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The Effect of Adding Waste of Cement "fly ash" in Some of The Mechanical Properties of NBR composites

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ABSTRACT

Composite materials consist of merging two materials or more are different in mechanical and physical properties, The aim of research is to study the effect of changing in the reinforce percentage by fly ash in mechanical Properties ,for composite material consist of NBR rubber reinforced by carbon black (40pphr) and fly ash (0,15,18,20,23,26,30 pphr), which included tensile strength, modulus, elongation, hardness, tear, resilience, after reinforced NBR rubber with different weight percentage from fly ash and study the effect on above Properties as illustrated in the diagrams

Keywords**:** composite materials; Mechanical Properties; waste of cement; fly ash

1. INTRODUCTION

The study of the mechanical properties of materials Engineering is 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 [Marc A, 1999] and Under the influence of various external conditions as Pressure, temperature, time of stress Damocles.

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 [Brain, 1999; Lucas, 2005; Jane, 2006].

Composite materials consist of two or more materials with different specifications associated with each. In a certain way to give a compositions and be better than the characteristics of the properties materials included in the composition if they use Individually, [Hull, 2003; Callister, 2003], reinforcement material may be particles or fibers or sheets etc., And because of the lightness of the composite materials in Weight, a good electrician and thermal insulation has increased. The urgent need to be used in many Civilian and military fields, Prompting a lot Amendments to properties specially Mechanical properties this of workers in this field to make some By rainforced with other materials To reach the desired properties of their to be use in a lot of applications [Peter, 2006; Chawla, 1987; Higgen, 2006], in this research samples were prepared from a polymer matrix composite reinforced by a different weight percentage of fly ash particles and then the mechanical properties were studied.

2. MATRIX MATERIALS

NBR Rubber

A polymer widely used because of its good properties, which is a copolymer of acrylonitrile and polycarbonate Albiotdan, and it's compositional formula shown in Figure (1).

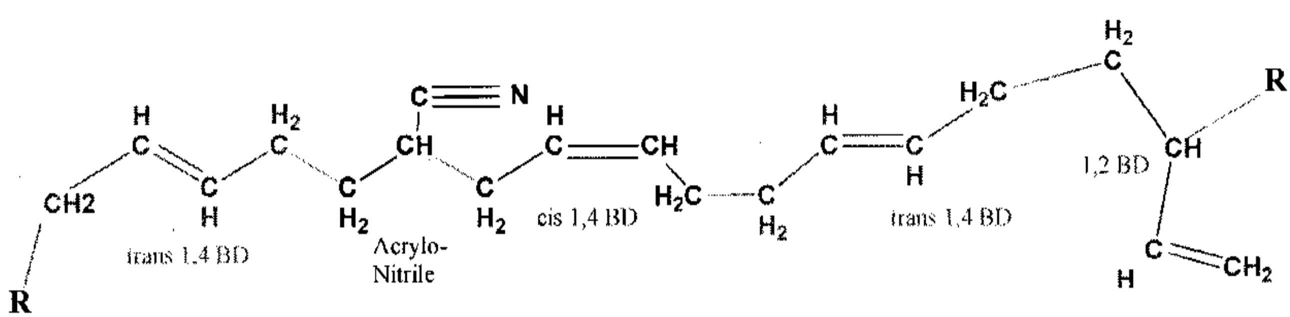

Figure 1. Compositional formula of NBR Rubber [Bayer, 1997].

Waste of Cement "fly ash"

Fly ash is a coal combustion byproduct, which accumulates due to electrostatic precipitation of the flue gases in thermal power plant. When coal is burnt in thermal power plant the ash is carried forward in flue gases as fused particles, which solidifies as a spherical particle. Most of these spherical particles have a gas bubble at the center. Fly ash depends upon the source of coal, contain different proportions of silica, alumina, oxides of iron, calcium, magnesium etc. along with elements like carbon, Ti, Mg, etc. So the fly ash has properties combined of spherical particles and that of metals and metal oxides. Table (1) shows the results of chemical analysis of the fly ash using a technique (XRD).

Table 1. Results of chemical analysis of the fly ash.

