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Investigation of Using Rubber Granules in Concrete

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Abstract: **-** While rapid but patchy urbanization occurs, the substructure of the city gets behind in rapid urbanization. Rapid and unplanned urbanization in the country has brought considerable social and administrative problems with population explosions in some cities and increase in the number of vehicles. The amount of waste tires was increased according to number of vehicles. Waste tires are used as raw materials in many sectors. In this study, usability of rubber granules in buildings and rigid pavement has been investigated. The aim of this study is to test the availability of using rubber granules in concrete. The rubber granules were not increase the strength of concrete.

Keywords: **-** *Rubber, granule, concrete, waste material, tire*

I. INTRODUCTION

Our country is among the developing countries at all points. While rapid but patchy urbanization occurs, the substructure of the city gets behind in rapid urbanization. Rapid and unplanned urbanization in the country has brought considerable social and administrative problems with population explosions in some cities and increase in the number of vehicles. The most important of these problems are excessive fuel consumption, environmental pollution; accidents transportation difficulty and traffic jam whose social cost is high [1]. According to increasing in number of vehicles, the amount of waste tires was increased. Due to increasing of amount of waste tires environmental pollution was increased (Fig. 1.1).

Fig.1.1. Waste tires and environmental pollution

It has gained importance that the recycling of waste tires in order to reduce the environmental pollution due to these materials. The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

The purpose of the study is while investigating the usability of waste tires in structural materials; use them as a recycled tool. At first, before using rubber powder, control samples have been prepared. The samples that obtained using rubber granules include 5% and 10% of the cement amount. Concrete compressive strength of control and rubber granule involved samples was gained and the results were compared. According to the findings some suggestions were provided.

II. MATERIAL AND METHOD

Waste tire is a tire removed from a vehicle after determining its useful time span has completed, and no longer can be used on a car, or scrap tires that generated during production. Waste tires are called junk tires [2]. Tire is a product which has various types and sizes that is produced from rubber by linking and strengthening components for passenger and cargo transport vehicles, classified depending on the reinforced material used. The vehicle tier is composed from combination of several chemicals with rubber, tire cord fabric and steel wires, and is one and only part that provides interaction between the vehicle and ground. Tires are a composition of

rubber, steel, fiber and other contaminants. Table 1 below shows the percentage of these components in a tire. 95% of the waste tires consist from recyclable products [2].

Table 1. Percentage of components in waste tires

Product type	Trucks tires	Car tires
Rubber	70 %	70 %
Steel	27 %	15 %
Fiber and others	3 %	15 %

Rubber granules are produced with different sizes, and are commonly used in many industries. Rubber granules are generally used in football, volleyball, basketball and Astroturf, tennis courts, tartan and athletics floors, walkways, rubber flooring and manufacture of products which can be shaped (Fig.2.1).

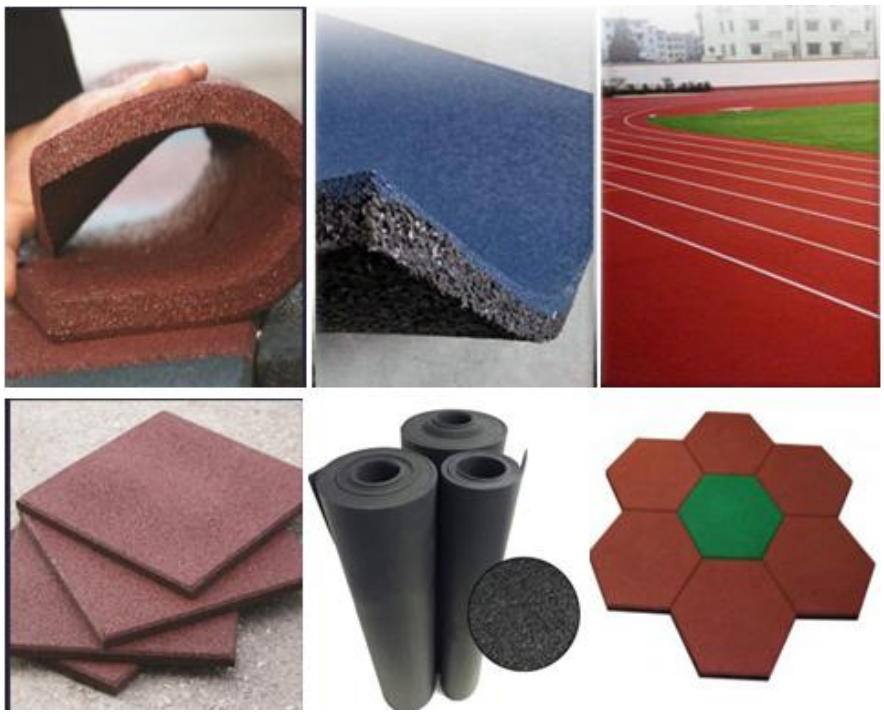

Fig.2.2. Some uses areas of rubber

This study was investigated the use of rubber granules in the concrete. Nowadays, the concrete aggregate that widely used in building construction is obtained from a mixture of cement, water, and other necessary ingredients in ratio calculated.

