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EFFECT OF AGGREGATE TYPE ON MORTARS WITHOUT CEMENT

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ABSTRACT

The purpose of this study is to investigate the usability of polyethylene (PET) wastes in cementless mortar production. It was examined the effects of PET wastes, silica, river and crushed-stone sands on different properties of mortar. In this sense, cementless mortars were prepared by mixing sands homogeneously with molten PET waste after PET wastes had been molten at the temperature of 200^{o}C. Specific weight of each sample was measured and then thermal conductivity, water absorption capacity, bending strength and sound conductivity of samples were tested. According to the obtained test results, it was shown that most of the properties of cementless mortars produced with PET wastes were strongly related with type of sand.

Keywords: Acoustical properties, mechanical properties, thermal conductivity

INTRODUCTION

Many researches have been performed on the harmful effects of wastes on natural ecosystems. Developed countries are pointed out that recycling of plastic wastes is an important topic in order to decrease environmental pollution and prevent waste of resources. Plastic materials are the most important commercial materials due to their easy processability. Despite of their easy processability and usability, it is too difficult to recycle their wastes because classification of plastic wastes is a tremendous problem during recycling process. For example, plastic bags are produced by collecting and reprocessing of PET bottles, medical wastes or used plastic buckets. On the other hand, only 1% of plastic bags are recycled and 99% of them contribute environmental pollution [1, 2].

Recycling of plastic wastes can be possible by using these wastes as a component of a composite construction material. They can be used as an inorganic filling material. By this way, it can be possible to increase surface stiffness and fire resistance, to alter thermal and electrical conductivities, to improve aesthetic appearance and to decrease production cost [3]. It was achieved to use PET wastes in concrete as an aggregate material and this phenomen was proved in previous studies [4-7]. On the other hand, PET wastes were succesfully used in cementless concrete production and ductility of concrete was improved by recycling these wastes [8]. Some studies have been done on usability of plastic wastes in polymer concrete production for a long time. Polymer impregnated concrete, the first polymer concrete composite, has a wide usage area nowadays [9].

In this study, it was investigated the usability of PET wastes in cementless mortar production and the effects of three different sand types on mechanical properties of mortar. Water absorption capacities, bending strengths, specific weights, thermal and sound conductivities of samples were measured.

MATERIAL AND METHOD
Material

Polyethylene (PET), silica sand, river sand and crushed Stone sand: used in this study.

METHOD
Production of Cementless Mortar

Plastic bottles were broken into small pieces. 50 % PET in weight was put into a pan and it was molten at 200 ^{o}C. Melting process continued until a viscous solution was obtained from PET (Fig. 1). 50% sand in weight was added onto this molten PET and sand/molten PET mixture was continuously stirred to obtain a homogeneous mixture. This mixture was then poured into 4 x cm x 4 cm x 16 cm moulds. After being dried during 2-3 hours, these samples were removed from the molds by cooling them with cold water. These processes were repeated for each sand type. It was tried to obtain samples having good surface properties during all process applied to produce cementless mortar (Fig. 2).

Fig.1. Melting process of PET

Fig. 2. Samples removed from moulds

EXPERIMENTAL STUDIES
Specific weight and water absorption capacity

Specific weights and water absorption capacities of samples are obtained (Table 1).

Sound Conductivity

In a solid material, ultrasonic sound emission alters according to the elastic properties and density of solid material. Sound emission rate is indirectly used as a criterion to obtain quality ofa solid material. Spaces and unductilities can be seen in some material blocks. In such cases, predetermination of these faults is very important to qualify properties of material and to measure its sound emission rate. In this study, inductilities of samples were detected by PUNDIT sound conductivity tester. This method was succesfully applied to brick and concrete samples in previous studies [10-12]. Sound conductivities of samples were given in Table 1.

Thermal conductivity

Thermal insulation is indispensible not only for today, but also for tomorrow. If thermal conductivity of a material is under the value of 0.060 kcal/mh°C, it is called as “thermal insulator” according to the Turkish Standarts TS 825 and Institute of German Standarts DIN 4108. If its conductivity is higher than the critical value 0.060 kcal/mh°C, then it is classified as “construction material”. Materials used in buildings have different thermal conductivities [13]. Thermal conductivities of ligth-weight materials are generally lower than those of heavy materials. For this reason, ligth-weight materials are frequently preferred [14]. Results of thermal conductivity test were shown in Table 1.

