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Effect Weathering Conditions on the Mechanical Properties of the Sport Surfaces Prepared of Crumb Rubber

Mohammad H. Al Maamori*, Murtadah Kateeb

University of Babylon, Hilla, Iraq

Abstract : This research aims to study the effect of weathering conditions(UV ray and heat at 70^0 C) on the mechanical properties for prepared. These sports surfaces were manufactured from the crumb rubber (which considered as pollutant materials for the environments that is available at the state company for rubbers industries and tires industry in Al-Najaf city which considered as a base material in this work and added for him various ratios from acrylic polymer material as binder material. In this research the binder polymeric material has been added in different proportions to the crumb rubber which has particle size 2 mm and through the results found that the tensile strength before aging is 0.467 MPa and after aging with UV is 0.466 MPa and after aging with heat is o.466 MPa and the hardness before aging is 59.6 and after aging with UV is 62 and after aging with heat is 60.3 and the resilience before aging is 52.9 % and after aging with UV is 57 % and after aging with heat is 53.1 % and the friction coefficient before aging is 0.75 and after aging with UV is 0.79 and after aging with heat is 0.88 and the wear resistance before aging is 0.647 % and after aging with UV is 0.635 % and after aging with heat is 0.625 % and compression set before aging is 0.69 % and after aging with UV is 0.72 % and after aging with heat is 0.26 % and the fatigue Resistance before aging is 616 and after aging with UV is 539 and after aging with heat is 561 and the densitybefore aging is 0.99 g/cm^3 and after aging with UV is 0.8197 g/cm^3 and after aging with heat is 0.828 g/cm^3.

Keywords: Weathering Conditions, Mechanical Properties, Sport Surfaces, Crumb Rubber.

1. Introduction

One of the various problems which mankind faces as it enters into the21st century is the problem of waste disposal management. Since polymeric materials do not decompose easily, disposal of waste polymers is a serious environmental problem[1-9].

Scrap tires that have accumulated in stockpiles can be used by mosquitos and rats for breeding, posing a potential human health threat. Fire in stockpiled tires is also a concern since fires can release pollution into ground or surface water and the air. In landfills, tires can "float" to the surface and break the cap of the landfill. Once this occurs, rodents and insects can enter the landfill, rainwater can infiltrate the landfill leading to greater amounts of leachate from the landfill, and gases can escape the landfill[10, 11].

Scrap tires, which have been used for more than half of its operational life, are one of the types of solid waste; they are classified as one of the growing environmental issues in last few years. Many researches, which have been worked on damaged tires graveyard, stated that it is a source of many poisoned gases which negatively affect the life of living beings. Gases emit from treating damaged tires by uncontrolled incineration are CO, SO_X, NO_X, and volatile and non- volatile organic compounds as well as compounds absorbed by soil.

Consequently, these wastes should be treated in an economic and healthy manner, therefor, recycling tire are the perfect solution to get rid of this problem. Outdoor sport surfaces should be resistance for weathering conditions from UV ray and heat beacons of these surfaces that are exposed to sunlight throughout the year[1, 8, 12-16].

2. Experimental Part

2.1 Materials

* Crumb rubber: It was provided from the state company for rubbers products and tires industry in Al-Najaf city – Iraq which is a product of scrap tires.

* Acrylic elastomer polymer: It was provided from Iraq factories, which consider as binder material.

2.2 Preparation of Samples

The samples were prepared by mixing the acrylic elastomer polymer with crumb rubber. In this process the crumb rubber and binder material mixing by electric mixer device with speed 10 rpm, this speed help in homogenous of crumb rubber with acrylic polymer. in this process acrylic polymer add in to various ratio 100, 150, 200,250 g in to 400 g of crumb rubber and mixed together in mixing device at the above speed and at room temperature for period reach to 5 min. after complete mixing process, the mixture put in to mold with dimensions of 30 X 30 cm and the surface of mixture modified by manual trowel– after this pressure with load about 10 kg which consider weight of the machine that used in manufacture of sport surface applying on the mixture and leave this load for 5 min after that the load remove and mold leave at room temperature for 24 hr. after this time the sample exit from the mold and which will be ready for inspection.

