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Development of new laboratory equipment for measuring the accelerated polishing of asphalt mixes

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A B S T R A C T

The skid resistance of pavements tends to decrease over time, resulting in greater risks for drivers. Currently, skid resistance and macrotexture values can only be determined for existing pavements. It would be of interest to be able to predict the evolution of the skid resistance of an asphalt mixture before its installation as a highway wearing course. This paper summarizes the experience gained and the results obtained during the development of a test procedure which has been applied in the laboratory to measure the evolution of the skid resistance of hot mix asphalts through a modified version of an accelerated polishing machine which is normally used to determine the polished stone value of aggregates.

1. Introduction

Skid resistance is the term commonly given to the friction generated between vehicle tires and wearing course of a pavement [1]. It is one of the characteristics which most significantly affects the safety of a pavement and it has serious repercussions on the reduction of accidents, especially in the event of rain or wet surfaces [2–6]. However, due to traffic and other factors, skid resistance decreases over time [7–10].

Because of this, the measurement of skid resistance has become a basic tool for highway network management [11]. Nowadays, it is still of great importance to develop standardized procedures to quantify the skid resistance of a pavement during the formulation of the asphalt in the laboratory [12], as well as to predict the evolution of this important property after the pavement has been constructed. Currently, skid resistance and macrotexture values can only be determined for existing pavements. It is merely assumed a priori that pavements will exhibit adequate values for these properties, especially if they are manufactured within specific grading parameters, using aggregates resistant to polishing, and installed according to the specifications of applicable standards [13].

In not a few cases, however, despite having rigorously followed the requirements of the current standards, the macrotexture and skid resistance of the resulting pavement do not meet the specifications, requiring the contractor, at best, to pay a fine or, at worst, to remove and reinstall a new wearing course, with which he may have the same problem.

It is clearly of great importance, then, to develop a testing procedure capable of determining the macrotexture and skid resistance values of a mixture in the laboratory before it is manufactured and laid down, and which can also estimate the evolution of these properties over time [9,11–14].

The following sections describe the new piece of laboratory equipment created for this purpose as well as the first results obtained.

2. Design and development of testing equipment

2.1. Initial approach

From the outset, the purpose of this study was to develop a testing procedure that would be as simple as possible and which would not require laboratory personnel to receive much, if any, additional training. The new machine created for this study is therefore based on commonly used laboratory equipment.

The development of the new testing device began with the machine used to determine the polished stone value (PSV) of

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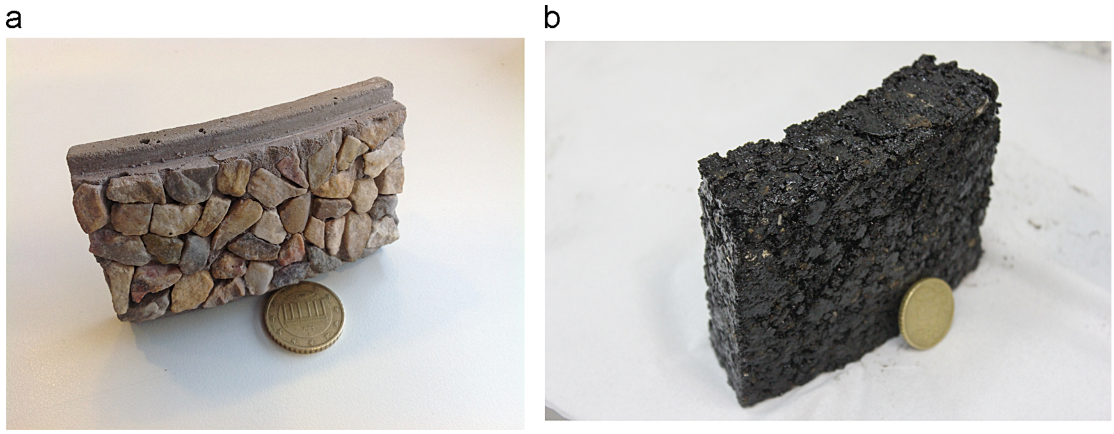

Fig. 1. (a) Aggregate specimen. (b) Asphalt specimen.

aggregates described in EN 1097-8 (Tests for mechanical and physical properties of aggregates. Part 8: determination of the polished stone value). The PSV is directly related to the tendency of an aggregate to lose its roughness or initial microtexture due to the polishing effect of tires [12]. The importance of the PSV for tire-pavement friction had already been recognized by Knill in 1960 [15].

