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STUDY THE EFFECT OF ADDING WOOL FIBERWASTE ON THE MECHANICAL PROPERTIES OF SBR/R.R COMPOSITES

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ABSTRACT

The effect of fillers such as mix of wool fiber on mechanical characteristics are studied in styrene butadiene rubber (SBR) and reclaim rubber (R.R) blend. The present study carried out through six recipes according to the loading level of mixed of industrial scraps (wool fiber) that it used as reinforcement materials in the compounds. The mechanical properties tests carried out according ASTM specification. All compounds are composed of wool fiber (0, 10, 20, 30, 40, 50) pphr. The results revealed that the mechanical properties were varied according to loading level, therefore; tensile strength and elongation were decreased with increasing the loading level of mix W.F. Also, the elastic modulus, tear resistance, hardness shore A and water absorption was increased with increasing loading ratio of W.F waste.

Key words: Composite materials, Mechanical properties, Waste, Wool fiber.

INTRODUCTION

The study of the mechanical properties of materials engineering one of the very important things that must be taken into consideration because they define the behavior of these materials under influence of stress applying on it[1] and under the influence of various external conditions as pressure, temperature, time of stress, the speed of the stress, the nature of chemical solvents and other factors that affect a lot on the mechanical properties of the polymer matrix composite materials, the study of Mechanical properties a very complex because of many variables that affecting on each property[2-4]. Composite materials consist of two or more materials with different specifications associated with each in a certain way to

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give a compositions and be better than the characteristics of the properties materials included in the composition if they use individually[5-6] reinforcement material may be particles or fibers or sheets etc.

Many researchers have extensively studied fluid resistance and compression set behavior of rubber and rubber blend compounds loaded with different filler[7-11]. The effect of wool fiber loading on the mechanical properties of SBR and reclaim rubber compounds needs to be understood deeply. Therefore the aim of this paper was to determine the effect of the wool fiber loading on the mechanical properties in antiwetness covers at different temperatures on SBR and R.R compounds.

Rubbers can be divided broadly into two types: thermosets and thermoplastics thermosets are three-dimensional molecular networks, with the long molecules held together by chemical bonds. They absorb solvent and swell, but do not dissolve; furthermore, they cannot be reprocessed simply by heating. The molecules of thermoplastic rubbers, are not connected by primary chemical bonds. Instead, they are joined by the physical aggregation of parts of the molecules into hard domains[12]. Hence, thermoplastic rubbers dissolve unsuitable solvents and soften on heating, so that they can be processed repeatedly. In many cases thermoplastic and thermoset rubbers may be used interchangeably. However, in demanding uses, such as in tires, engine mounts, and springs, thermoset elastomers are used exclusively because of their better elasticity, resistance to set, and durability. The addition of various the chemicals to raw rubber to impart desirable properties is termed rubber compounding or formulation[13].

Reclaim rubber is a rubber-compounding ingredient. Scrap rubber, unlike scrap steel, undergoes a special process before it can be reused and the obtained rubber at the end of this process is known as reclaimed rubber[14]. Reclaim is in fact a mixture of rubber, carbon black, oil, zinc oxide, stearic acid, and other compounding ingredients used in the original compounds. It is lowers the green strength and tensile strength of the compounds in which it is used. Reclaim can be used in many tire applications such as internal casings components and innerliner compounds, sidewalls, chafers, and rubber used in bead components[15].

Waste of Textile "Wool Fiber": because of the chemical composition of wool fabrics they possess the highest degree of flexibility and resilience and more than all other types of fiber, and fiber is the silk and nylon elastic fibers consider but somewhat less flexibility when woven or non-existent. It owns fiber woolen abrasion resistance and bending more than other fibers, and because the high proportion of N/O_2 also be resistant to combustion and flame Unlike fiber, rayon and cotton, and can be withdrawn to about 70% of the original length, because the molecules are linked in chains is not horizontal, as in the form of corkscrews chains, knows alpha-helix[16].

Vulcanizing Agents: Sulfur is the most well-known vulcanizing agent. It is easily available in powder and prilled form packed in polyethylene bags. Sulfur vastly improves properties of raw rubber, which is sticky and soluble in solvents. With the addition of sulfur, rubber is converted into a nontacky, tough, and elastic product[17].

This article study some of the mechanical properties such as tensile set and hardness and water absorption, So, we can calculate the tensile strength (T.S) by the equation;

$$T.S = F/A \qquad \ldots(1)$$

Where F is the observed force required to break the specimen.