3. Results and Discussion

3.1 Tensile Strength

Figure (1) shows the effect of UV ray and heating aging affected on the samples, but very little effect does not exceed the standard specification values. It is clear from this figure that tensile strength after UV aging less than non-aging sample, because the rays of UV breaking the bonds that near from the surface and the creation of free radicals in the rubber chains are working to form a new interlocking lead to the generation of microscopic cracks transverse and longitudinal within the material, which appears in the microscopic pores which give the material flexible spongy nature and thus a drop in tensile strength occurs.

As well as the heat aging sample possess little tensile strength, because the heat work on breaking down the linkage bonds formed between the binder material and crumb rubber and thus resistance to tensile stress is weak.

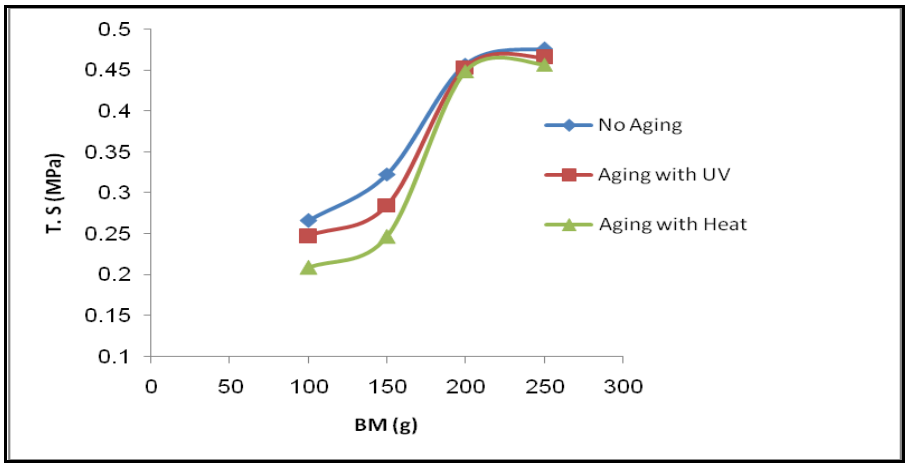

Fig.1: Express effect of binder material and weathering conditions on tensile strength

3.2 Hardness and Resilience

Figures (2) and (3) show aging effects on the hardness and resilience properties, Noting that the hardness and resilience increases when aging with UV, because the rays UV will work on breaking down the chains near on the sample surface and thus reacts oxygen with chains and re-arranged and thus will decrease the free volume and thereby increase the hardness and resilience values. While the influence of heat, the hardness values and resilience is less, because the heat energy is less compared to the UV ray, because the UV energy is focused while the temperature is random.

