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Reclaimed Tire and Carbon Black Mixture Effect on Mechanical Properties of Rubber Blends SBR/NR/BR_{cis} Uses as Damping Materials

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ABSTRACT

Rebound resilience for various elastomeric composites has been measured by Tripsometer devise , in order to investigated effect of mix of C.B& Reclaim loading on elastomeric materials to absorb or damping vibration or shocks by fenders uses in the Iraqi berths. The samples included 4 rubber blends from (SBR/NR/BR_{cis}) and four loading levels of mix carbon black (type N-375) and Reclaim to become 16 compound contain SBR(100,60,60,60),NR(0,10,20,30),BR_{cis}(30,20,10,0) and loading level for C.B, Reclaim (10,20,30,40). Damping measurements have been carried out by the method Free Vibration Resilience Pendulum method (by using Wallace R2-Dunlop Tripsometer) and from this Resilience Pendulum method, both the resilience percentage value (R %) and damping time (t_0) have been measured at 50°C. Found that the results of this method proved that the increment of C.B, Reclaim level in these robber composite leads to increasing hardness decreasing the resiliency (R %) and damping time.

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INTRODUCTION

The study of impact strength of material is considered as the first key to study the properties of the material. It is defined for un notched sample as the absorbed energy during the impact to the cross section area of the sample at the fracture of polymer of high toughness has high crack energy, and it is possible to calculate the impact strength from the following relation (Al-Maamory, 2005).

Impact strength =Energy required for crack / sample cross sectional area. Its unit is (j/m^2) and it depends on various variables including type of the materials, temperature, stress system, strain rate, manufacture, and geometry of article, fabrication and environment conditions. In case of rubber the case is different, when rubber is deformed, the energy, which is not returned as mechanical energy, is dissipated as heat in the rubber. The ratio of the energy returned to the energy applied is termed the resilience. When the deformation is owing to a single impact, this ratio is termed as rebound resilience. A collision between two bodies, which occurs over a short interval of time, is known as an impact. Consider an impact between two bodies,

A and B as shown in Fig(1) The principle of conservation of linear momentum is used in cases where impacts occur. Momentum before impact = momentum after impact (Al-Maamory, 2005).

Thus $M_A V$ impact. Consider an impact between two bodies, A and B as shown in Fig. (2) The principle of conservation of linear momentum is used in cases where impacts occur. Momentum before impact = momentum after impact (Mattham, 1998) (Al-Maamory, 2005) (Young,1977).

$$M_A V_A + M_B V_B = M_A V'_A + M_B V'_B \quad (1)$$

Where M_A and M_B are the masses, V_A and V_B the velocities before impact and V'_A, and V'_B, the velocities after impact. The ratio of the relative velocities is known as the co-efficient of restitution (e_r):

e_r = - relative velocities after impact / relative velocities before impact

$$=- (V'A - V'_B) / (VA - V_B \quad (2)$$

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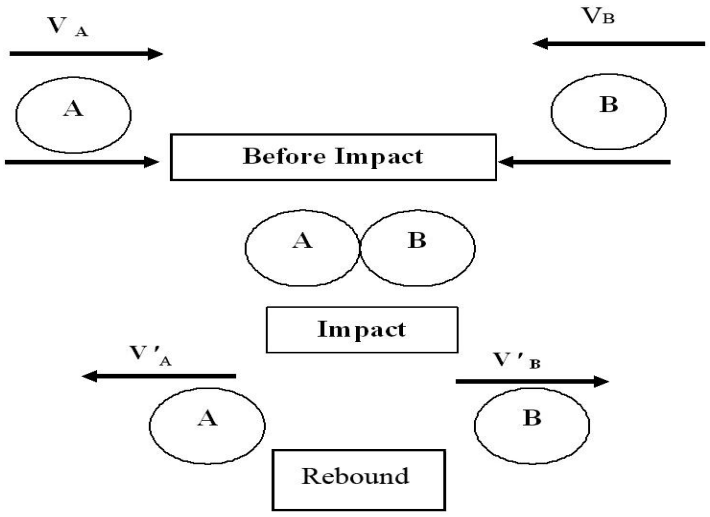

Fig. 1: Elastic collisions(Al-Maamory, 2005).

$$e_r = \sqrt{2gh'} / \sqrt{2gh} = \sqrt{\frac{h^-}{h}} \quad (3)$$

h' /h is known as rebound resilience (for single impact) where h' is the height rebound and h is the height of fall rebound, resilience is related to rebound angle and angle of drop (Al-Masudi, 2007).

