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Use of ground tire rubber in asphalt pavements: Field trial and evaluation in Taiwan

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Abstract

In December 2000 and May 2001, with the assistance of the Taiwan Highway Bureau, two asphalt rubber (AR) pavement test sections were constructed as the pilot projects: one with gap-graded design and the other with open-graded design. The four-year field evaluation results demonstrate their satisfactory performance and the potential to replace modified asphalt in domestic usage. The field data collected from the demonstration projects indicates suitability in using the wet process in Taiwan with local asphalt and ground tire rubber (GTR). The laboratory test results also show that plant mixed AR meets most ASTM specifications and the test sections perform quite well based on the field monitoring data. By using the Arizona DOT AR mix gradations and mix design properties, GTR modified asphalt concrete mixtures can be successfully constructed and performed better than the conventional dense-graded mixes by using local materials and paving techniques.

Keywords: Ground tire rubber; Asphalt pavement; Asphalt rubber; Field trial

1. Introduction

In Taiwan, approximately 10 million waste tires are generated and discarded annually. The tire stockpiles and landfills caused a number of problems to the local community, such as fire hazards and environmental concerns.

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The use of recycled tire rubber is a major contribution to environmental conservation. The development of grinding technology allows processing of tires withdrawn from the market to be treated in the forms and dimensions necessary for further use. In order to achieve the ultimate goal of zero-bury, the current management of waste tires in Taiwan is to use GTR as an alternative fuel for coal or a substitute material for other industries. Using GTR on pavements is not only economically beneficial, improving pavement performance, but also be environmentally favorable, offering a better life-cycle for scrap tires.

In years of 2000 and 2002, with funding from Public Construction Commissions and Environmental Protection Agency, one gap-graded and one open-graded AR test sections, respectively, were constructed to evaluate the technical feasibility about the use of GTR from local sources in pavement construction. A four-year field evaluation program was carried out to compare the performance between the conventional and AR pavements. This paper presents part of the results from the field evaluation program.

2. Background

The use of GTR in asphalt pavements has shown promise in many literatures (Epps, 1994; FHWA and EPA, 1993). The addition of GTR has been found to reduce temperature susceptibility and increase the viscosity and ductility of the asphalt binder. Several state highway agencies in the U.S. have developed mix design procedures for AR mixtures (Morris and Carlson, 2001). A preliminary study (Chiu and Lu, 2007) was conducted to evaluate three different GTRs from local waste tire grinding plants. The results were shown in Table 1. From Table 1, we can see that the specific gravity and chemical compound

Table 1
Properties of ground tire rubber in Taiwan

	Item	Denotation of ground tire rubber		
	Sieve no. (size, mm)	Truck #30-mesh	Car #30-mesh	Car #20-mesh
Particle distributions (percent passing)	No. 10 (2.000)	–	–	100
	No. 16 (1.180)	–	–	97.7
	No. 20 (0.850)	100	100	62.6
	No. 30 (0.600)	98.8	97.7	24.3
	No. 40 (0.425)	59.2	61.1	8.1
	No. 50 (0.300)	32.4	33.9	3.3
	No. 80 (0.180)	12.7	12.5	0.9
	No. 100 (0.150)	7.9	7.5	0.5
	No. 200 (0.075)	0.0	0.0	0.0
Moisture content (%)		1.2	1.1	1.0
Specific gravity		1.131	1.161	1.163
Chemical components	Major rubber components	NR/BR/SBR	NR/BR/SBR	NR/BR/SBR
	Acetone extract (%)	9.0	11.0	11.5
	Rubber hydrocarbon (%)	55.0	50.5	51.5
	Carbon black content (%)	28.0	32.5	31.0
	Ash content (%)	8.0	6.0	6.0
	Natural rubber content (%)	43.0	34.0	26.0