Ingredients	ratio
SiO_2	13.40
R_2O_3	5.44
Al_2O_3	2.80
Fe_2O_3	2.64
SO_3	9.83
CaO	37.97
L.O.I	18.50
Total	85.14
MgO	1.68
Res	86.82

Accelerators

Accelerators of vulcanization are classified into organic and inorganic types. Organic accelerators are known to the rubber industry for over a century. Their use in rubber compounding has become universal. Some examples of organic accelerators are hexamine, mercapto-N-cyclohexylbenzothiazolesulfenamide, sodium diethyl dithiocarbamate, tetramethylthiuram disulfide, tetramethylthiurammonosulfide, etc.

These compounds represent almost the entire range of organic accelerators from moderate to ultra accelerators. Inorganic accelerators such as lime and litharge are used in slow curing products like rubber lining. Accelerators reduce the time required for vulcanization.

The benefits of using accelerators are economy of heat, greater uniformity of finished goods, improved physical properties, improved appearance, and better resistance to deterioration [Chandrasekaran, 2007].

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 the 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 [Leny, 2009].

Activators

Activators help accelerators in the vulcanization process. Zinc oxide and zinc stearates are the most popular activators. Zinc oxide is also a reinforcing filler. [Jason, 2007]

Antioxidants

Rubber is degraded by oxidation. In order to prevent this, inhibitors are used during rubber compounding. These inhibitors are called antioxidants. The commercially available antioxidants are grouped into amine types and phenolic types. Products derived from amines, mostly aniline or diphenylamine, are called staining antioxidants because they tend to discolor nonblack vulcanizates on exposure to light and products derived from phenol are referred to as no staining antioxidants. [lenart, 1982]

Process Oils

These materials are added to rubbers primarily to aid in the processing operations such as mixing, calendering, and extruding. They are used along with fillers to reduce the cost of the compound. Peptizing agents are also softeners which increase the mastication efficiency and reduce the Mooney viscosity level to the desired processibility [Chandrasekaran, 2007]

Experimental work

Very briefly, the open mill mixing process is to masticate the polymers until an even and smooth band is formed around the front roller. The fillers and oil are added alternately followed by any small additions and finally the vulcanizing materials. During the whole operation, cutting and blending by hand rolling is carried out. So mixing is the first stage in the conversion of rubber and its compound ingredients into finished products. The mixing was carried out on available laboratory mill, rolls dimensions are: outside (150 mm), working distance (300 mm), speed of the slow roll (24 rpm) and gear ratio (1.4). The roll mill has the facility of controlling the gab distance between the rolls and the rolls temperatures. The mixing operation was executed on two stages, the ingredients of rubber blend are showing in Table (1)

The steps of mixing process are:

a) Passing rubbers through rolls several times with decreasing a mill roll opening to 0.2 cm, at 70 °C.

b) Adding of stearic acid.

c) Adding of zinc oxide.

d) Adding of carbon black.

e) Adding of oil process.

f) Adding TMQ

g) Adding of TMTD

h) Cooling the batch to the room temperature.

i) Adding the sulfur to the master batch.

j) Adding the accelerator

k) Adding of fly ash with different weight percentage

Finally the vulcanization processes are doing in the thermal piston ,and we are making sheets in order to conducting the necessary tests and according to the universal system "ASTM".

Table 2. Ingredients of rubber blend.

Compounding ingredients	Ratio pphr
NBR (Acrylonitirile Butadiene Rubber)	100
Zinc oxide	3
Stearic acid	1
Carbon black	40
Oil	5
TMTD	2
MBTS	1
TMQ	3
Sulfur	1.5
Fly ash	0, 15, 18, 20, 23, 26, 30

Mechanical Properties

Tensile Strength: This is defined as the force per unit of original cross-sectional area which is applied at the time of rupture of the dumbbell test specimen. It is calculated by dividing breaking force in Newton's by the cross-section of unstressed specimen in square meters the samples were prepared by cutting uncured compound sheet to give a test piece of constant volume. This test had been done according to ASTM-D 2705 & D2084-89

Modulus: The term modulus, or stress, is used to express the amount of pull in Newton per square meter required to stretch the test piece to a given elongation. It expresses resistance to extension, or stiffness in the vulcanized rubber.

Once again, in the common parlance of rubber technology the stress required for a given elongation is used to represent the material stiffness. This quantity is called the modulus. A 300% modulus, for example, means the stress required to produce a 300% elongation. In mechanical engineering usage, however, the term *modulus* is defined as the ratio of stress to strain. If this ratio is constant the material is said to be obey Hook's law and the constant is called *Young's modulus* or *modulus of elasticity*. In practice, the term *Young's modulus* is often used to represent the ratio of stress to strain even in situations where it may vary with change in elongation [Wise, 1973].