In this study, the concrete compressive strength were determined using the rubber material, which is 70 percent of car tires, obtained from recycled rubber granules. Using certain amount of rubber granules, it has been examined that how to modify the properties of concrete pressure resistance. In this study, the parameter taken into consideration is withstanding of the reinforced concrete pressure. Classifications according to the characteristic cylinder compressive strength are shown in Table 2.

Table 2. Classification of concrete strength [3]

Concrete Class	C20	C25	C30	C35	C40	C45
f_{ck} (MPa)	20	25	30	35	40	45

This study examines hardened concrete samples that have different aggregate samples. One obtained from a crushed stone plant located in Bitlis. The other one is a common commercially available concrete which was produced using PÇ32,5 cement and water.

2.1 Aggregate

Aggregate used in the study were obtained from the ready-mixed concrete plant located in the province of Bitlis. Aggregates are used by segregation to grain boundaries, shattering and cleaning in the furnace. Used material to produce concrete aggregates is crushed stone and limestone material. Specific weight of the aggregate is 2.77 gr/dm3.

2.2 Cement

The cement type was PKÇ/B 32.5R which was obtained from Siirt Kurtalan Cement Fabric. Chemical components of the cement used in concrete that will be used in concrete compressive strength tests are shown in Table 3.

Table 3. Chemical analysis result of cement (PKÇ/B 32,5 R)

Component	**Percentage**
Silisyum dioksit (SiO_2)	27,74
Alüminyum oksit (Al_2O_3)	7.27
Demir oksit (Fe_2O_3)	3.96
Kalsiyum Oksit (CaO)	49.97
Magnezyum Oksit (MgO)	2.85
Kükürt trioksit (SO_3)	2.21
Klorür (Cl)	0.0012
Loss on ignition (K.K.)	4.99
Not assigned (T.E.)	-
Insolubleresidue (E.K.)	-
Free lime (s.CaO)	1.06
Total additive	28.99

2.3 Mixing Water

One of the compounds in concrete is also water. For the concrete production drinking water of Bitlis province was used.

2.4 Rubber Granules

Stiren Butadiene Rubber are manufactured from tires of used the idle truck, bus and truck by separating the fragmented textile and steel using crushers with mechanical blade. Used SBRs are illustrated in the Figure 2.3.

Fig.2.3. Rubber granules that used in concrete

III. EXPERIMENTS AND RESULTS

The performed experiments were conducted in construction laboratory of BEU, Vocational School of Technical Sciences. The findings of experiments and results are given below.

3.1 Obtaining the samples of hardened concrete

Test sieve analysis on aggregate samples obtained from furnace was performed. In order to use it in concrete sample, TS 1227 suitable 0.25mm, 0.50mm, 1mm, and 2mm,and TS 1226 suitable 4mm, 8mm, 12mm 16mm, 22,5mm square mesh sieves were used for the aggregates. Figure 3.1 illustrates the sieve analysis results and grain size.