Table 1.Experimental results of samples

Properties	Sample		
	Silica sand	River sand	Crushed stone sand
Specific weight(g/cm^3)	1.390	1.597	1.837
Water absorption (%)	0.724	0.554	0.998
Sound conductivity (m/sec)	1.887	1.851	2.702
Thermal conductivity (W/mK)	0.5948	0.7766	0.8409
Bending strength (N/mm^2)	13.67	11.72	12.55

Bending strength

All samples were exposed to one-point bending strength test. Test results were given in Table 1 and stress-strain curve was illustrated in Fig. 3.

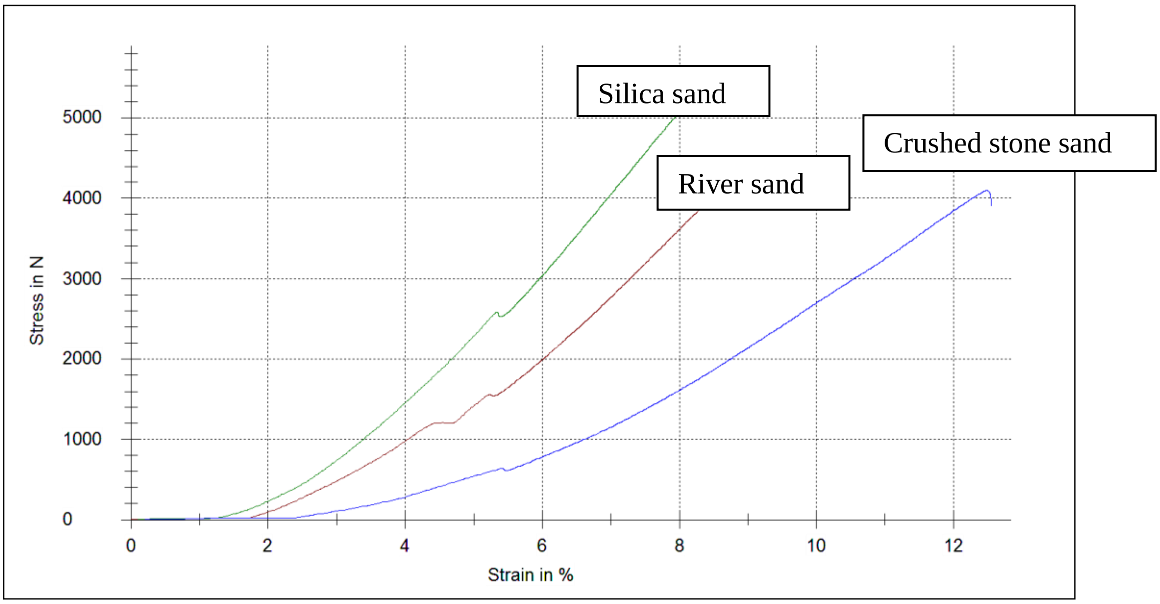

Fig.3. Tensile stress/strain curve

RESULTS

Specific weight and water absorption capacity

According to the results, sample containing crushed stone sand has the highest specific weight than those of others. However the lowest water absorption capacity is seen in sample produced from river sand.

Sound and thermal conductivity

Sound conductivity of samples containing silica or river sands are nearly the same with each other. Their sound conductivity performance is lower than that of sample containing crushed stone sand. Sample produced from silica sand has the lowest thermal conductivity.

Bending strength

Bending elasticity, bending resistance and toughness values are determined via one-point bending strength testing. The best and poor bending elasticities are observed in samples containing river sand and silica sand, respectively. Sample produced from river sand has the highest bending resistance. Mortars with cement, produced with same molds, had approximately 7-8 MPa bending strength after they had been cured during 28 days [15-19]. If obtained test results are compared with bending strengths of samples containing cement, it is seen that samples produced from various sands have extremely higher bending strength values.

When it is determined the area remaining under stress-strain curve, it is seen that thoughness of samples containing silica, river and crushed sands are 9000 J, 2000 J and 6000 J, respectively. The highest toughness value belongs to the sample produced from silica sand.

CONCLUSION

It is resulted that the material prepared from crushed sand meets the demands for using as a construction material. Ductility level of cementless mortars will positively affect the behaviours of high buildings against earthquake forces. If it is considered that large amount of world is on the seismic zone, it is very important to improve brittle property of concrete. Damages on buildings can be decreased because energy absorbability of these type of materials is higher against the dynamic forces. Consequently, both recycling of PET waste and production of high ductile material can be possible by using PET waste in cementless mortar production. Advantages of cementless mortars prepared in this study can be listed as below.

1. They have enough bending resistance.
2. These samples have extremely high insulation properties.
3. Environmental pollution can be declined by recycling of PET wastes.
4. Building weightincreases amount of damage caused from eartquake. Thereby, decreasing building weight is an important factor in order to reduce damages and casualties. By this suggested material, building weight can be decreased.

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