Elongation: The term elongation is used to describe the ability of rubber to stretch without breaking. To describe this property as measurement, it is more accurate to refer to it as "ultimate elongation", since its value, expressed as percent of the original length, is taken at the moment of the rupture [Roger, 1973].

Tensile strength and elongation properties serve as an index to the general quality of a rubber compound. Rubber compound less than 6.9 MPa in tensile strength are usually poor in most mechanical properties and those with tensile strength over 15.7 MPa are usually good in most mechanical properties. The above three tests were carried out by using Monsanto T10 Tensometer equipment and according to ASTM-D412 [Saltman, 1973].

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

Tear resistance (or tear strength): is resistance to the growth of a cut or nick in a vulcanized (cured) rubber specimen when tension is applied ,this test was were carried out by using Monsanto T10 Tensometer equipment and according to ASTM-D412.

Abrasion: This property in rubber may be defined as the resistance to wearing away by rubbing or impact in service, this test was carried out in accordance with British standard B.S 903 PTA-9 by using Akron Abrader [Roger, 1973].

3. RESULT AND DISCUSSION

As additives increase the tensile strength, modulus, tear resistance, increase also, elongation decrease, because of increasing cross-link between rubber and filler and this result from the small particle size of the fillers" waste of cement" which mean large surface area can interact with rubber chain. As showing in Figures 1,2,3,4.

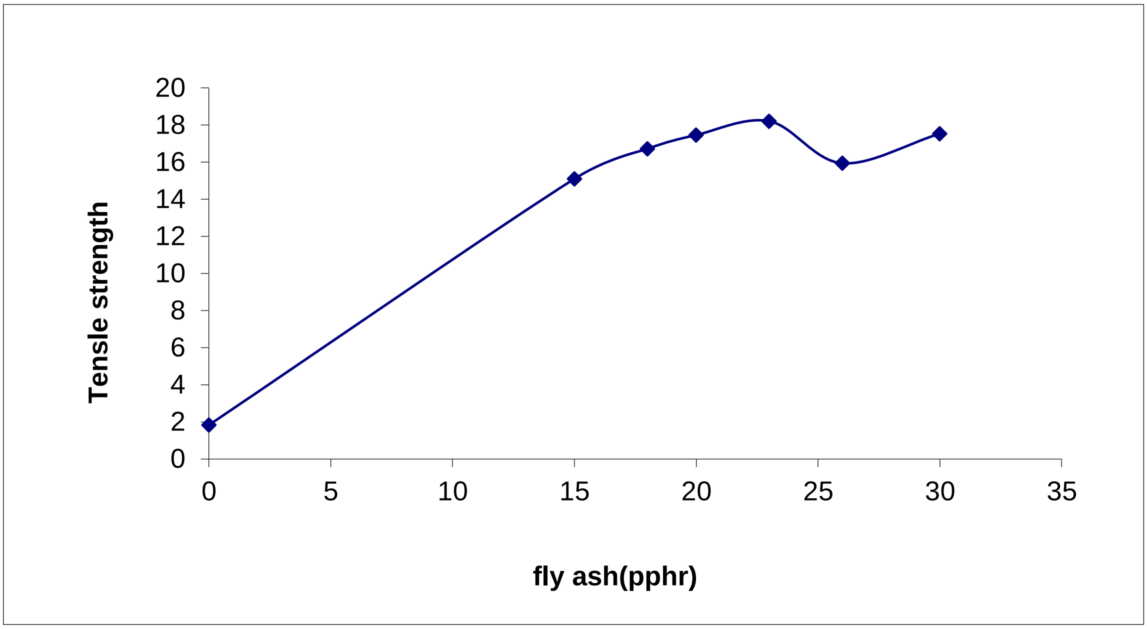

Figure 2. Effect of adding waste of cement on tensile strength.