In order to determine their PSV, the aggregates are placed in a curved mold and cemented with a resin mortar (Fig. 1a). The specimens are then placed on a testing wheel, or road wheel, along with specimens of a control aggregate; they are then subjected to polishing cycles using a loaded rubber tire, water, and two abrasives which are applied sequentially, each for three hours. After the polishing is complete, the skid resistance of the aggregate is measured with the British Pendulum Tester to obtain the PSV, as outlined in NLT-174/93 (Accelerated polishing of aggregates).

2.2. *Adaptation of the accelerated polishing machine*

In order to determine the PSV of bituminous mixtures instead of aggregates, it was necessary to make some modifications to the original road wheel, its lateral plates and the axle, as well as to increase the capacity of the motor. Modifications to other parts of the machine were not required.

The original polishing machine had a road wheel to which 14 aggregate samples – 90.6 mm in length, 44.5 mm in width, and 12.5 mm thick (Fig. 1a) – could be fixed. As it was not possible to manufacture asphalt specimens with these dimensions, the original testing equipment needed to be reconfigured.

The specimens of the bituminous mixture were manufactured with the same curvature as that of the aggregates, so that the polishing process would be similar. The asphalt samples were 30 mm thick and 82 mm wide (Fig. 1b), as this would guarantee sufficient compaction in the mold and a density and void content as similar as possible to those of the job mix formula. The tools and compaction procedures used to prepare the samples are described in the following sections.

The road wheel was modified to have an interior diameter of 350 mm so that the external diameter – the wheel plus the specimens – would be the same as on the original machine (410 mm). With this configuration, 12 specimens of the bituminous mixture with the above-mentioned dimensions could be attached to the wheel. The new lateral plates feature a continuous rim to support the samples during polishing. The rim covers 18 mm of the specimens on each side, leaving an area 46 mm wide for polishing (Fig. 2).

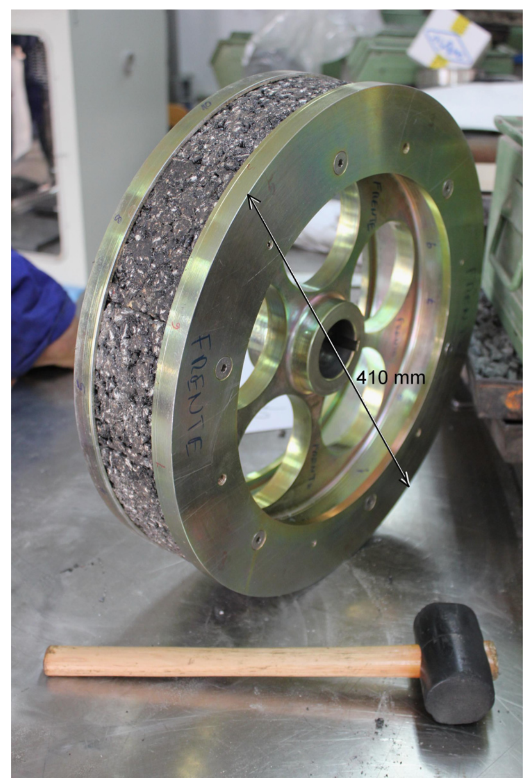

Fig. 2. New road wheel with specimens of the bituminous mixture.

2.3. *Procedure for manufacturing specimens of the asphalt mix*

The first step was to design a compaction method and the necessary accessories with which to construct the curved specimens of the bituminous mixtures. As can be seen in Fig. 1b, each specimen had an exposed convex surface and a concave surface which rested on the road wheel of the adapted polishing machine.

The compaction procedure needed to guarantee density, void content, and macrotexture for the laboratory specimens representative of field values of the same asphalt [16]. This was not possible with samples of the dimensions required when determining the PSV of aggregates. Therefore, specimens were manufactured which were 82 mm wide, 30 mm thick, 107.3 mm long on the external face and 91.6 mm on the internal face, with the aim of achieving the proper density, void content, and macrotexture for a mixture with a maximum aggregate size of 11.2 mm. Molds were then prepared for the preparation of specimens with these dimensions.