Young's modulus was reported as the slope of the initial linear region of the stress–strain. Actual experimental values were reported as stress–strain curves. The stress and strain are described by the following expressions[18];

$$\text{Stress } \sigma = \frac{\text{Force or load F}}{\text{Cross sectional area A}} \qquad \ldots(2)$$

$$\text{Strain } \varepsilon = \frac{(L - Lo)}{Lo} \qquad \ldots(3)$$

Thus, Young's modulus in a tensile test is given by;

$$E = \Delta\sigma/\Delta\varepsilon \qquad \ldots(4)$$

Therefore, the ultimate elongation is mathematically calculated by the relation;

$$E = [(L-L_o)/L_o]*100\% \qquad \ldots(5)$$

where L_o = Initial thickness and

L = Final thickness.

with respect to the tear strength or the tear resistance in rubber, it may be described as the resistance for growing a neck or cut when the tension is applied on the specimen and it depends upon the width and thickness of the test piece and the test results as the load necessary to tear specimen of standard width and thickness.

$$\text{Tear .S} = F*t_1/t_2$$

where F = Maximum force,

t_1 = Thickness of standard piece, and

t_2 = The measured thickness of the specimen tested[18].

Hardness may be defined as resistance to indentation under specific conditions. This test is conducted on rubbers in accordance with ASTM D1415-68, ASTM D2240-75, and ASTM D531-78.

Water Absorption: the amount of water absorbed by a material under specified test conditions. Commonly expressed as a weight percent of the test specimen. All plants need to good insulate buildings of moisture and rain, groundwater and surface nominated by. It disadvantages of the impact of moisture and water seepage on the buildings they help to damage the elements of construction materials and structural thereby reducing the age ofbuilding[19].

EXPERIMENTAL

Materials

The SBR used is SBR-1502 with 23.5% styrene content (made by the emulsion process), Supplied by the Petkim, Turkey. The Properties of SBR are listed in Table 1 and the properties of fiber are listed in Table 2.

Zinc oxide (97%) and stearic acid (99.4%) were supplied by Durham, U.K. MBS [N-oxydiethylenebenzothiazole 2-sulfonamide] (98.2%) is supplied by ITT, India. Paraphenic oil was supplied by the South Patrol Company. Sulfur was supplied by the Durham, U.K.

Table 1: Properties SBR 1502

Properties	
Density (g/cm^3)	0.95
Bound styrene	23.5 ± % max
Volatile matter	0.75% max
Ash	1.5% max
Soap	0.5% max
Organic acid	4.7-7.2%

Table 2: Properties of fibers

Material	Tensile strength of fibers at equal weight N/mm^2 (Mpa)
Silicon carbide	7000 – 20000
Beryllia Type A	1000 – 4000
Boride	700 – 1500
Iron whiskers	700 – 1500
E-glass	700 – 1100
Fused silica glass	400 – 1100
Tungsten wire	70 – 200
Zirconia fibers	50 – 200
Steel	200 – 280
Nylon 66	689.655

Equipments

Laboratory mill: Baby mill was used, the two roll mills, having provisions for passing cold water. These rolls are cylindrical in shape and of 150 mm diameter and 300 mm length. The roll speed is 20 r.p.m.

The hydraulic press is equipped with thermocouple and maximum temperature is equal to 300°C and vulcanization process done at 20 min.

Equipment for the measurement of Tensile Strength, Tear resistance, Elongation and Modulus of elasticity

Tests are carried out on samples, which were prepared mill laboratory according to ASTM D412. Monsanto T10 tensometer was used. The test sample, which is movable at speed of 200 mm/min for all except tear resistance at 50 mm/min.

Equipment for hardness and water absorption

The International Hardness test is used in measurement of the penetration of rigid ball (according to Brinall method) into the rubber specimen. The measured penetration is converted to the International Rubber Hardness Degrees (IRHD), the equipment as shown in

Fig. 3.16. The scale of degrees is so chosen that zero representsa material having elastic modulus equal to zero and 100 represents a material of infinite elastic modulus. The scale covers all the normal range of hardness. Test was carried out according to ASTM D1415 specifications (Andrew, 1999), (Alan., 2001). And test of water absorption was carried out according to ASTM D471.

Moulds preparation

The necessary moulds were manufactured for test samples to study their mechanical properties according to British standard (BS).

