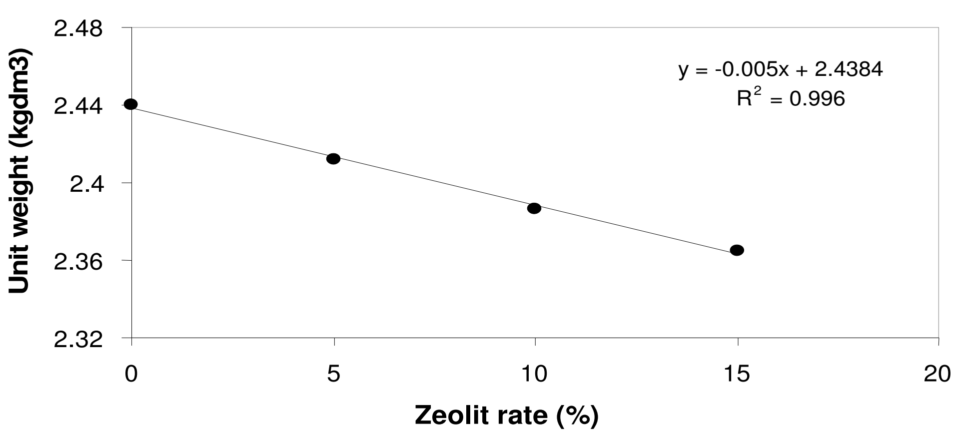

Figure 4. Unite weight of the concrete as a function zeolite rate.

weight has also been decreased with the increasing zeolit rate in the concrete as shown in Figure 4. The correlation between unite weight and thermal conductivity has been shown in Figure 5 where the linearity can clearly be seen. It can be concluded from this work that the zeolit is a porous materials and thus made density of the concrete's

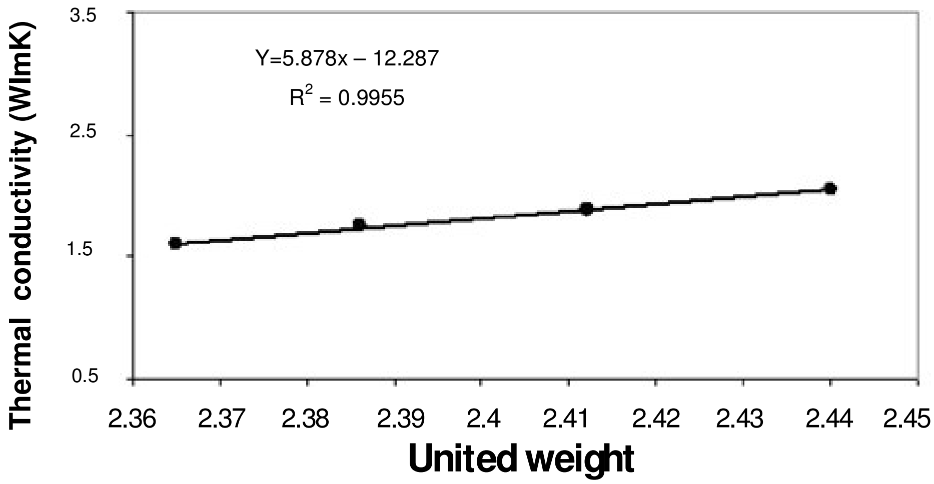

Figure 5. Unite weight of the concrete as a function zeolite rate.

density reduced. While a linear relation has been found between zeolite rate and compressive strength non linear relation between has been found between thermal conductivity, unite weight. As the thermal conductivity is an important parameter in concrete production, due to low thermal conductivity, zeolite can be used to obtain isolation in the structure.

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