PRELIMINARY INVESTIGATION ON THE USE OF WASTE CORK DUST AS FILLER IN HOT-MIX ASPHALT

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INTRODUCTION

The cork contains significant amounts of a biopolymer called **suberin** (45%). Polymers have been frequently used in the manufacture of hot-mix asphalt (HMA) to improve their properties. Particularly, when a bitumen is modified with a polymer, the thermal susceptibility of the binder is low, leading to mixtures with higher resistance to the permanent deformation at high temperatures and higher resistance to the fatigue cracking at low temperatures. At the Universidade da Coruña (UDC), a preliminary investigation was carried out in which the feasibility of using **waste cork dust from the manufacture of plugs**, as **filler** (<0.063 mm) in the manufacture of **HMA** was analyzed. Firstly, the **aggregate-binder adhesion** was analyzed by means of two types of tests: the boiling water test and the rolling bottle method. The performance of the cork filler was compared with the performance of **conventional natural filler**. Secondly, a HMA type **AC 22 bin S**, for binder course of road flexible pavements, was manufactured, with a bitumen content of 3.8%. Indirect tensile test after immersion in water were conducted, in order to compare the **moisture damage resistance** of mixtures made with filler cork and natural filler.

MATERIALS, METHODS AND RESULTS

1. WASTE CORK DUST, NATURAL FILLER, AGGREGATES AND BITUMEN

Figure 1. Waste cork dust as filler.

Figure 2. Natural filler.

Figure 3. Natural aggregate (hornfels).

Figure 4. B50/70.

2. AC 22 BIN S

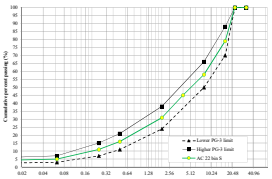


Figure 5. Grain size distribution of AC 22 bin S. Limits given by the PG-3.

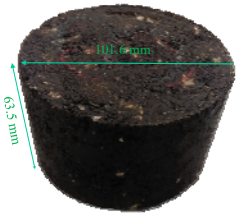


Figure 6. Marshall sample of AC 22 bin S compacted with 75 blows per face. The chosen bitumen content for the preliminary analysis was 3.8%.

3. AGGREGATE-BINDER ADHESION

Boiling Water test: ASTM D3625:

Loose mixture (8/11 mm) in boiling water for 10 minutes (variable coating requirements: 70% or 95%):

Figure 7. Boiling Water test procedure.

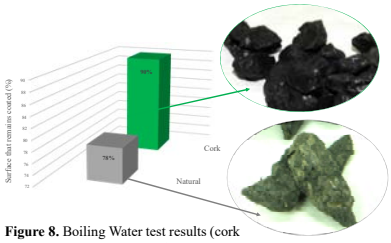


Figure 8. Boiling Water test results (cork better coating results).

Rolling Bottle test: UNE 12697-11:

Loose mixture (8/11 mm) rolling for 24 hours in a bottle with cold distilled water (no coating requirements):

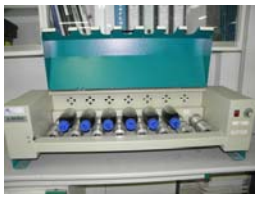
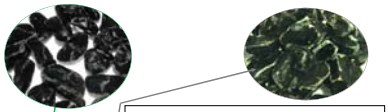


Figure 9. Rolling Bottle test procedure.



	Surface that remains coated after 24 h rolling (%)
Cork	79.4
Natural	78.9

Figure 10 and table 1. Rolling Bottle test results (cork slightly better coating results).

4. MOISTURE DAMAGE RESISTANCE

Water sensitivity of bituminous specimens: UNE-EN 12697-12:

In this test, the loss of indirect tensile strength, expressed in terms of the tensile strength ratio (TSR), is determined. A set of 8 cylindrical Marshall samples is subdivided into two subsets of 4 samples each: the "dry" subset and the "wet" subset.

Figure 11. The "dry" subset was kept at room temperature.

Figure 12. The "wet" subset was saturated and was held in a water bath for 3 days at 40°C.

Figure 13. The tensile strength of the dry (ITSd) and the wet (ITSw) subset were then determined at 15ºC.

	ITSd (Mpa)	ITSw (Mpa)	TSR=ITSw/ITSd (%)	PG-3 requirements for AC 22 bin S
Cork	1.622	1.010	62.3	TSR≥80%
Natural	1.770	1.045	59.0	TSR≥80%

Table 2. Moisture damage resistance test results (cork slightly better moisture damage resistance results, but very similar to those obtained using natural filler).

CONCLUSIONS:

1. In the case of the use of waste cork dust as filler, both tests (Boiling Water test and Rolling Bottle method) yield very satisfactory results in terms of aggregate-binder adhesion.
2. AC 22 bin S made with waste cork dust as filler, perform similar than the control mixture (made with natural filler) in terms of moisture damage resistance. Particularly, the TSR is slightly higher in the case of the mixture made using waste cork dust as filler.
3. This preliminary analysis shows encouraging results, but further investigation is needed in order to determine the feasibility of using waste cork dust as filler for HMA (more bitumen contents, volumetric properties, optimum bitumen content, permanent deformation, etc).

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