Using the Travertine Wastes in Denizli and its Surroundings as an Additive of Cement

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ABSTRACT

It is intended to minimize the damage to agriculture of travertine wastes, which are one of the most important export products in Denizli, to reduce the waste piles, to minimize the waste costs of travertine factories and to improve the mechanical properties of concrete in this study. In this experimental study, travertine has been used in concrete instead of 5%, 10%, 15%, 20%, 25% and 30% of cement. Compressive strength and flexural strength has been tested after 28 days from the production of concrete. The travertine doped samples were compared with natural models.

Through this study, optimum travertine percentages had found and a waste, which harms the agriculture, had used in concrete as an additive material. And producing concrete pavings and curbs with this optimum percentages is planned.

Keywords: Recycle, waste, travertine mud, compressive strength, flexural strength

INTRODUCTION

The travertine is a rock type that is identified with the city Denizli and every year 800000 m^3 travertine are removed from quarries. After processed from factories, travertines are manifactured as coating and paving materials. Every year approximately 120000 m^3 travertine are processed from factories and between %20-%60 of them are left as waste and stashed at empty places near the factories. Because of travertine's chemical properties, these empty places become unsuitable for agriculture. Transporting, stacking and destroying the wastes means extra cost to the travertine factories.

Using travertine wastes in concrete is going to contribute to the economy. When the chemical structure of travertine examined silicon dioxide (SiO_2) and calcium oxide (CaO) rates are similar to cement. After availability of travertine wastes has been proved with tests, then with the facilities which builded close to the factories, travertine wastes are going to be back for the production. Most important widespread impact of this study is not only a brand new material has been developed but also a waste, which harms the agriculture, had used in concrete as an additive material

There are studies about using wastes in the literatüre. Filiz at al., studied binding ability of marble dust with using marble dust instead of cement [1]. In an other study Yazıcıoğlu and Demirel used the pumice in Elazığ instead of cement and examined effect to strength [2]. Kavas and Kibici examined the contribution as an additive to cement the production of marble waste [3]. In this context, marble powder, barite, pear move, corncobs, brick powder, flotation wastes, granite wastes, adobe, pumice , methacholine and travertine have been used.

MATERIALS AND METHODS

In this study, samples which travertine wastes were used instead of cement weight percentages of %5, %10, %15, %20, %25 ve %30 has been produced. When producing the samples, 4x4x16cm steel templates has been used. To stabilize the homogeneity , travertine muds have been added to samples with the mixture of water. Samples that taken into molds have been shaken with the shake table and wait for them 1 day to reach the power point. And then samples was put in pool and has been waited for another 28 days. After 28 days, compressive strength and bending strength test has been applied to the samples and compared with the mere samples.

Materials-Cement

In this experimental study, Portland cement (CEM II/ B-M (P-L) 42,5N) is used as cement, silica sand is used as aggregate. Physical properties of the cement we use are given in Table 1 and chemical properties of the cement we use are given in Table 2.

Table 12 Physical Properties Of Cement

	Cement	Standard	Unit
Initialize of power point	165	min.60	minute
End of power point	260	-	minute
Specific weight	3,13	-	g/cm³
Volume expansion	1,1	max.10	cm
2 days strength	26,2	min.20	MPa
28 days strength	59,5	min./max. 42,5/62,5	MPa

Table 13 Chemical Properties Of Cement

	Cement	Standard	Unit
SO_3	2,65	max. 4,0	%
MgO	1,15	-	%
Boiling lose	3,30	max 5,0	%
Insoluble residue	0,34	max. 5,0	%
CI-	<0,01	max. 0,1	%
Total Alkali $Na_2O+0,658\ K_2O$	0,65	-	%
Free Lime	0,95	-	%

Materials- Travertine

Physical properties of the travertine that we use are given in Table 3, chemical properties of travertine that we use are given in Table 4. 3 pieces was taken from travertine wastes which were taken as mud and dried in 100°C for 24 hours. Then pieces weighed out to find losing weight percentages. (Table 5).

Table 14 Physical Properties Of Travertine

Hardness	4	Mohs
Unit weight	2,5	gr/cm^3,

Specific weight	2,72	gr/cm^3,
Suction in boiled water	1,2	%
Porosity	2,3	%
Compressive strength	570	Kgf/cm^2
Impact resistance	11	Kgf/cm^2
Bending Resistance	108	Kgf/cm^2
Modulus of elasticity	5,38x104	Kgf/cm^2
Degree of porosity	8,1	%

Table 15 Percentages Of Travertine Content

SiO_2	0,26
Feo_2	0,32
CaO	54,55
MgO	0,31

Table 16 Water Content Of Travertine

Sample number	First weight (gr)	Weight after drying (gr)	Percentages of losing weight
1	200	153,6	23,20%
2	200	154,6	22,70%
3	200	154,8	22,60%
Average	200	154,37	22,80%

Method-Bending Strength Test

With the loader cylinder ,prism samples have been loaded vertically until it loses its strength with the increase speed of (50 ± 10) N/s.