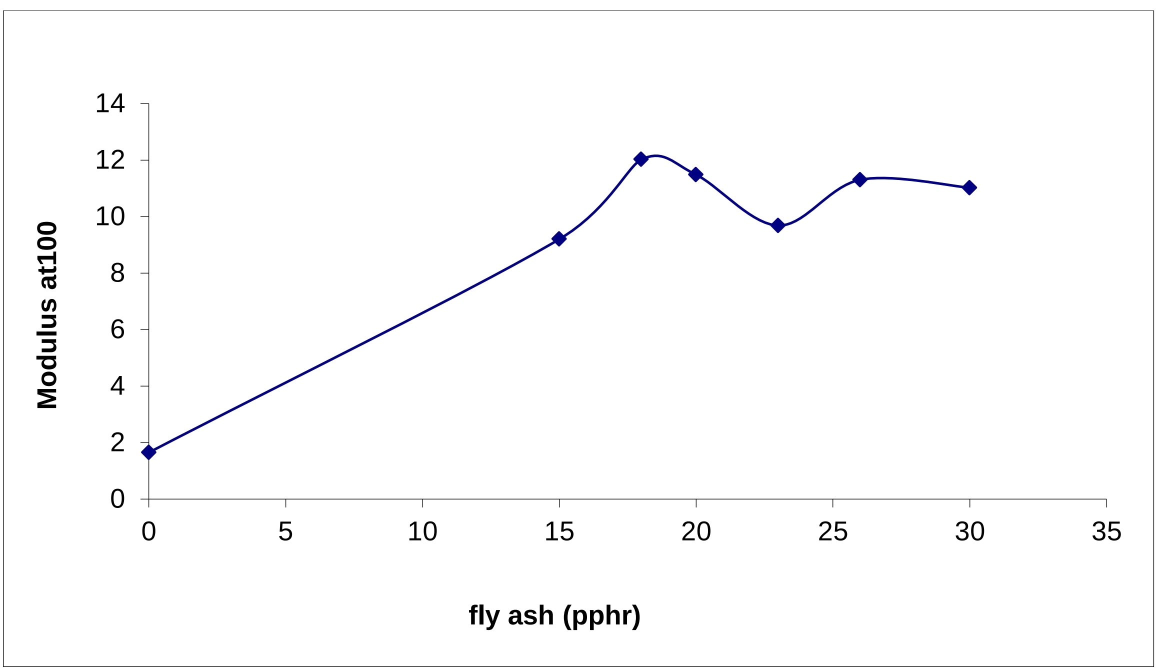

Figure 3. Effect of adding waste of cement on modulus.

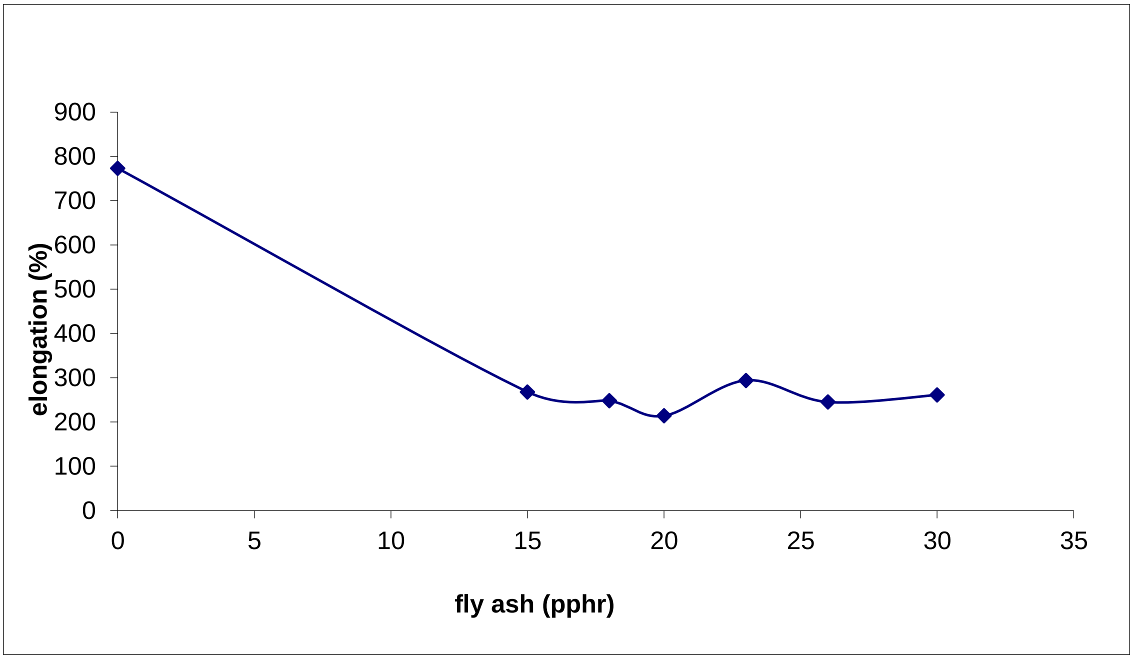

Figure 4. Effect of adding waste of cement on elongation.

