STORAGE-STABILITY OF MODIFIED ASPHALT WITH GROUND TIRE RUBBER AND SANDY COMPOUND

JOHNNY GILBERTO MORAES COELHO[1], ANDRÉ LUIZ AMARANTE MESQUITA[2], CARMEN GILDA BARROSO TAVARES DIAS[3]

[1]Graduate Program in Engineering of Natural Resources of the Amazon, Federal University of Pará – UFPA, johnny@ufpa.br

[2] Graduate Program in Engineering of Natural Resources of the Amazon, Federal University of Pará – UFPA, andream@ufpa.br

[3] Graduate Program in Engineering of Natural Resources of the Amazon, Federal University of Pará – UFPA, cgbtd@ufpa.br

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Fatigue cracks occur during the life of the pavement and usually results in severe damage to the structure thereof. The thermal cracks are caused by exposing the pavement to a single cycle of temperature where the temperature reaches the minimum temperature or several cycles in which the bottom temperature is above the minimum critical temperature, normally in a direction perpendicular to the traffic.

From the viewpoint of environmental and economic use of waste rubber tires (B) to replace virgin polymer is the most preferred method of recycling, resulting in further cost savings, lower energy consumption and lower environmental pollution. In addition to the rubber (B), improve resistance to permanent deformation or settlement at high service temperatures, also increases the resistance to thermal cracking, increasing the flexibility of bitumen, at low temperatures. The viscosity of B in a temperature range between 50-163°C, increases with the size of the particles B is inserted and much more viscous than the corresponding pure bitumen and processed. Moreover, the flow behaviour of modified bitumens become more non-Newtonian as temperature and increase particle size[1, 2].

It is common to add fines in the asphalt binder, the in general, improved storage stability when mixed with B is one of the most important advantages of the clay, for example. Can be improved storage stability at high temperature, of course, by choosing a suitable amount of nanoclay and forming a exfoliated structure. Therefore nanoclays can improve resistance to aging of binders modified with B. The extent of influence kaolinite clay differs depending on the rubber content. When the content was low, 3% or 4%, the properties, including high temperature, mechanical properties, rheology and morphology may have a little change[3]. The objective of this work is to study the rheological properties of asphalt and modified asphalt during the storage at 120°C.

The asphalt binder was used CAP 50/70 (A) produced by PETROBRAS (LUBNOR), modified by red quartz sand (AQ) in passing square mesh sieve No. 200, and ground rubber tire (B), in passing square mesh sieve No. 80. The asphalt binder was heated at 180°C and then was inserted recycled rubber passing through sieve No. 80 mesh was obtained the compound A/B in the dosage 80/20, the mixture was made manually. Mixtures were made B/AQ fraction of 100/30 by weight, a rotation of 200 rpm for 12 min. and subjected to ultrasonic bath thermostated at a temperature of 140°C. Was then produced A/B/AQ in the dosage 80/14/6, mixed manually in a controlled heating temperature of 180°C. The order of addition of components may impair the quality of the final product therefore adopted the same sequence of addition of components in the amounts set out in this work for both compound A/B and A/B/AQ.

It was then made the rheology of the binder and modified binder, the top and bottom of the samples stored in an aluminium tube (with diameter 23 mm and 108.12 mm in height) after 24 and 48 hours to test the storage stability. The rheometer used was the type HAAKE RS6000, parallel plate and gap of 15 mm, results were obtained regarding the complex modulus (G*) and phase angle (δ) in the frequency sweep from 10^{-3} to 10^{2} Hz at 120°C.

The complex modulus is defined as the ratio between the maximum stress (shear) for maximum deformation, providing a measure of the total resistance to deformation when the asphalt is subjected to a shear load.

The phase angle as defined above as the phase difference between stress and strain in an oscillatory test is a measure of the balance of viscoelastic behaviour of materials. If δ is 90°, the bituminous material can be considered purely viscous in nature, while 0° corresponds to a purely elastic behaviour. Between these two extremes the material behaviour can be considered viscoelastic in nature with a combination of viscous and elastic responses. A high value represents the complex modulus greater rigidity while a lower phase angle represents a greater elastic response. For testing the rheology measurements were made as shown in Table 1, there is the proportion of A, B and AQ.