Mould for preparing samples for tensile, tear, elongation, and modulus tests

For preparing samples for the above tests, the sheet sample from each recipe with a dimension of 150*150*2.5 mm was prepared by using mould, which consists of three parts, the middle one in a dimension of 395 mm*158 mm*2.5 mm contains six sections with 150*150*2.5 mm dimension fixed on base of 395*160*10 mm and covered with a cover of the same dimension as that of the base for regulation of thickness.

Mould for testing hardness, and water absorption

For preparing samples for hardness, impact and water absorption, the mould in the laboratories of Tyre Company was used. The mould consists of three parts, the middle part in a dimension of 200*180*6.5 mm, which contains (9) circular equivolume open with 65mm diameter and 5 mm thickness while one of other two parts is bottom base and the other is a cover for the purpose of samples thickness regulation. They have a dimension of 150*150*10 mm.

RESULTS AND DISCUSSION

Tensile, elongation and elastic modulus

Figs. 1-3 show that the increasing of loading ratio of wool fiber causes decreasing in tensile strength and elongation, and the reason is that fibers are blended with the rubber randomly. These fibers are short lengths, they increase the cross-link density but the bonding strength between the rubber chains (correlation between the two rubber chains) stronger than the bonding strength between fiber and rubber (correlation between the thread fibrous and rubber chain) so that yarn short fiber be an impurities separating rubber chains and thus weaken the cohesion between the rubber chains, leading to decrease in tensile strength and elongation. The low elongation leads to increase the elastic modulus because it is inversely proportional to elongation.

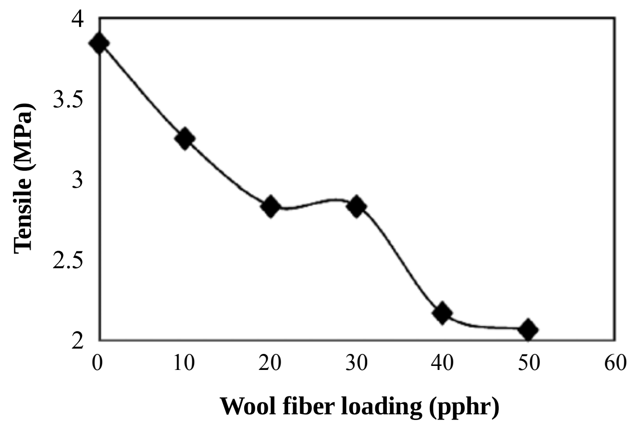

Fig. 1: Effect of adding "Wool Fiber" on tensile strength

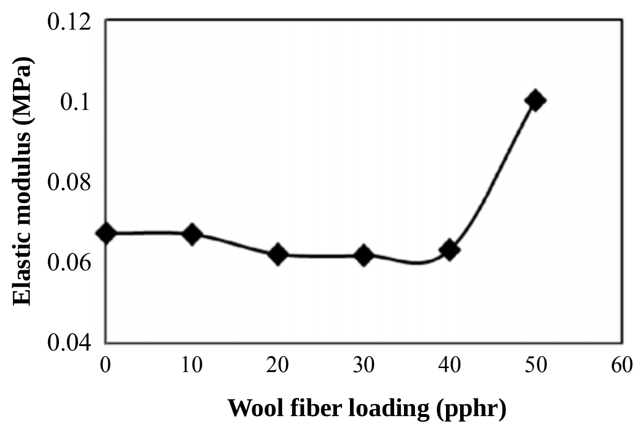

Fig.2: Effect of adding "Wool Fiber" on elastic modulus

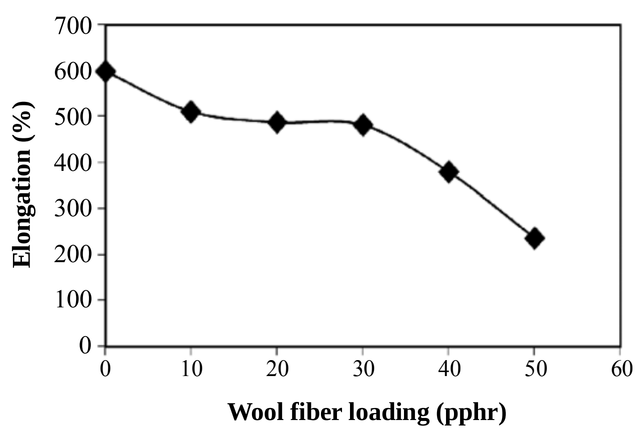

Fig. 3: Effect of adding "Wool Fiber" on elongation

Tear resistance

Fig. 4 shows that the increasing of loading ratio of wool fiber causes increasing in tear resistance and the reason, when the sample is subject to the tear strength, these fibers are to assume the bulk of the load on the sample and this lead to increase the tear resistance with increase the proportion of fiber.