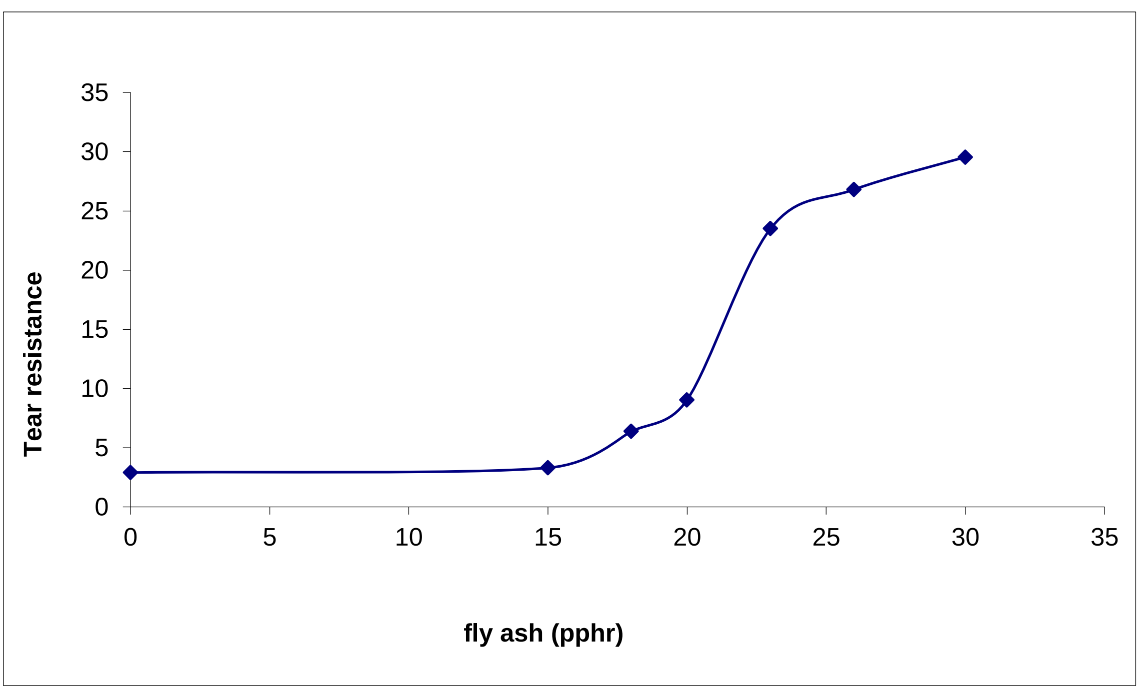

Figure 5. Effect of adding waste of cement on tear resistance.

