"Physical recycling of crumb rubber through the formation of modified asphalt."

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1. Summary

The tire industry produces annually 25 millions of tires in México, only 9% is recycled and the rest (91%) is not properly processed and left without control [1]. This practice also creates serious pollution problems, like "dengue" and COV (this occurs when tires are burned). Due to the present environmental regulations, it is mandatory to find ways for recycling tires. One option is the incorporation of crumb rubber of tires into the asphalt. In this work three samples of modified asphalts (asphalt with crumb rubber of tire) were characterized by the Marshall technique, (Mexican norm N-CMT-4-05-002/01). One control sample and three more containing 1%, 2% and 3% of crumb rubber of tire were studied, Stability, Flux and Voids were determined. It was found that incorporation of tire into asphalt work well at 1%.

Index words: *physic recycling, crumb rubber, modified asphalt, morphology.*

2. Introduction

Recycling of plastics has been very important in recent years, due to economic interesting, and for the news environmental regulations, one of this materials to recycle are the tires. Only 9% of tires are recycled, normally the tires are incinerated but this practice produces COV. It is reported that modification of asphalt with tires improve asphalt properties, as there is good adhesion between tire and floor, and a lowest tire/pavement noise levels [2,3,4]. In this work we studied one way to recycle the tires. It consists in the incorporation of the crumb rubber of tire into the asphalt to form modified asphalt, named CMR-HMA.

Three samples of modified asphalt (with 1, 2 and 3% of crumb rubber) were compared with one model asphalt. The parameters studied were the stability, flux, and voids, by the Marshall technique. The results show that the mold with 1% is the ñore adequate. Higher elastomer concentrations result in a low-quality asphalt. Polymer

morphology of samples was also studied by differential scanning calorimetry (DSC). Discussion of phase separation observed by this technique will be presented.

3. Experimental Conditions

3.1 Preparation of samples

3.1.1 Materials

Grinded car wheels, Asphaltic cement , Stones of different sizes as mentioned in the ,Zinc stearate, Gasoline to clean utensils.

3.1.2 Method

Weigh 1.250 grams of stones previously sifted as mentioned in the Mexican norm CMT-4-05-002/01.

Heat the stones to 140 °C.

Also heat the asphaltic cement to 140 °C.

When the asphaltic cement has reached the desired temperature add it to the stones to form a homogenous mixture.

Place this mixture in the mold to produce molds and close it with the cover.With a 5 kg piston hit both sides of the mold 75 times covering a length of 50 cm.When the mold is formed take out the mold to obtain the model sample.When the mixture is made with crumb rubber, add 1, 2 or 3 % en weight of crumb rubber of tire with respect to the stones depending of the dosage one wishes.Take out the mold and measure the diameter and the height of each one.Apply the Zinc Stereate to carry out the vacuum experiments.For the vacuum experiment weigh the mold covered with the Zinc Stereate in water and air, write down the mass and clean the molds with a brush.Place them in a bath at 60°C for an hour.After doing this measure stability and flow with the Marshal apparatus for every mold and report the average measurement for every mold.

4. Results and discussion.

A comparative study was carried out for the model molds and the ones which contained 1 %, 2 %and 3 % of crumb rubber. The parameters were stability, flow and vacuum. It was observed that the proportion of 1 % of grinded wheels is the most adequate percentage to use in the asphalt mix, because with this proportion the mold complies with

the standards established by the Secretary of Communications and Transports, described in table 1, in which is specified that for a daily flow of vehicles of more than 2000 in one way, the study must be done with molds which received 75 hits on both sides during its compaction. In table 1 are also mentioned the limit values permitted for the stability which has to be more than 700 kg, for the flow which should be between 2 and 4 and the vacuum which should be between 3 and 8.

Table 1. Permitted value limit established by SCT (Stability, flow, vacuum for a asphaltic carpet)

Secrterya of communication and transport	
Caracteristic	TDPA > 2000 vehicles
Amount of hits	75
Estability (kg)	>700
Flow (mm)	2 a 4
Vacuum (%)	3 a 8

Table 2 indicates the values obtained for parameters studied stability, flow and vacuum) of the model mold and the sample molds of CMR-HMA (mixture asphaltic mixed with grinded tire wheels) which contain 1%,2% and 3 % of grinded tire wheels.

Table 2 Comparative values obtained for model molds and molds of CR-HMA (1,2 and 3 %)

Property	Model sample	Llancreto at 1 %	Llancreto at 2 %	Llancreto at 3 %
Stability(kg)	897.4	773.7	751.9	432.2
Flow(mm)	5.14	4.45	3.68	4.66
Vaccuum(%)	4.47	6.53	8.92	12.71

As one can observe, the CMR-HMA mold which contains 1 % of grinded tire wheels presents values of stability, flow and vacuum which are within the permitted limits of the SCT (see TABLE 1). The stability for the CMR-HMA mold at 1 % is 773.7 and the specification set by SCT is a value bigger than 700, which means that it complies with the parameter set by SCT. The flow for the CMR-HMA mold is 4.45 mm at 1 % and the value specified by SCT is between 2 and 4. The amount of 0.45 is neglible because one has to remember that every sample is different and that the composition of every sample therefore will vary from another. For the vacuum a value of 6.53 was obtained for the CMR-HMA at 1%; this value is within the range of the limits of SCT.

5. Conclusions

Based on the results, one can observe that the grinded wheels can be recycled by incorporating it with asphaltic mixtures for the construction of highways. Also the most adequate concentration is 1% of grinded tire wheels with respect to the added stones. At the same time is important to note that it is necessary to do new studies with compositions of different CMR-HMA molds which involve larger quantities of asphaltic cement to improve the incorporation of grinded tire wheels and obtain better values of resistance, flow and vacuum which comply more with the limits of SCT.

6. References.

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