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EFFECT OF USING FILLER PARTICLES RUBBER MODIFIED ON PAVEMENT RESISTANCE

A. S. Al-Fraihat, S. Abu-Mahfouz
Department of Civil Engineering, Faculty of Engineering,
Philadelphia University, Jordan

ABSTRACT

Additives are commonly used by many constructions. It can reduce pollution and benefit a developing circular economy and binding properties. Rubberized Hot Mix Asphalt (HMA) is more elasticity than (HMA) mad from conventional (HMA). It also shows a greater resistance to aging, crack, rut, and skid. Laboratory tests performed to assess the engineering properties, to determine the stability and resistance to plastic flow of bituminous mixtures using the marshal apparatus. The results were compared with experiments of marshal with0%,10%,!5%,and20%,25%,30% rubber ,second test we determine the stability and flow from filler with rubber Versus (vs),and without rubber. The rate of filler and Asphalt was 5%. Then results were compared .The authors found that the rubberized asphalt is more effective with surface resistance, than conventional pavement. The authors notice that the best percentage rubber was 25% on this percentage stability increased at first, and then decreased, when reached the optimum %AC, also the flow increased while increasing %AC. The reason for failure of use filler with rubber, first reason asphalt is absorbed by the rubber particles, second reason use filler that passing sieveN#200.The solution is using a particles larger size, than finer size of rubber.

Key word: Asphalt Performance, Rubber Particles, Bituminous Concrete, Pavements, Stability and Flow.

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1. INTRODUCTION

Development of infrastructural facilities like road is vital for the economic growth of any country [1]. Pavements are engineering structures placed on natural soils and designed to withstand the traffic loading and the action of the climate with minimal deterioration and in the most economical way [1, 3]. The majority of modern pavement structures may be classified as flexible or rigid pavement structures [2.6]. Each of these pavement types has specific failure mechanisms and each failure mechanism is caused by specific factors. Example of such failure mechanisms include: fatigue damage and Toughness of rigid and flexible pavements, faulting of rigid pavements, and rutting of flexible pavements .These failures ultimately result in fatigue cracking, and caused by vertical or horizontal movements in the pavement beneath the overlay resulting from traffic loads, temperature ,and earth movements[5] .Rubber modified asphalt ,when used in Specifically Stress Absorbing Membranes (SAM)or Stress Absorbing Membrane Interlayers(SAMI),Greatly Reduces the occurrence of reflective cracking Because of its elastic properties. The SAM or SAMI can effectively stretch and move with underlying pavements rather than cracking from the stresses .Several previous studies recommended using rubber and polymer fibers to improve the fatigue life of HMA[6,7,8] .

Additives are commonly used by many constructions. It can reduce pollution and benefit a developing circular economy and binding properties[3] .Rubberized Hot Mix Asphalt(HMA)is more elasticity than (HMA) mad from conventional(HMA).It shows also shows a greater resistance to aging , crack ,rut, noise and skid[9,11.15] .

However the problems of life expectancy, recyclability, emission safety as is related to the use of rubber in production and construction of asphalt pavement is still not quite clear. However most in use, and Europe the research work concentrated on roads and using Asphalt rubber[10,12],but in to many Country as Jordan with tropical climate ,and different road traffic situations need more research work in it. The objective of the research project is therefore: To determine the stability an flow of bituminous mixtures with different percentage of rubbers and filler, to investigate the possibility of using ground scrap tire rubbers as component of asphalt cement mixture used in road pavements.

2. MATERIALS AND METHODS

Laboratory tests performed to assess the engineering properties ,to determine the stability and resistance to plastic flow of bituminous mixtures using the marshal apparatus[10] .Tests for aggregates with International systems (IS) codes were applied .Grading : Coarse :retained on N#8 (2,36 mm)&fine :passing N# 8,,filler passing N #200 (0,075mm) table 1were used in this research Asphalt AC 60-70 for hot weather were used in specimen. Properties of pure bitumen are shown in table 2.