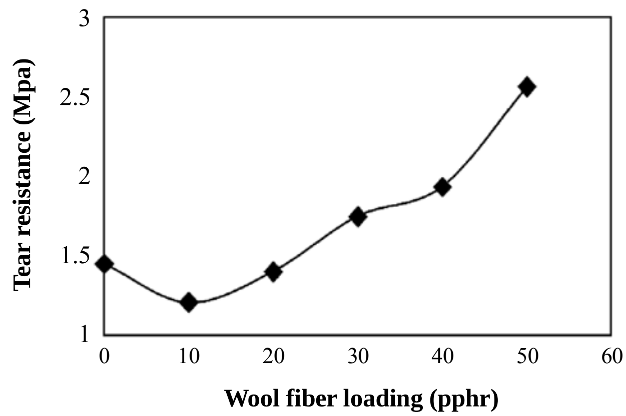

Fig. 4: Effect of adding "Wool Fiber" on tear resistance

Hardness

Fig. 5 shows that the increasing of loading ratio of wool fiber causes increasing in hardness, because fiber increases the density of cross-link and when stitches the needle of hardness test device, the cross-links of threaded fiber works to withstand pressure and lead to increase the resistance of sample surface of the stitch strength and thus increase the hardness of the material surface and this go along with[20].

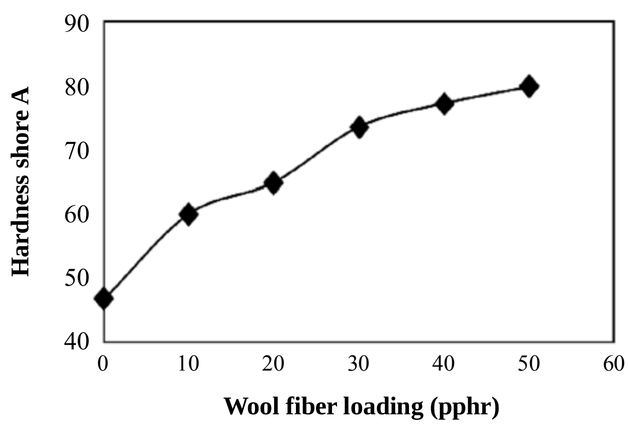

Fig. 5: Effect of adding "Wool Fiber" on hardness

Water absorption

Fig. 6 shows that the increasing of loading ratio of wool fiber causes increasing in water absorption, because of short fiber are impurities within the rubber composite lead to increased pores and this leads to increased water absorption.

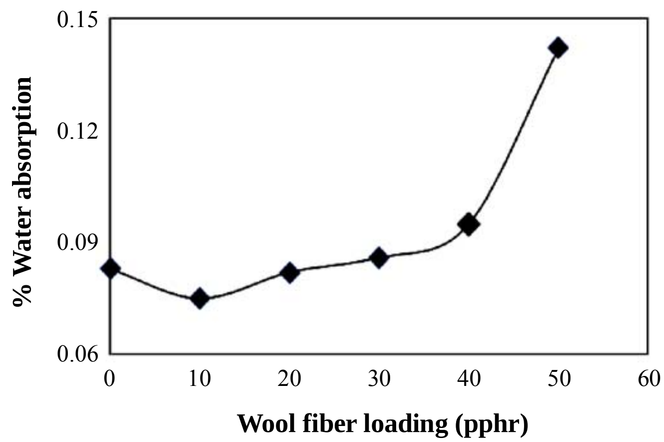

Fig. 6: Effect of adding "Wool Fiber" on water absorption

The samples subjected to a water column pressure by (2940 Pa). This process is performed for all samples, filled the graduated cylinder with water and close the nozzle of this cylinder by sample to be tested for permeability to water, have been identified height of the water in the cylinder (30 cm) and for seven days, and after observing height of the water found that unsubsidized in the cylinder and this shows that the samples not allow to water admission through it.

CONCLUSION

(i) The increasing of additives ratios of waste of textile "wool fiber" causes decreasing the tensile strength and elongation.

(ii) The increasing of additives ratio of waste of textile "wool fiber" causes increasing the elastic modulus and tear resistance.

(iii) The increasing of additives ratios of waste of textile "wool fiber" causes increasing the hardness.

(iv) The increasing of additives ratios waste of textile "wool fiber" causes increasing the water absorption.

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