Samples which divided into two parts after bending strength test have been preserve for compression strength test. Eq (1).

$$R_f = \frac{1{,}5 x F_f x I}{b^3} \quad (1)$$

R_f : Bending strength, (Newton/mm^2)

b : The side of the prism square section (mm),

F_f : Breaking force (Newton),

I : The distance between the bearing rollers (mm).

Method-Compressive Strength Test

Samples which divided into two parts after bending strength test have been prepared for compression strength test. Each half prism has been tested with side surface loading with the compression apparatus.

Results of compression and bending strength test are presented in Table 6.

Table 17 Results Of Compression And Bending Strength Tests

Test set	Average compression strength (MPa)	Average bending strength (MPa)
Pure Samples	31,55	7,0312
%5 Travertine	32,6041	7,4062
%10 Travertine	40,8333	8,5312
%15 Travertine	38,1875	8,5312
%20 Travertine	35,125	8,1562
%25 Travertine	31,6041	7,4062
%30 Travertine	21,8333	6,5624

CONCLUSIONS

The samples which travertine doped instead of cement weight percentages of %5, %10, %15, %20, %25 ve %30 has been compared with the pure samples. (Figure 1-2).

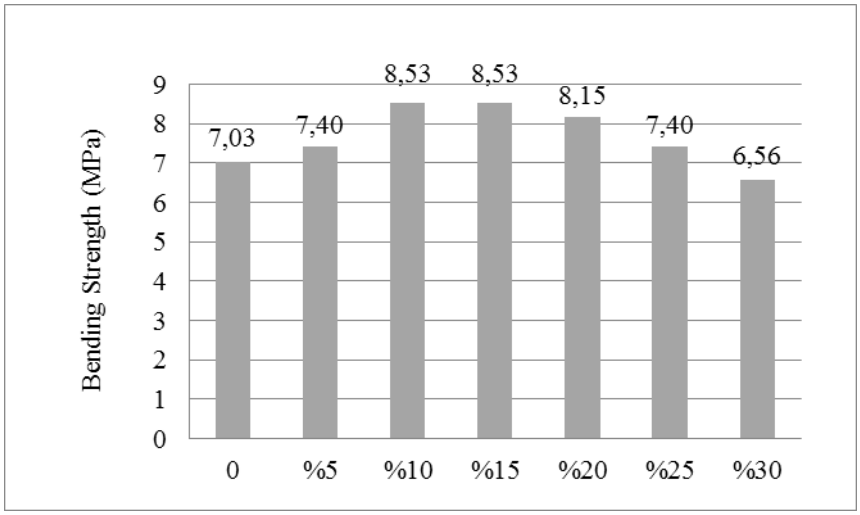

Figure 15 Results of bending strength tests

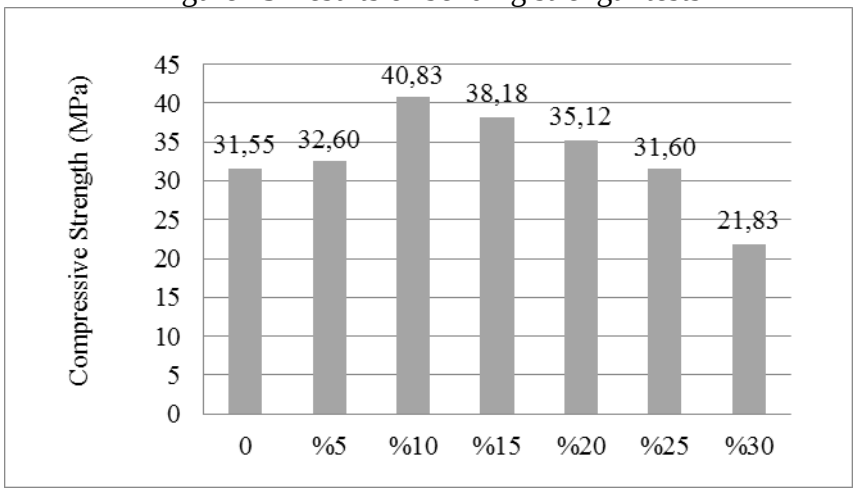

Figure 16 Results of compressive strength tests

In this experimental study, to minimize cost of production, travertine wastes were taken as mud and added concrete instead of cement in different percentages. Succesfull results have been observed until the additive rate of %25. In the additive rate of %30, compression and bending strength levels have been decreased.

Using travertine mud instead of cement in concrete proved travertine's binding sufficiency.

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