Rebound resilience (R %) uncorrected = (1-cos i) /(1-cos j) ×100 (4)
Where i = rebound angle
j =angle of drop (45^0)

(R %) corrected = (1-cos {i+i.x/2}) /(1-cos {j+j.x/2}) x 100 (5)

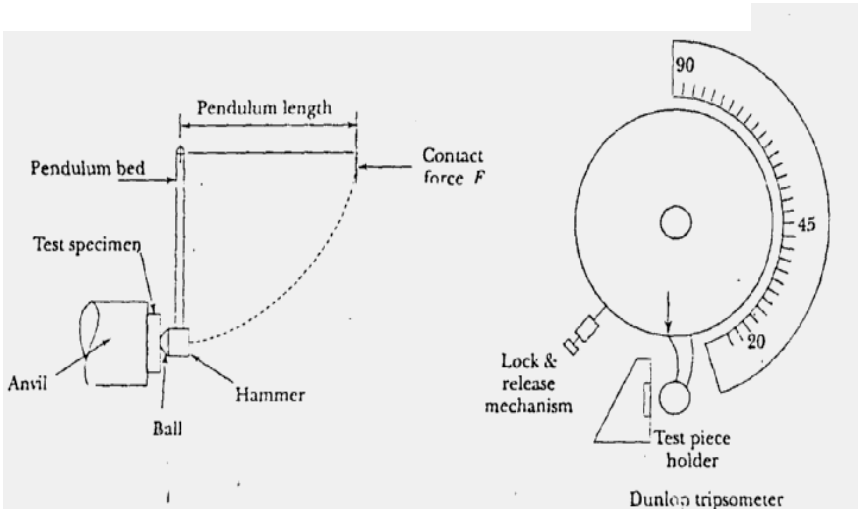

Fig. 2: Schematic representation of a rebound pendulum(Mattham, 1998).

Where x = 1/2n x loge j/i
n= number of swings

The Healey pendulum springs from predetermined height and rebounds to height determined by the resilience of the rubber specimen as in Fig.(2).Rebound resilience: this property is one of the outstanding features of rubber. It shows the ability of a rubber vulcanized to return the energy used to deform it. Resilience is important mainly because it affects the operating temperature of a rubber product, thus influencing its strength and ageing behavior .Rebound resilience increases with temperature.

Experimental part:

1. Materials:

The NR, SBR and BR_{CIS} were reinforced by different volume fractions of carbon black (CB), N375 and reclaim (reclaimed tire grains) supplied by the Babylon tire company.

NR used in this study was of SMR 20, supplied by the Perlis, Malaysia. The compositions of NR are listed in Table (1).

Table 1: Compositions and properties of NR.

Composition and Properties	
Rubber (SMR 20)	94.3%
Protein	1%
Organic matter	2%
Nitrogen content	0.2%
Volatile matter	0.5%
Ash	1%
slag	0.2%
Water	0.8%
Density (gm/cm^3)	0.92
Plasticity	39-48

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 (2). The properties of N375 are listed in Table (3) and the properties of BR_{cis} are listed in table (4).

Zinc oxide (97%) and stearic acid (99.4%) were supplied by Durham, U.K. The 6PPD [N- (1,3 – Dimethyl butyl) – N – Phenyl – Para – Phenylenediamine] (98%) was supplied by Flexsys, Belgium .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 2: 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 3: Properties of Carbon black N375.

properties	N375
Density (g/cm^3)	1.8
Specific surface areas(Iodine number) m^2/g	92±5
DBP absorption number ml/100g	114±5
Particle size (nm)	32
Loss at 105 °C	1%
Ash content	0.75%

Table 4: Properties of BR_{cis}.

Properties	%
Density (g/cm^3)	0.90
ETA extract	1.00 % max.
Volatile matter	0.75% max.
Ash	0.20% max.

2. Preparations of batches:

We are prepared these batches by using laboratory mill and the ratios of the compounding gradient shown in this table:

3. Equipment for Rebound resilience and hardness:

The Dunlop tripsometer takes the form of an out of balance metal disc revolving on virtually frictionless bearing and which acts as a slow moving pendulum. The test piece is placed against a rigid support so that it receives a blow at its centre. A circular scale is provided for measuring the angle of displacement .The measured quantity is the angle to which the disk rebounds after the hammer strikes the specimen. Tests are carried out according to ASTM D1054.

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 Figure 3.16. The scale of degrees is so chosen that zero represents

a 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).

Table 5: Compounding gradient.