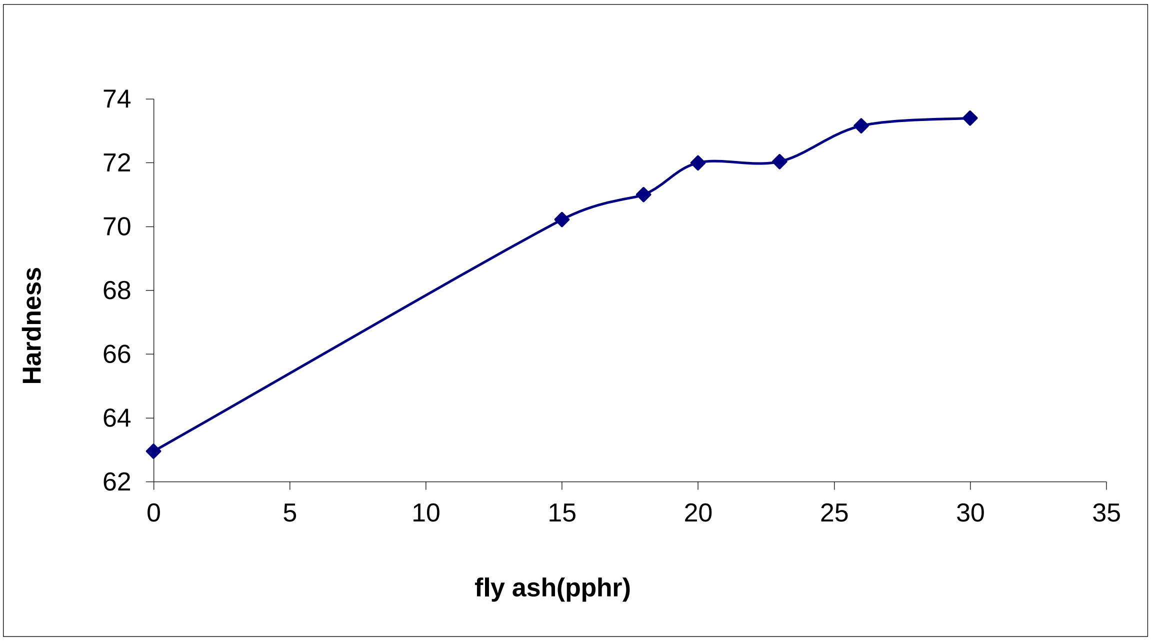

Figure 6. Effect of adding waste of cement on hardness.

As showing in Figure 5, as additives increase ,hardness increase because of the iterating between additives "wasrw of cement" and rubber chains that lead to increasing the ability of Penetration resistance.

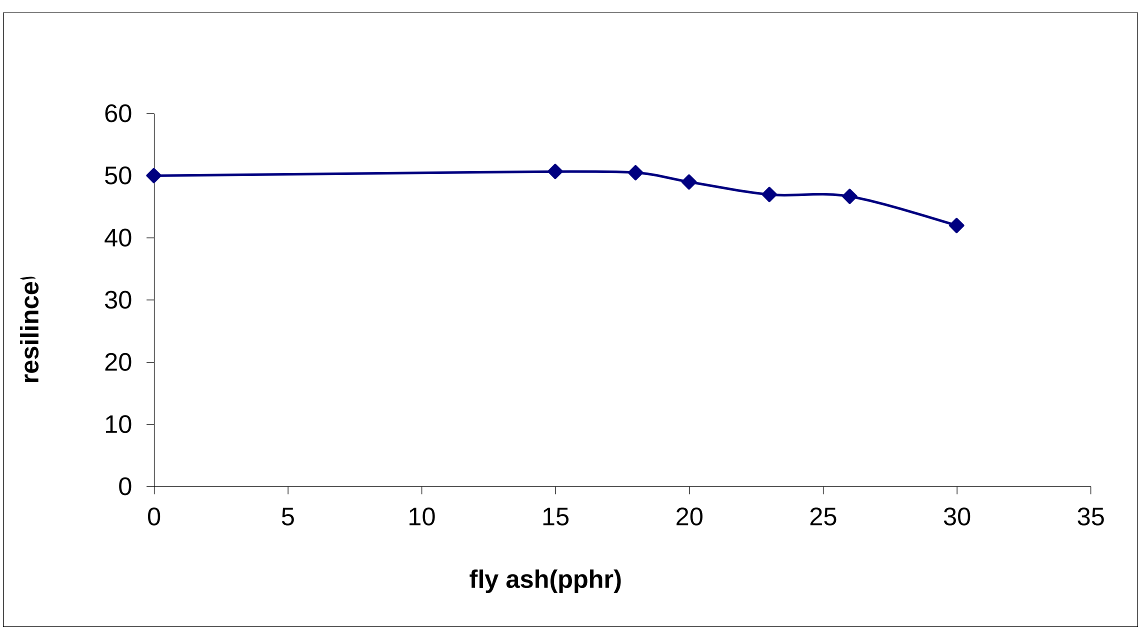

Figure 7. Effect of adding waste of cement on resilience.

As showing in figure as additives increase, resilience decrease because of the icreasment of cross-link and after applying out side energy on the sample will be absorbe it and change it to a heat distribute between the rubber chains.

6. CONCLUSIONS

- The increase of additives ratios waste of cement "fly ash" causes increase the tensile strength and modulus
- The increase of additives ratio of causes waste of cement "fly ash" decreasing in elongation and resilience.
- The increase of additives ratios of waste of cement "fly ash" causes increase the hardness.
- The increasing of additives ratios waste of cement "fly ash" increase the tear resistance.

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