Crumb Rubber Bituminous Mixes from Waste Tires in Argentina

By Marcela Balige

Scrap tires contribute to one of the most serious environmental problems in the world. In recent years, Repsol-YPF of Argentina has been looking for a way to make good use of scrap tires. This is mainly due to the increase of automobiles and the lack of a systematic recovery program.

In Buenos Aires, a large number of scrap tires are thrown away daily, creating numerous problems. The tires occupy large volumes of landfill space. They can contaminate the soil and ground water. They increase the possibility of fires and the potential emanation of toxic gases. Piles of tires also contribute to the proliferation of rodents and insects.

One way to reduce this problem is to make use of some of the tires by crushing the rubber into fine granules and incorporating them into an asphalt mix. The blended rubber can improve the performance aspects of the asphalt mixture such as thermal susceptibility, elastic behavior, fatigue cracking resistance and aging stability.

This improvement is largely due to the tires containing many kinds of polymers such as SBR and SBS together with carbon black.

Wet and Dry Processes

There are two ways of incorporating crumb tire rubber. The wet process incorporates the crumb rubber into the asphalt cement and blends or reacts the two materials prior to mixing the rubberized asphalt with the aggregates. The dry process incorporates the crumb rubber into the mixture as an aggregate or as a filler.

The ability of the crumb rubber to improve the mix properties depends on many factors, including the incorporation technology (dry or wet process), nature of the rubber, size of the rubber particles, the percentage of rubber by weight in the mix and its reaction time (wet process) or its digestion time (dry process).

Test Sections

A study was conducted in Buenos Aires where the test section was subjected to high stresses from the 4,000 buses circulating there daily. The braking and starting of the buses generated high tangential stresses as well as static loads in the bus stop zones.

Table 1. Binder Properties

Test		Asfasol 20	Asfalplus	Standard
Penetration at 25ºC (100 gr, 5 sec)	[0.1mm]	75	41	IRAM 6576
Softening Point (A y E)	[ºC]	47.7	56.3	IRAM 115
Penetration Index		-0.8	-0.2	IRAM 6604
Specific Gravity 25ºC/25ºC		1.0052	1.0071	IRAM 6586
Viscosity 60ºC	[Poise]	1910	4830	ASTM D-4402
Solubility en 1 1 1 Trichloroethane %	[%]	> 99	>	IRAM 6604
Oliensis (Spot Test)		Negative	Negative	IRAM 6594
Aging Test (RTFO)				
Mass loss	[%]	0.43	0.37	ASTM D-2872
Penetration regarding original	[%]	54.6	-	IRAM 6576
Residue viscosity at 60ºC	[Poise]	3880	14300	ASTM D-4402

The existing surface was a deteriorated asphalt layer which was milled before building the test section. Under this asphalt layer, the pavement structure consisted of a poor concrete over paving blocks on a sand bed. A conventional rapid-setting emulsion was used to tack the new rubberized HMA layer to the milled surface. The rubber-modified layer was placed at an average thickness of 4.5 cm.

Placing the rubber modified asphalt.

The test section incorporated four different asphalt mixtures, two with crumb rubber added by the dry process, while the other two mixes used standard asphalt cement. The rubberized mixes each contained 1 percent crumb rubber having a maximum width of 1.5 mm and a maximum length of 7 mm. The two binders used were a conventional, commercial CA-20 asphalt cement (Asfasol 20 from Repsol-YPF) and a special asphalt cement modified with asphaltite, a natural bituminous material containing a high asphaltenes content (Asfalplus from Repsol-YPF).

The binder content of the mixes was selected according to the Marshall method. The immersion-compression test (detailed in the Spanish Standards NLT 162/84) determined the percentage of rubber and the digestion time. The required digestion time was a minimum of two hours, which was approximately the length of time from mixing till placement. Recommendations from the work of Dr. Juan Gallego were taken into account.

Binder Characteristics

The characteristics of the two asphalt cements are shown in Table 1. Note that the asphalt cement "Asfasol 20" is a direct distillation binder, while "Asfalplus" is an asphalt containing a special additive.

Aggregates

The aggregates used were commercial materials frequently used in Buenos Aires. Limestone filler was added to the mix. The properties of the aggregates are shown in Table 2.

Performance Results

The test section was constructed in September 2002. A batch plant was used to produce the mixes and the materials were placed between 9 p.m. and 12 a.m. Light rains complicated the compaction efforts, leading to the use of dynamic (vibratory) compaction.

Evaluation of the test strip continues, and the results will be reported later this year. Use of rubber modified asphalt is expected to continue.

Table 2. Aggregate Properties

Type	Ag. Stone 6 – 12	Ag. Stone 0 - 6	Siliceous sand
Origin	*Sierra de Tandil Granite Quarry*		*Sand Dune*
Los Angeles Abration Test [%] (NLT 149/91)	23.8	-	-
Slab Index [%] (NLT 354/91)	13.6	-	-
Specific Gravity [gr/cm^3] (NLT 154/82)	2.732	2.710	2.656
Absorption [%] (NLT 154/82)	0.1	1.1	0.8
Sand Equivalent Test [%] (NLT – 113/72)	-	89	77

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