Table 1 Dosages for rheology test material in percent (%)

%	R1	R2	R3
A	100	80	80
B	-	20	14
AQ	-	-	6

The storage stability indices (Iss) were calculated using the following equation (1).

$$I_{ss} = \log\left[\frac{G^{*}(bottom)}{G^{*}(top)}\right] \quad (1)$$

Where Iss is set to the rate of separation, G* (bottom) is the complex modulus of the bottom of the stored sample, and G* at the top is the complex modulus of the upper. Iss values equal or close to zero indicate a slight tendency to phase separation during storage.

The curves of rigidity modulus and the phase angle were obtained according to the mathematical model power law to facilitate evaluation of the data obtained (Figure 1).

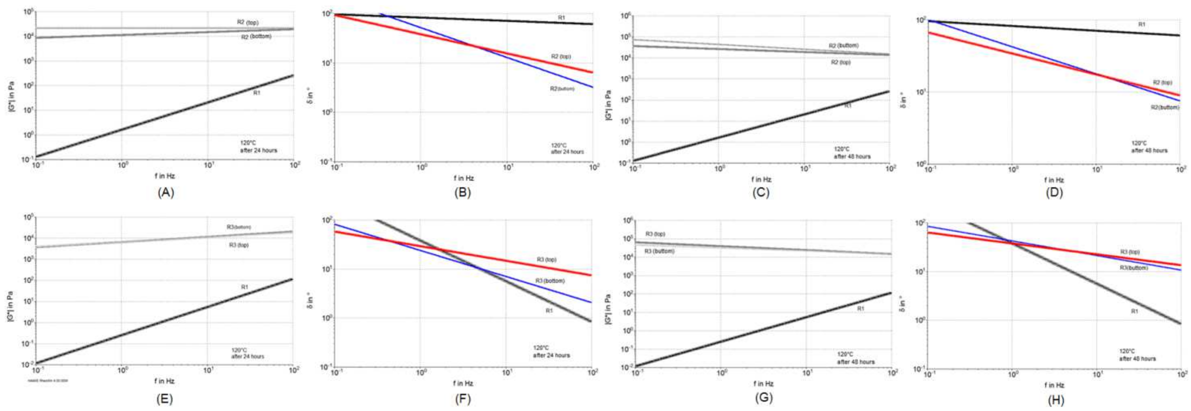

Figure 1: Curves of rigidity modulus and the phase angle. (A) Rigidity module of A and A/B after 24 hours at 120°C. (B) The phase angle of A and A/B after 24 hours at 120°C. (C) Rigidity modules of A and A/B after 48 hours at 120°C. (D) The phase angle of A and A/B after 48 hours at 120°C. (E) Rigidity modules of A and A/B/AQ after 24 hours at 120°C. (F) The phase angle of A and A/B/AQ after 24 hours at 120°C. (G) Rigidity modules of A and A/B/AQ after 48 hours at 120°C. (H) The phase angle of A and A/B/AQ after 48 hours at 120°C.

In Table 2 shows the results of storage stability, calculated from the ratio *Iss*. We can observe a tendency to higher stability of the samples A/B/AQ during the storage period of 24 hours at 120°C. The additives incorporated acted as potential compatibilizers for mixtures A/B and A/B/AQ.

Table 2: Dosing for rheology of table

Specimen	G*(Pa) after 24 hours at 120°C		Iss
	Top	Bottom	
A/B	31949,95	16662,47	-0,28273
A/B/AQ	12074	13654,51	0,053425

Specimen	G*(Pa) after 48 hours at 120°C		Iss
	Top	Fundo	
A/B	49914,68	31489,28	-0,20007
A/B/AQ	38233,47	49178,47	0,109331

The rheological properties of the asphalt binder has been improved upon addition of B/AQ, observing an increased complex modulus and lower phase angle, increased elasticity, especially in longer time, which increases resistance to permanent deformation, especially when the binder is used in hot climates, such as northern Brazil.

The compound B/AQ was further dispersed in the binder during the storage and helped in the excellent property of compatibility in the content used, which differs from modified binder with B, in which higher values were of the rigidity obtained during storage. The compound B/AQ when mixed with binder, have excellent storage properties in low and medium frequency.

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