Table 1 Gradation

Size (mm)	%retained	Mass(g) =%ret*1100
19.5	0	0
12.5	20	220
9.5	12	132
4.76	23	253
2.36	15	165
0.425	21	231
#200	4	44
Pan	5	55
Total	100%	1100

Table 2 REQUIREMENTS FOR 60/70 AND 85/100 PENETRATION ASPHALT CEMENTS

TEST	Penetration Grade			
	60/70		85/100	
	Min	Max	Min	Max
Penetration at 25°C, 0.1mm	60	70	85	100
Flash point (Cleveland open cup), °C	232	-	232	-
Ductility at 25°C, cm	100	-	100	-
Solubility in trichloroethylene, %	99.0	-	99.0	-
Retained penetration after TFOT, %	52	-	47	-
Ductility at 25 °C after TFOT, cm	50	-	75	-

Source: ASTM D (1994)

We used the correlation ratio when the thickness not equal 63, 5, and the limits of flow was 2-4mm.In the factory, the wires are dragged from waste tires, and the rubber is cut into small pieces. The crumb rubber is melt in bitumen at 170∘C and mixed with aggregate. We will make 4 samples of mixes, each mix with a specific PHA. From each sample we will make 3 specimens and do the tests upon it. The values we get for the 3 specimens of each sample will be averaged to get one value for each sample. So we will have four points for each term for each sample.

Specimen mold assembly: The cylindrical molds are 101.6mm in dia. and 76.2mm in height. Specimen extractor. Compaction hammers weighing: 4.54Kg and having a free fall of 457mm. The average Asphalt cement percentage (AC%) was used for values taken from stability .the rate of filler and Asphalt was 5%[4.12].

3. RESULT AND DISCUSSION

The main objective of this research was to study the change in asphalt mixture rubber, using marshal test, stability and flow of the prepared samples were recorded, the results without rubber are shown in table 3, and figure1,2.

The results were compared with experiments of marshal with 0 % ,10%,!5%,20%,25%,30% rubber table-3,We notice that the test marshal without rubber give an increase in stability with increase the %AC until we reach the optimum %AC then its decrease. Figure 1.. Also the flow will increase while increasing the %AC. Figure 2, second test we determine the stability and flow from filler with rubber Versus (vs).