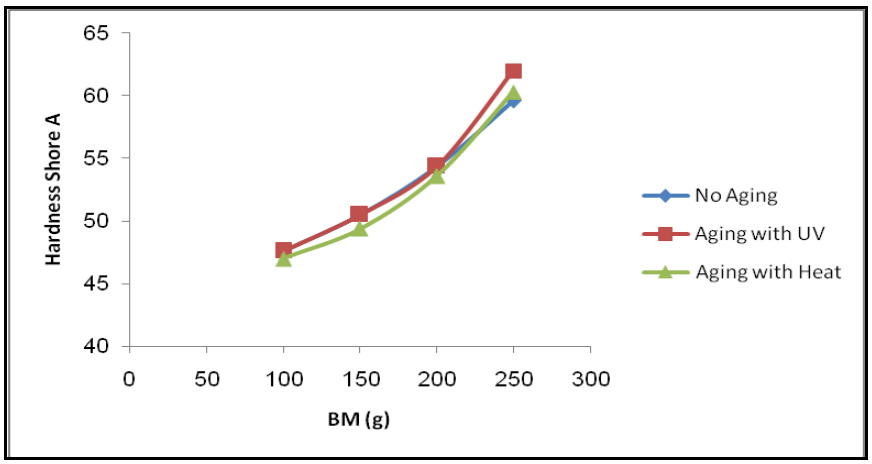

Fig.2: Express effect of binder material and weathering conditions on hardness

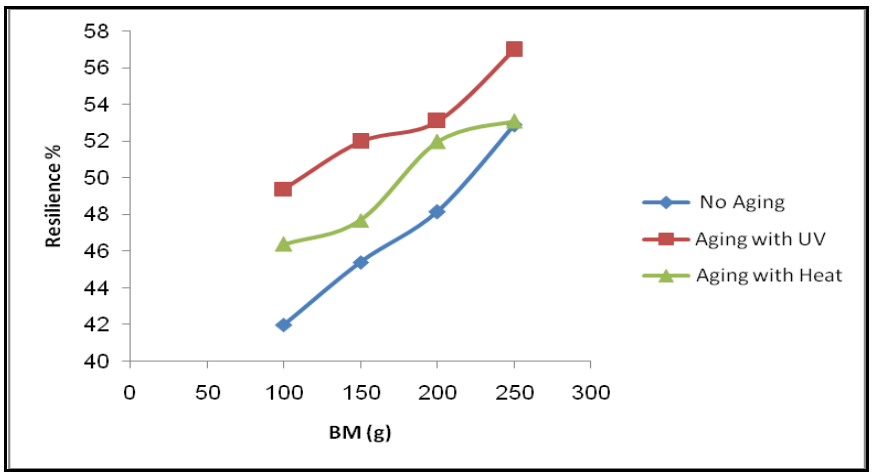

Fig.3: Express effect of binder material and weathering conditions on resilience

3.3 Friction Coefficient

Figures (4) shows the effect of aging on friction coefficient and this is attributable to that after weathering conditions increasing hardening of rubber and thus formed micro cracks and increases the hardness of the surface and thus will increase the coefficient of friction.

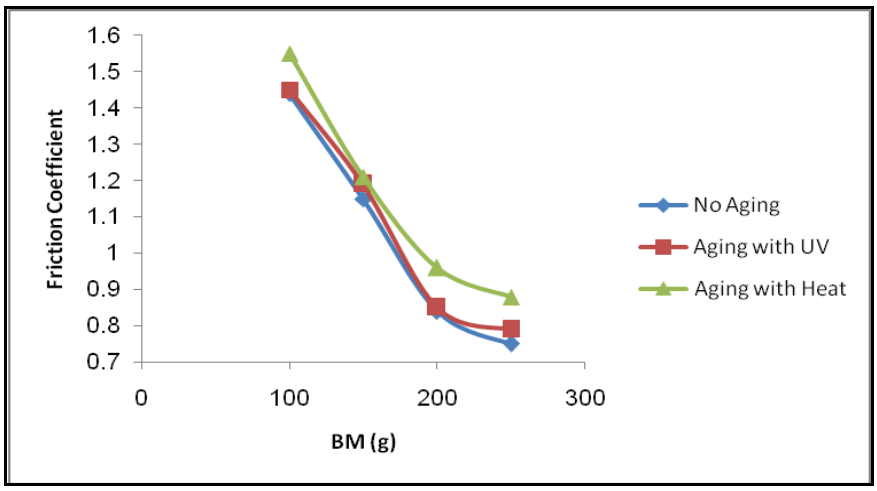

Fig.3: Express effect of binder material and weathering conditions on friction coefficient

3.4 Wear Resistance

From figure (5) we noted that that the ratio of particles loss increases with a few percent at the weathering conditions and the reason is that after aging, it will increasing the hardening of rubber and thus consists bombed and micro cracks and thus less bonding resistance between particle and other so less resistance to wear and tear.

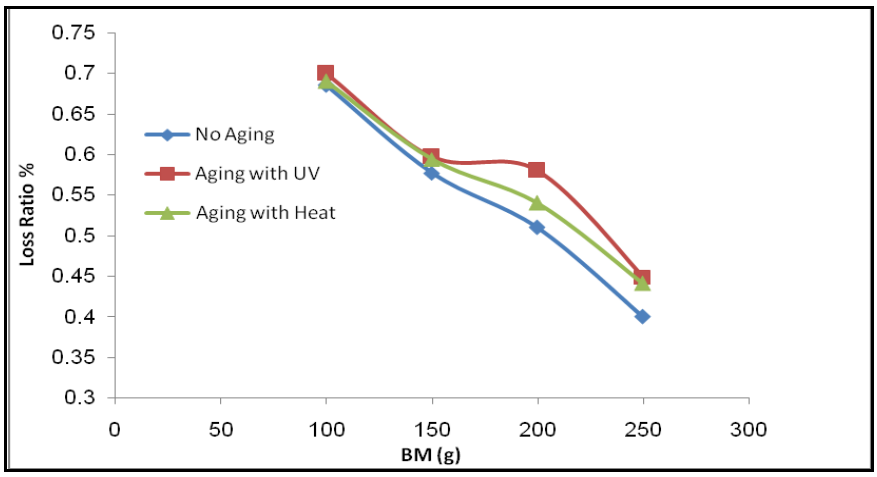

Fig.4: Express effect of binder material and weathering conditions on wear resilience

