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INVESTIGATION OF THE USABILITY OF RECYCLED ASPHALT PAVEMENTS AS CONCRETE AGGREGATE

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Özet: Günümüzde, artan inşaat faaliyetleri nedeniyle atık malzemelerin değerlendirilmesi çalışmaları da hızlanmıştır. Beton ve yol malzemelerinin geri dönüştürülmesi ekonomik faydanın yanı sıra çevresel kazanımlar da sağlamaktadır. Bu bağlamada deneysel olarak yürütülen bu çalışmada, kazınmış asfalt kaplamasının beton karışımında agrega olarak kullanılması hedeflenmiştir. Üretilen beton numuneler de agrega olarak farklı oranlarda kırmataş, bazalt ve kazınmış asfalt kullanılmıştır. Bağlayıcı olarak CEM I 42.5 R tipi çimento ve çimentoya belli oranda ikame uçucu kül kullanılmış, ayrıca işlenebilirliğin kolay sağlanması ve buna bağlı betonun uygun kalıplanabilmesi için polikarboksilat kökenli kimyasal katkı kullanılmıştır. Üretilen numuneler üzerine basınç deneyi uygulanmış olup sonuçlar, kazınmış asfalt malzemenin agrega olarak kullanımının beton basınç dayanımını düşürdüğünü ancak uygun oranlarda kullanımının umut verici olabileceğini göstermiştir.

Anahtar Kelimeler: Geri Kazanılmış Asfalt, Beton Katkıları, Beton Basınç Dayanımı

Abstract: Today, due to the increasing construction activities, the evaluation of waste materials has also accelerated. Recycling concrete and road materials provides environmental benefits as well as economic benefits. In this experimental study, it was aimed to use the scraped asphalt pavement as aggregate in the concrete mix. Different proportions of limestone, basalt and scraped asphalt were used as aggregates in the produced concrete samples. CEM I 42.5 R type cement and a certain amount of replacement fly ash were used as binder, and a polycarboxylate based chemical additive was used to ensure easy workability and appropriate molding of the concrete. Pressure test was applied on the produced samples, and the results showed that the use of scraped asphalt material as aggregate reduces the compressive strength of the concrete, but its use in appropriate proportions can be promising.

Keywords: Recycled Asphalt, Concrete Admixtures, Concrete Compressive Strength

1. INTRODUCTION

Concrete, which is a composite material consisting of cement, aggregate, water and different types of additives, has been frequently used in construction activities from past to present. The use of concrete, which is necessary to meet the increasing human population and accordingly the increasing vital needs, is constantly increasing. For this reason, the supply of materials used in concrete is becoming an increasingly important problem. The recycling of materials has an important place in terms of reducing the consumption of natural resources and preventing environmental pollution, as well as providing economic benefits in concrete production (1, 2, 3). The supply of aggregate, which is used in the highest ratio by volume and weight (4), is one of the main factors that cause environmental problems in concrete production. For this reason, recycling studies in the world are accelerating day by day. Today, in addition to aggregates such as limestone and basalt, obtained by recycling e.g.; waste iron (5, 6), waste tire (7, 8), waste

concrete (9, 10, 11), waste asphalt (12, 13) slag (14, 15) many different materials are being tried to be used. Concrete additives are used to overcome the workability (5, 9, 10, 12, 16) problems that may occur with the use of these aggregates. Plasticizer chemical additives contribute to the workability of fresh concrete (17, 18). Similarly, fly ash is known to increase workability in fresh concrete due to its fine and spherical grains (17, 19, 20).

Due to scraped asphalt materials, which have a usable value for different purposes even after scraping, which are left idle in waste sites and thus create a negative environmental impact, in this study the usability of the scraped asphalt material, which has completed its life as concrete aggregate was investigated.

2. EXPERIMENTAL STUDY

Three different types of concrete were produced for experimental studies. On production, CEM I 42.5 R type cement as cement, fly ash obtained from Çatalağzı Thermal Power Plant as fly ash, Polycarboxylate based plasticizer concrete admixture in accordance with TS EN 934-2 + A1 standard and as an aggregate; limestone, basalt and recycled asphalt materials are used.

Basalt material was used in the mixture in response to possible strength reduction due to recycled asphalt aggregate. In order to compare this mixture, another mixture produced with basalt and limestone was produced without using recycled asphalt.

The recycled asphalt used was obtained from the hot mix asphalt pavement and was used without any extraction from bitumen, only by sieving in accordance with the gradation in Table 1.