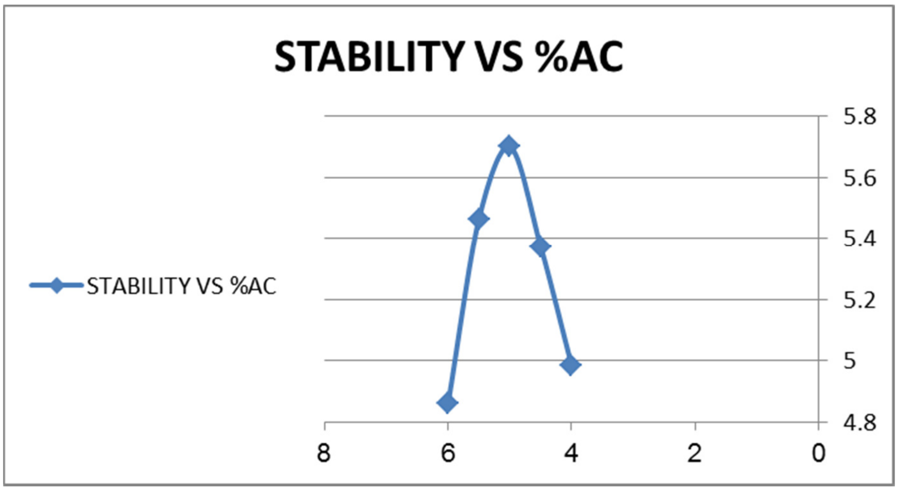

Figure 1 Asphalt without Rubber

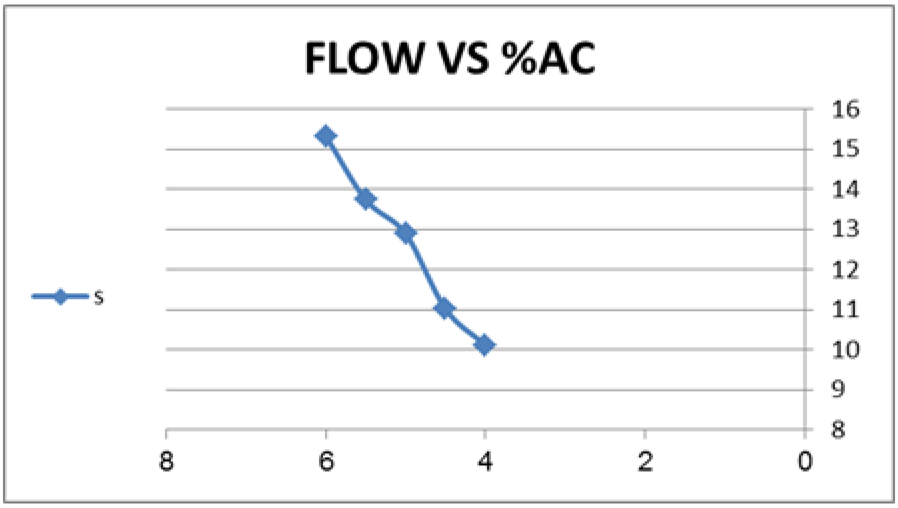

Figure 2 Flow without Rubber

Compare the results between the experiments of marshal and marshal with rubber with different %, the result in table-3.

The average values of marshal Test parameters with different rubber percentage were summarized in table-4.Comparing the results of stability and flow for rubber-asphalt mix with conventional mix showed that there is an improvement in stability at 25%rubber of bitumen percentage of 5% .We notice that the test marshal with rubber 25% give an increase in stability with increase the %AC until we reach the optimum %AC then its decrease. Figure 3.

Table 3 Stability and flow results

Bitumen	**Rubber %**	**AC%**				
		4.0 %	**4.5%**	**5.0%**	**5.5%**	**6.0 %**
Stability(kN)	No Rubber	1.984	5.373	5.700	5.464	4.860
Flow (mm)		10.118	11.019	12.885	13.734	15.322
Stability(kN)	10%	5.05	5.673	5.883	5.290	4.77
Flow (mm)		8.7706	8.9	9.6	10.907	11.306
Stability(kN)	15%	5.9	6.32	7.44	6.453	5.33
Flow (mm)		10.066	11.013	12.7	13.083	13.813
Stability(kN)	20%	4.72	7.7666	8.19	7.933	6.23
Flow (mm)		7.833	9.7333	12.0766	12.3	13.333
Stability(kN)	25%	7.3433	7.66	8.7	8.256	8.13
Flow (mm)		7	9.8	12.033	12.533	13.666
Stability(kN)	30%	5.1566	5.9	6.11	4.63	4.33
Flow (mm)		8.833	9.8	11.166	12.13	12.366