3.5 Compression Set

From figure (5) we noted a decrease compression set with increasing of a binder material and the reason for this is to get a large interlocking between crumb rubber and binder material which prevents the polymeric chains from slipping over each other where binder polymer material is going to bear large part from applied load on the sample due to cohesion power between two materials and formation of a strong correlation between them, so the compression set decreases.

Through below figurewe noted that the compression set at the heat aging less because when the sample is exposed to heat, the temperature of sample will increase and hence the softness will increase due to the decrease of the vandervalis bonds and increased freedom of chains movement and thereby increase Relaxation Time for chain as well as increase the Brownian motion.

As well as when the sample is exposed to the UV, because the UV gives heat but with less degree compared with heat oven.

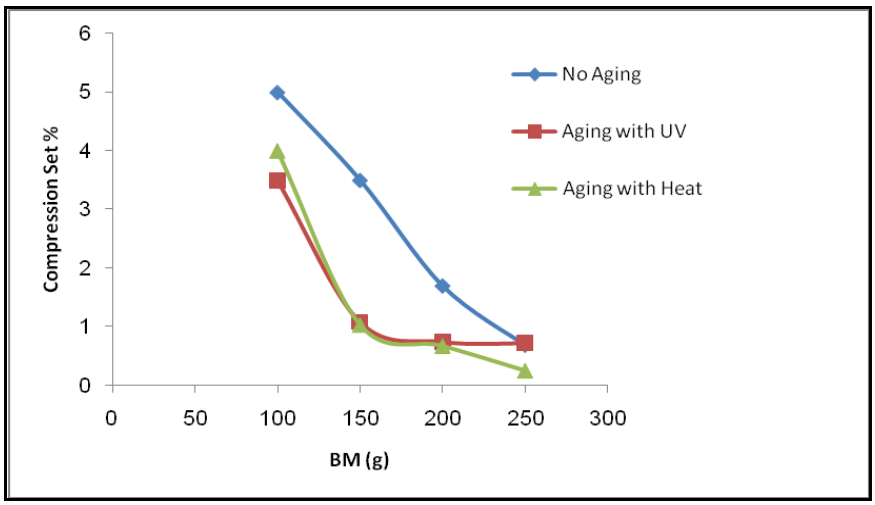

Fig.5: Express effect of binder material and weathering conditions on compression set

3.6 Fatigue Resistance

From figure (6) wenoted that the resistance to fatigue increased at aging with UV ray and heat, but fatigue resistance value at thermal aging higher than UV ray, because the heat is working on cracking fewer chains compared to the UV and thus the sample surface is flexible compared to the UV so they It will give a higher resistance to fatigue.

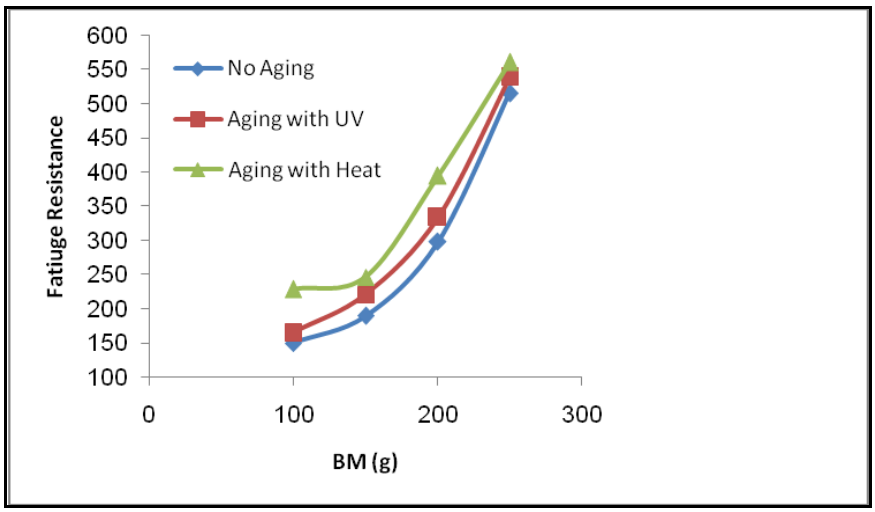

Fig.6: Express effect of binder material and weathering conditions on fatigue resistance