Compounding gradients%	Recipe (1)	Recipe (2)	Recipe (3)	Recipe(4)
SBR 1502	100	60	60	60
NR SMR20	0	10	20	30
BR_{CIS}	0	30	20	10
ZINC OXID	5	5	5	5
STEARIC ACID	2	2	2	2
PARAPHINIC OIL	2	2	2	2
CARBON BLACK	Variable (10,20,30,40)	Variable (10,20,30,40)	Variable (10,20,30,40)	Variable (10,20,30,40)
RECLIAM	Variable (10,20,30,40)	Variable (10,20,30,40)	Variable (10,20,30,40)	Variable (10,20,30,40)
6PPD	0.5	0.5	0.5	0.5
MBS	1	1	1	1
SULFUR	1.5	1.5	1.5	1.5

4. Laboratory mill:

Baby mill was used, the two roll mills, having provisions for passing cold water. These rolls are cylindrical in shape and of 150mm diameter and 300mm 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.

5. Mould for rebound resilience and hardness:

For preparing samples for hardness, impact, and density tests, the mould in the laboratories of Tire Company was used the mould consists of three parts. The middle part in a dimension of 200*180*6.5mm 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*10mm.

RESULT AND DISCUSSTION

We get these mechanical properties for all recipe as shown in table (5) by using the molds and the equipment and using the ASTM for all testes.

Fig (3) , Fig (4) and Fig(5) shows the relation between rebound resilience ,damping time and hardness against mix of C.B & reclaim loading in series , from these three graph we indicated that the rebound resilience and damping time decrease with increasing mix of C.B and reclaim loading, while the hardness was increase with increasing mix of C.B and reclaim.

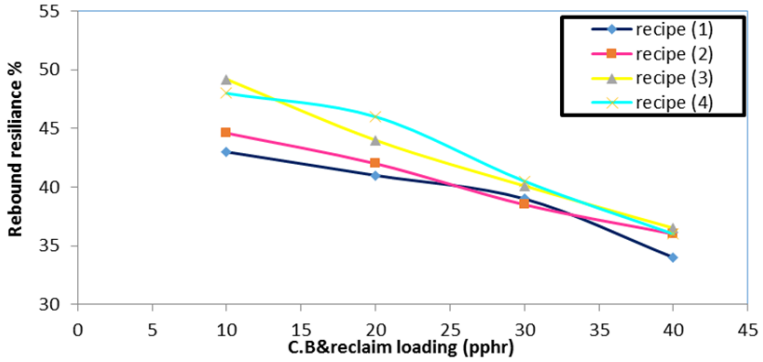

Fig. 3: Relation between loading percent and rebound resilience for different recipes.

These decreasing in rebound resilience and damping time attributed to presence of carbon black resulted increasing number of high adsorption active sites leads to active crosslinking sites between the rubber chains and rubber-C.B, rubber- reclaim this interaction leads to increase hardness in rubber composites (NR/SBR/BRcis) and filling the vacuum between the rubber chains. Hence, cause increasing the hardness while the hardness is inversely proportional with the resilience and damping time this behavior is agree with (Rattanasom, 2005), (Al-Maamory ,2005), (Hassan, 2011).

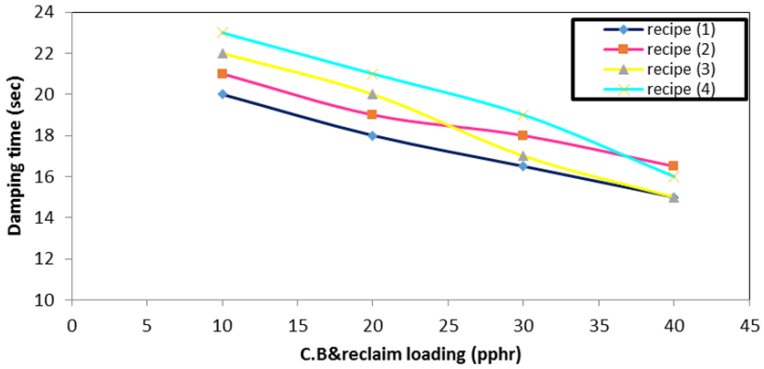

Fig. 4: Relation between loading percent and damping time for different recipes.

So we show that the resilience and damping time were increased with the increase of NR, BR_{cis} ratio this attributed to that NR, BRcis have high flexibility.