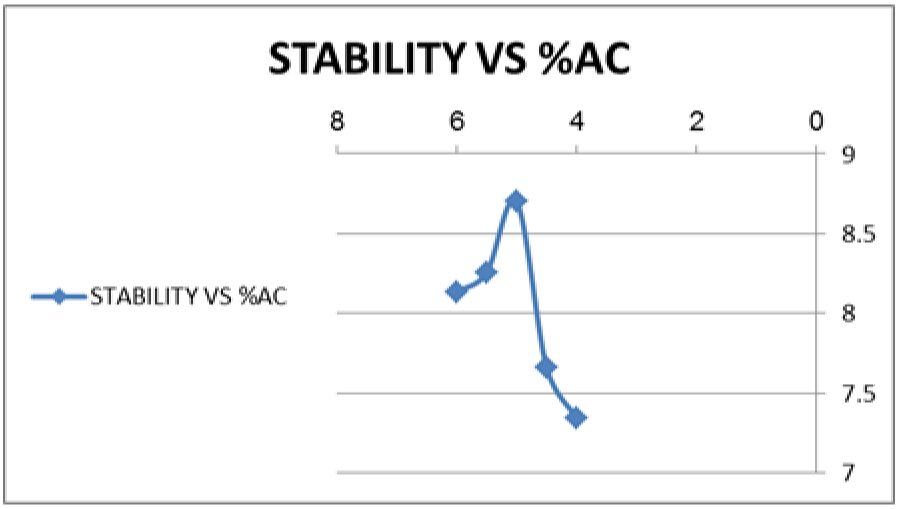

Figure 3 Stability with 25% Rubber

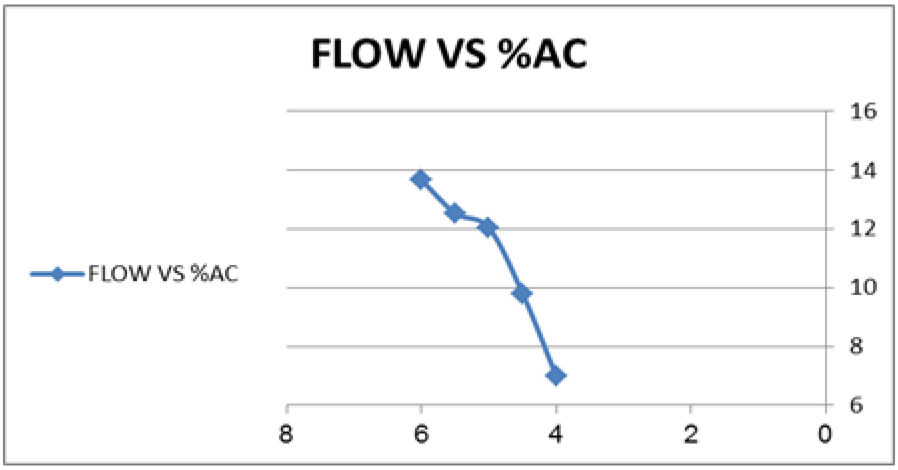

Figure 4 Flow with 25% Rubber

Table 4 AVG of AC% with Rubber

Rubber %	Stab (kN)	Flow(mm)
0	5.7003	12.885
10	5.8833	9.6
15	7.44	12.7
20	8.19	12.077
25	8.7	12.033
30	6.1167	11.167

Also the flow will increase while increasing the %AC. Figure 4

Typical Marshall Test design criteria for stability and flow at different traffic density are shown in table 4 below. Typical Marshal Design Stability and Flow Criteria for Medium Traffic (50 blows) is 3,40 (KN),and flow(0,25mm) between 8to 18 mm(4to6mm). All test values consistence with the specifications limits.

Table 5 Typical Marshall Design Stability and Flow Criteria

Mix Criteria	Light Traffic (< 104 ESALs)		Medium Traffic (104 – 106 ESALs)		Heavy Traffic (> 106 ESALs)	
	Min.	Max.	Min.	Max.	Min.	Max.
Compaction: number of blows on each end of the sample	35		50		75	
Minimum Stability (KN)	2.27		3.40		6.80	
Flow (0.25 mm)	8	20	8	18	8	16

(Asphalt Institute, 1997).

Filler with Rubber:

Second test we determine the stability and flow from filler with rubber Versus (vs) We will put the Rubber with Filler on optimum and measurement the stability and flow and comparison the result from Filler with Rubber VS result from Asphalt with Rubber that rate of Filler 5%. Table 6

Table 6 Filler VS Rubber

Filler %	Rubber %
5	0
4	1
3	2
2	3
1	4
0	5

Compare the results between the experiments of filler Marshal and filler Marshal with rubber, The optimum in the stability is 5% so that we will take this value and make the test in this value. Figure .6 As shown in table 7,the stability without rubber with AC 5% 13,,68,It is more than stability with rubber, but the flow is 4,1875mm table 7,but the flow in table 3 is 13,734 we can see the different between the result with filler.