Table 1. The granulometric composition of the aggregates used

Sieve Size (mm)	Passing (%)
31,5	100,00
16	75,50
8	57,50
4	44,00
2	30,62
1	22,37
0,5	15,17
0,25	8,42
0,125	3,75

Concrete mixing procedure: 30 s. dry materials (aggregate, cement and fly ash) followed by 90 s. liquid materials (water and chemical additives) 60 s. rest and 120s. to be the final mix total 300s. has been determined. Laboratory type concrete mixer was used for mixing.

Figure 1. Laboratory type concrete mixing machine

The additives used were kept constant in all mixtures and the difference in results due to additives was eliminated. The chemical additive rate was 0.5% (by cement weight) and the mineral additive was added to the mixture by replacing the cement at the rate of 20%. The purpose of the fly ash used is to wrap the bituminous material more easily by the cement paste and to increase the workability.

Aggregate ratios were chosen as given in Table 2. The gradation given in Table 1 was used for all mixtures and substitution was made for the mixtures according to the following material percentages.

Table 2. Aggregate ratios used for the mixture types produced

Mixture Code	Aggregate Type		
	Limestone	Basalt	Recycled Asphalt Material
Mixture I	100%	0%	0%
Mixture II	50%	50%	0%
Mixture III	25%	25%	50%

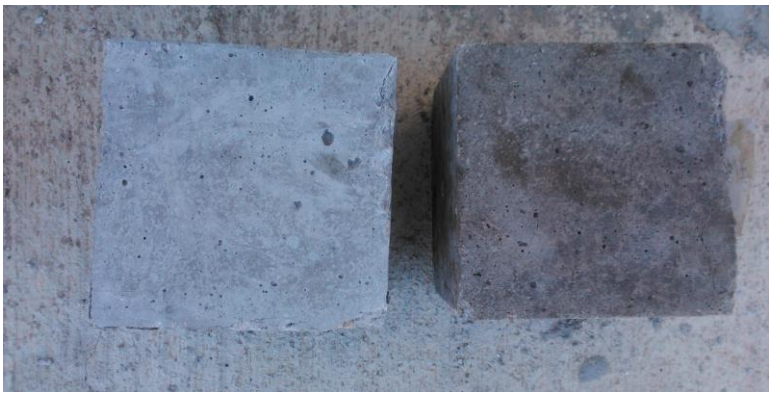

Figure 2. A concrete sample produced with limestone aggregate on the left, concrete sample using limestone, basalt and recycled asphalt aggregates together on the right.

3. RESULTS and DISCUSSIONS

The cube concrete samples produced were kept in the curing box and broken after 28 days and the results are given below.

Table 3. Concrete compressive strength values for mixture types

Mixture Code	Average Compressive Strength Values of Concretes at 28 Days (MPa)
Mixture I	34,40
Mixture II	35,30
Mixture III	24,90

As seen in Table 3, the highest compressive strength was obtained in Mixture II, where basalt and limestone aggregates were used together and in equal proportions. This is an expected result due to the use of basalt in aggregate replacement (21, 22, 23). Although the results are close to Mixture II for Mixture I produced with only limestone aggregate, substitution of half of the crushed stone with basalt slightly increased the compressive strength results in Mixture II. According to the literature, the compressive strength values of concrete tend to decrease with the increase in the recycled asphalt ratio used in concrete (3, 12, 24, 25, 26, 27). The results obtained from the experimental study matched the values encountered in the literature, and the lowest compressive strength among the produced mixture types was obtained from Mixture III, in which the recycled asphalt material was also used.

4. CONCLUSIONS

In this study, in which the use of recycled asphalt materials as concrete aggregate was investigated, 3 different mixtures were made and the cement, mineral and chemical additive types and ratios were used the same for these mixtures, only the effect of different aggregate type on the compressive strength was examined. The results are summarized as follows:

For the three different mixtures produced, the highest compressive strength was obtained from Mixture II, where basalt aggregate was used together with limestone aggregate.

The lowest compressive strength was found for Mixture III, which was formed by replacing the recycled asphalt material with basalt and limestone aggregate.

Similar to the literature (16, 26), it was thought that the recycled asphalt material could not be fully wrapped by the cement paste due to its bituminous nature and the aggregate cement adherence loss caused this situation. For this reason, it is thought that using only the aggregate of the recycled asphalt material in the mixture as extracted will have a positive effect on the compressive strength values.

However, although the use of recycled asphalt as aggregate reflects negatively on the compressive strength, its use at lower rates is thought to be promising for sustainability. In future studies, it is recommended to examine the results by making productions with different additives, higher cement dosage and a lower percentage of recycled asphalt material.

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