3.7 Density

Figure (7) shows the effect of weathering conditions on density, but we noted that aging sample with UV has a density higher than heat aging sample, because the rays UV will work on breaking down the chains on the sample surface and thus reacts oxygen in the atmosphere with chains and re-arranged and thus will decrease the free volume and thus will increase the density values. While the influence of heat, the density values are lower, because the heat energy is less compared to the UV, because the UV energy is focused while the temperature is random[1, 17-19].

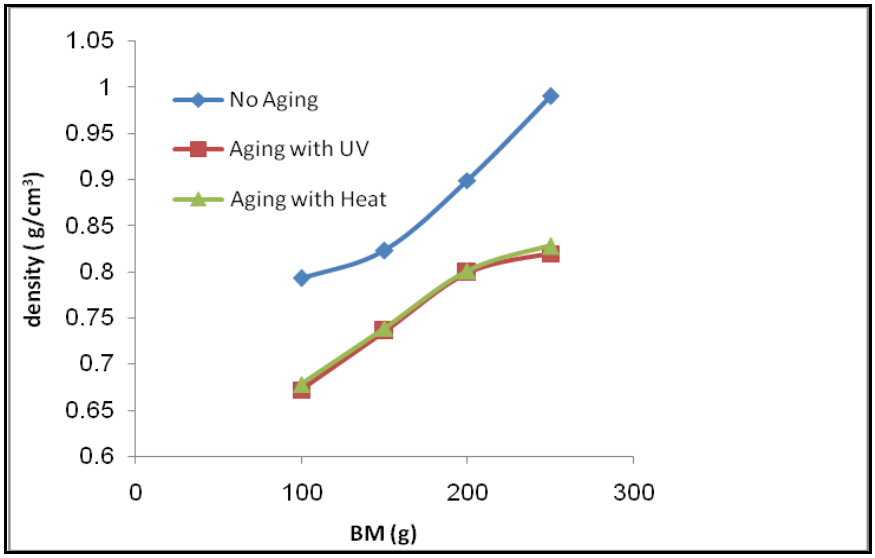

Fig.7: Express effect of binder material and weathering conditions on density

Standard specification depended in the research

Properties	**Standard Specification**		**Units**
	ASTM	**BS 7188: 1998**	
Hardness	60+/-5 (D-2240)		Shore A
Tensile Strength		0.4	MPa
Friction coefficient	0.88 (C-1028)		
Wear Resistance	0.5 (D- 3389)		g
Resilience		Less of 90	%
Compression Set	12 or less(D-395)		%
Density	1.0412 (D-792)		g/cm^3

Conclusion:

The effect of weathering conditions(UV ray and heat at 70^0 C) on the mechanical properties for prepared. These sports surfaces were manufactured from the crumb rubber (which considered as pollutant materials for the environments that is available at the state company for rubbers industries and tires industry in Al-Najaf city which considered as a base material in this work and added for him various ratios from acrylic polymer material as binder material. In this research the binder polymeric material has been added in different proportions to the crumb rubber which has particle size 2 mm and through the results found that the tensile strength before aging is 0.467 MPa and after aging with UV is 0.466 MPa and after aging with heat is o.466 MPa and the hardness before aging is 59.6 and after aging with UV is 62 and after aging with heat is 60.3 and the resilience before aging is 52.9 % and after aging with UV is 57 % and after aging with heat is 53.1 % and the friction coefficient before aging is 0.75 and after aging with UV is 0.79 and after aging with heat is 0.88 and the wear resistance before aging is 0.647 % and after aging with UV is 0.635 % and after aging with heat is 0.625 % and compression set before aging is 0.69 % and after aging with UV is 0.72 % and after aging with heat is 0.26 % and the fatigue Resistance before aging is 616 and after aging with UV is 539 and after aging with heat is 561 and the densitybefore aging is 0.99 g/cm^3 and after aging with UV is 0.8197 g/cm^3 and after aging with heat is 0.828 g/cm^3 .

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