Table 7 Average of Filler without Rubber

AC%	Stability (kN)	Flow (mm)
4	7.83	3.375
4.5	10.73	3.15
5	13.68	4.1125
5.5	9.408	4.1875
6	7.7678	3.615

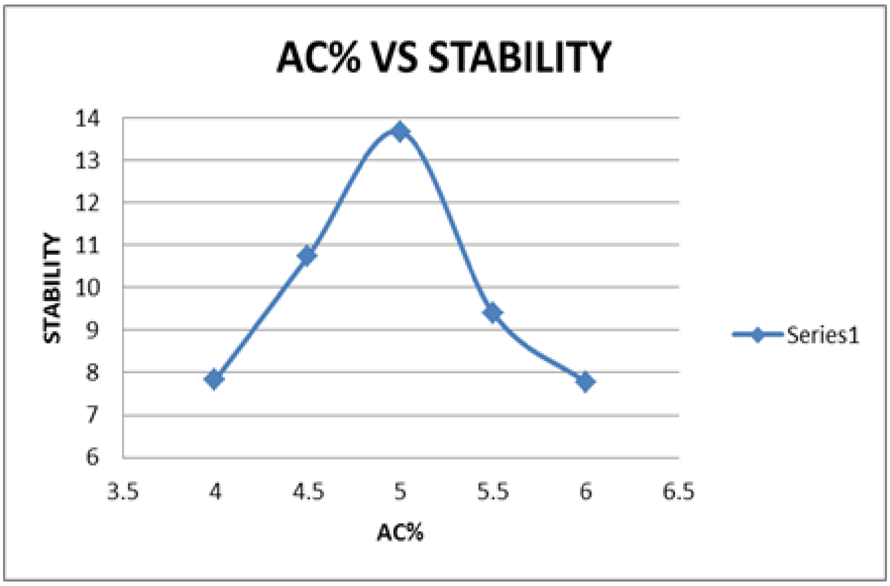

Figure 5 Stability without Rubber

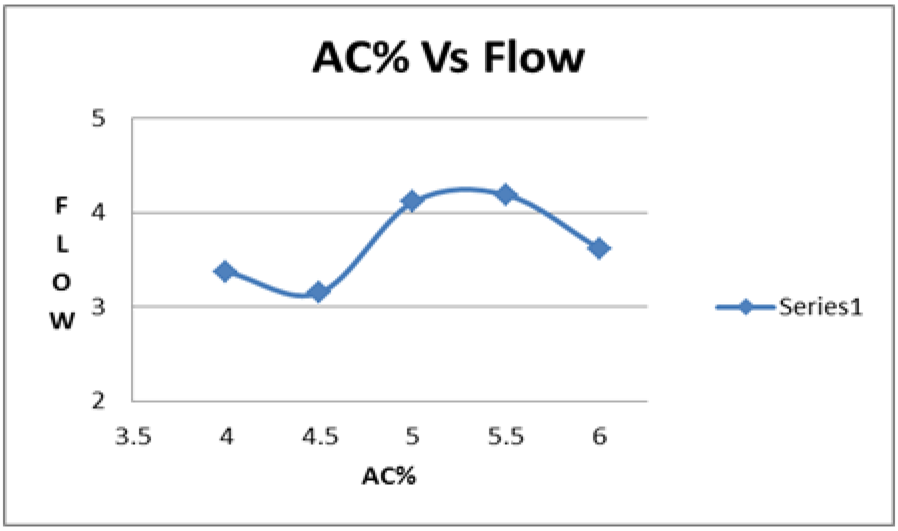

Figure 6 Flow without Rubber

We notice the optimum in the flow marshal is 5% ether. Figure1.7

The average value of marshal test with different filler percentage were in table 8 we can see the stability decreased with rubber %,it is shown in 5% rubber, the average of stability is 4.8 KN, and the flow 5.19 mm figure 7

Table 8 AVG of Filler with Rubber

Rubber%	Avg Stab (kN)	Flow (mm)
0	12.33	3.76
1	7.48	3.83
2	5.67	4.74
3	7.285	3.85
4	5.76	5.08
5	4.8	5.19