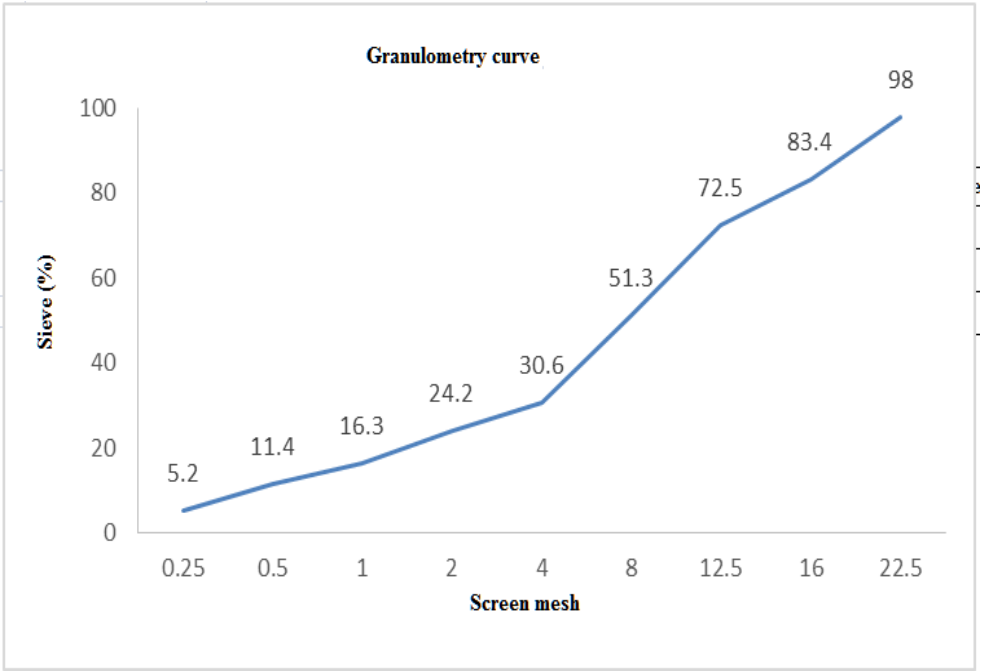

Fig. 3.1. Test results of sieve analysis

Mixing ratio of samples prepared considering to concrete class which obtained from aggregate fractions are given in Table 4. Mixing ratios are given for 1 m^3 concrete.

Table 4. Mixture ratios of samples

Material Type	C25/30
Large(kg)	435
Middle (kg)	-
Thin (kg)	355
Sand (kg)	1040
Cement (kg)	330
Water (kg)	180
W/C	0.54
Slump (cm)	10

The amount of materials used for the hardened concrete samples were illustrated in the table. The features of the mixture that was prepared involved concrete class of C25 and temperature of 11^0C. The ambient temperature was 10^oC, and settlement value was chosen as 10 cm. The concrete samples were obtained as 15*15*15 cm cube materials. The samples were left in cure bath at the temperature of 20±5 ^{o}C for 7 days. 7-day compressive strength of concrete samples held in the curing pool was measured. Pressure test values obtained from the arithmetic mean of control samples are given in Table 5.

Table 5. Compressive strength of control samples

Name of sample	**Curing time**	**Compressive Strength (Mpa)**
Control Sample	7	25.62

When the control sample experiments were done, other samples were prepared and subjected in the same manner. Pressure resistance values obtained using rubber granules which was 5% of the cement amount gathered from mix design are given in Table 6.

Table 6. Compressive strength of samples which have %5 rubber granules

Name of sample	Curing time	Compressive Strength (Mpa)
%5 Rubber Granules	7	11.43

Pressure resistance values obtained using rubber granules which was 10% of the cement amount gathered from mix design are given in Table 7.

Table 6. Compressive strength of samples which have %10 rubber granules

Name of sample	Curing time	Compressive Strength (Mpa)
%5 Rubber Granules	7	11.87

IV. CONCLUSION

The population growth in our country and in the world has triggered an increase of the number and usage of vehicles. Along with these increase the waste tire amount has also went up considerably. Since the amount of waste tire was increased; recycle of these materials has gained a specific interest. Nowadays, recycled waste tires are used in many industries. This study investigates the usability of the rubber granules in concrete obtained from waste tires and rubber which is 70% of the waste tires. For this purpose, concrete samples obtained using rubber products, then pressure tests were performed on samples, the results compared and some recommendations have been made.

This study investigates the availability of the waste products, which today increase dramatically, instead of raw material. From this point, waste management is one of the most important issues of the current century. With the correct realization of waste management, significant environmental and economical gains will be achieved. Numerous studies must be done over the availability of waste materials in different sectors. In this study, compressive strength of concrete produced from rubber granules found in waste tires were examined. The results have showed that rubber granules do not contribute the compressive strength of the concrete. Even, experiments showed that rubber granules have decreased it by 55%. The increase of compressive strength of concrete also increases the reinforced concrete structures' strength arise from both horizontal and vertical loads. According to these results, it is not possible to use rubber granules to increase the strength of concrete.

It is also not possible to use them for rigid pavements since the specifications for the repair of concrete pavement says that minimum comprehensive strength of the concrete must be 28 MPa. However, it may be possible to use waste tires in concrete production using some specific concrete production methods like Reactive Powder Concrete (RPC).

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