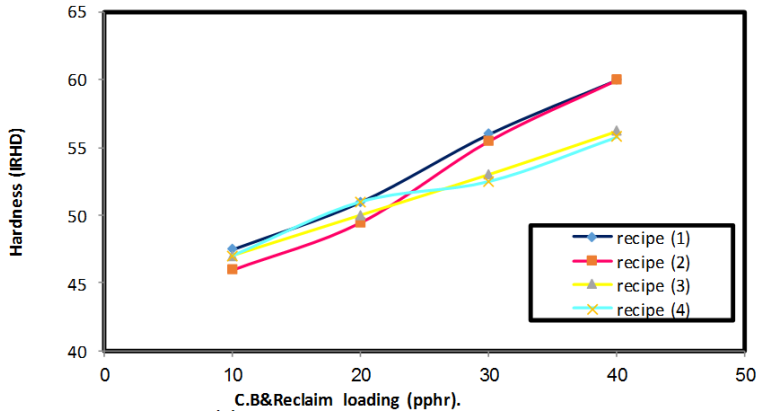

Fig. 5: Relation between loading percent and hardness for different recipes.

With respect to these four graph or four figure (6),(7),(8),(9)were shows the relation between resilience angle and damping time for different compound ,so we show that the damping time was decreased with the increasing of loading level for the same compound (Al-Masudi, 2007). So we get good compound have low rebound resilience and low damping time at high loading level of mix of C.B and Reclaim.

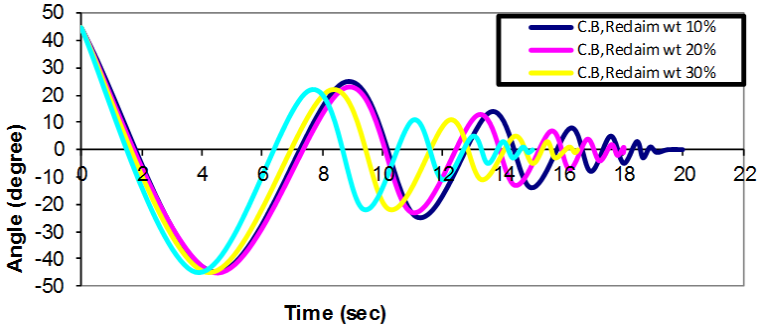

Fig. 6: Relation between resilience angle and time for the composite (SBR 100/NR 0/BR_{cis}0).

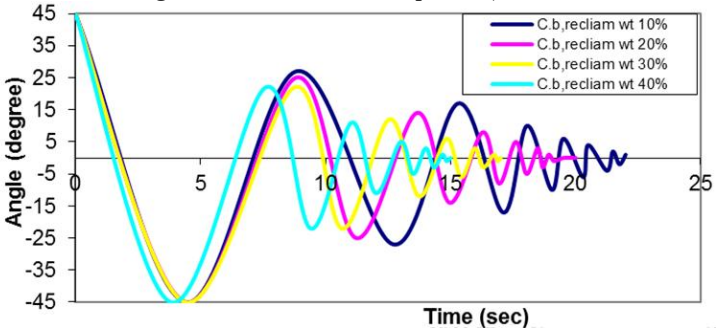

Fig. 7: Relation between resilience angle and time for the composite (SBR 60/NR 20/BR_{cis}20).

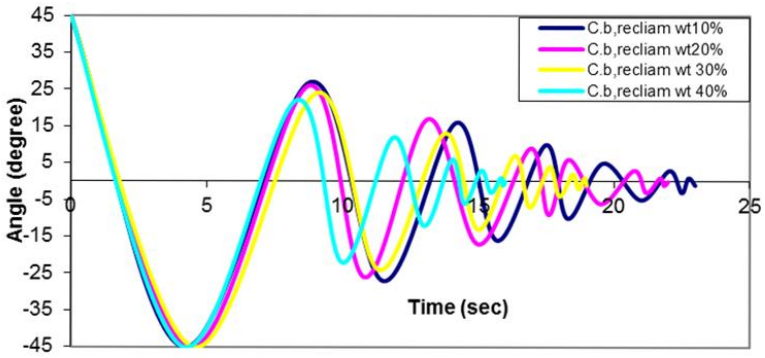

Fig. 8: Relation between resilience angle and time for the composite (SBR 60/NR 30%/BR_{cis}10).

Conclusions:

1) Some of the mechanical properties are decrease as mix of C.B and reclaim percent increase such as rebound resilience and damping time .so we can use the reclaimed tire as alternatives material of fillers.
2)The decrement of rebound resilience and damping time has the advantage in the fenders ships applications .
3)The increment mix of C.B and reclaim more than 60 (pphr) leads to that the composite become bad fenders.

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