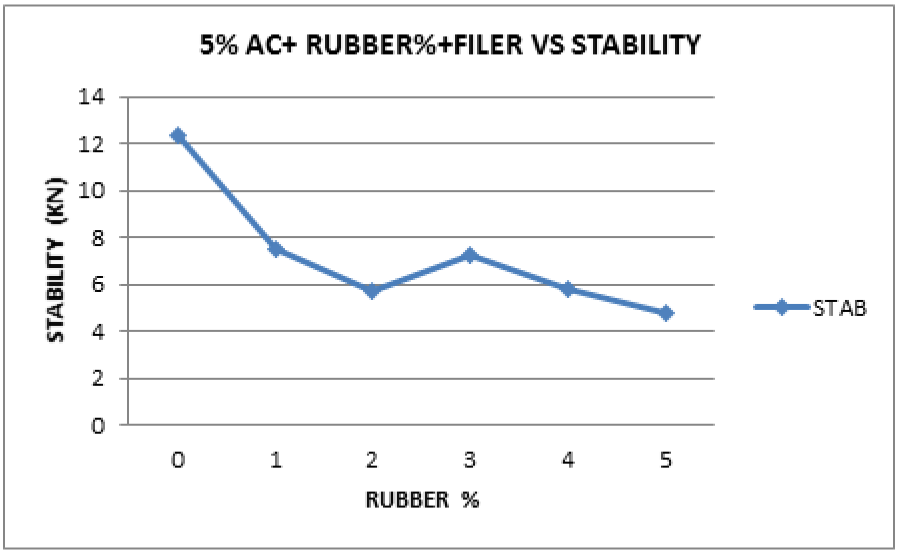

Figure 7 Stability with Rubber

The test give us negative the stability was good with 1% rubber, after start give us negative result. Figure 7.As the particles size of rubber is increased 0, 075mm to 0,425 mm there is an initial increase in tensile strength and modulus compressive, and increased from 0,425 to 0,6mm ,the best mechanical properties are achieved for rubber particles size 0,6 mm(13)have made observations .The attribute the initial increase in mechanical properties to the filling of voids and bridging of micro-cracks by rubber particles of appropriate sizes. Also possible that as the rubber particles increased the amount of binder asphalt concrete maybe attributed to possible ingress bond between the aggregate and the asphalt (10).

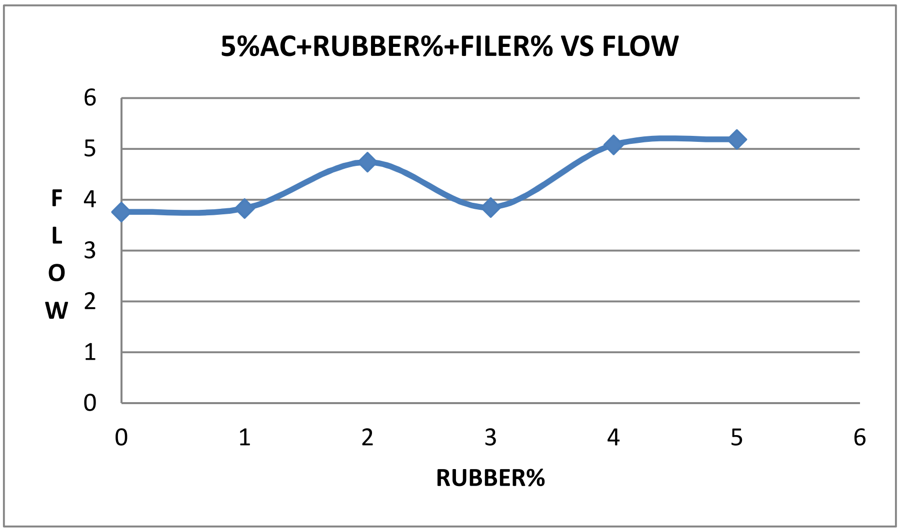

Figure 8 Flow with Rubber

We notice in the flow marshal not so different from filer without rubber. Figure 1.9

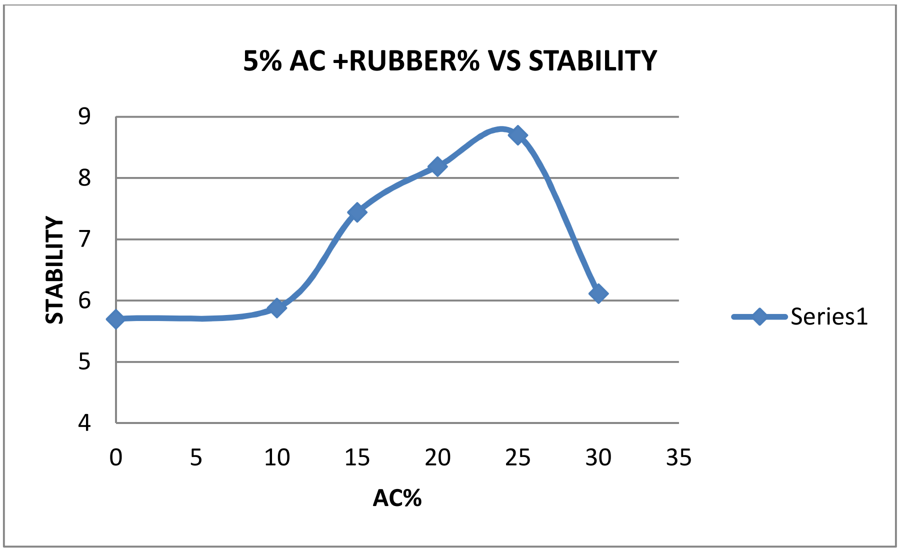

Figure 9 Stability with Rubber

We notice that the best %rubber is 25% from the asphalt in 5% asphalt. Figure 1.10

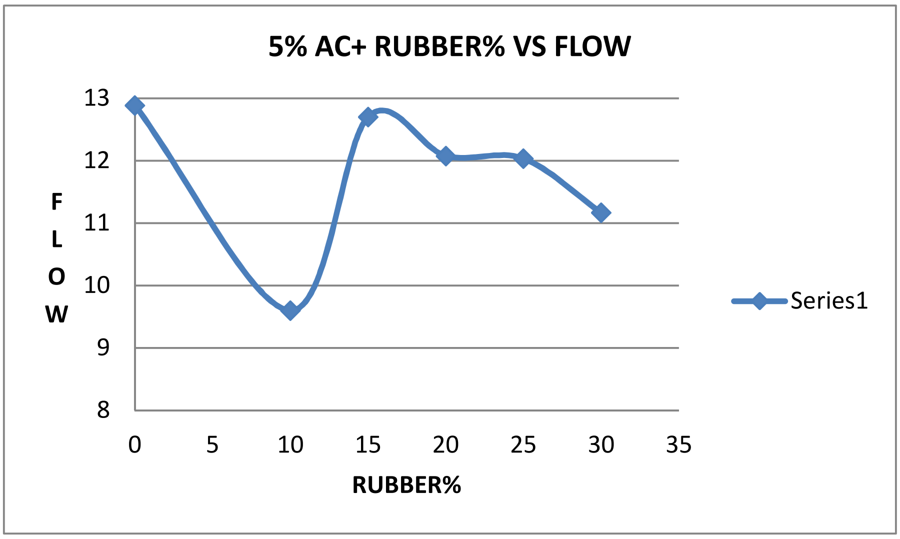

Figure 10 Relation between flow and rubber at different percentage.

The flow in the optimum was less than in 10% rubber. Figure 1.11.

CONCLUSION

Stability and flow were improved by adding rubber to the asphalt pavement. The appropriate percentage was 25% from bitumen weight. Standards indicated that minimum stability of Marshal Test at medium traffic (50blows) is 3, 40 Kg. and maximum flow is 4-6mm. The % of added rubber match with the above standards.

In this research article number of bitumen and asphalt samples was examined on laboratory tests. The conclusions are summarized as follows.

1. We found that the rubberized asphalt is more effective with surface resistance, than conventional pavement. The authors notice that the best percentage rubber was 25% on this percentage stability increased at first, and then decreased, when reached the optimum %AC ,also the flow increased while increasing %AC.

2. The reason for failure of use filler with rubber, first reason asphalt is absorbed by the rubber particles, second reason use filler that passing sieve N#200.The solution is using a particles larger size, than finer size of rubber.
3. We use correlation ratio when the thickness not equal 63.5mm.
4. For various rubber particle size, the stability and flow of rubber-modified asphalt aggregate increased at 25%, then decreased with increasing rubber/asphalt ratio of 5%, the flow in the optimum was less than10% rubber.
5. The results of this study apply only to the type of rubber that was used.
6. Other sources of rubber may produce different results.

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