Effect of temperature on toughness of several bituminous mixtures.

Author: Elisabet Garrote Villar
Supervisor: Adriana Martínez

ABSTRACT

This MSc thesis intends to analyze the effect of the kind of bitumen on the toughness of bituminous mixtures. For this purpose, a semidense mixture (S-20) has been prepared using three types of bindings: a conventional bitumen (B-60/70), a bitumen modified with polymers (BM-3c) and a bitumen modified with pneumatic rubber powder (BM-pn), in order to evaluate the differences in behaviour between a mixture elaborated with conventional bitumen and several types of modified bitumen.

Tests have been conducted at different temperatures (from -10 to 40 ºC), trying to embrace the rank to which flexible pavements built in our country are hold.

In order to evaluate the toughness of the several mixtures, a new direct tension test has been used, applied to prismatic cores, developed by the Road Laboratory of the Polytechnical University of Catalonia. Load is applied with displacement control until the core breaks, at a speed low enough as to consider the test static. Central cross-section of each core is reduced by means of some cuts at both sides, which allow to induce the formation of a crack in that section. The main advantage of this procedure is based on the prismatic geometry of the core, over which only tension forces are produced. This fact enables an easy computation of such parameters like tension strength, break energy and break strain.

The results of maximum stress under direct tension have been complemented with those obtained in the normalized indirect tension test.

The fact that toughness of a mixture involves both its mechanical strength and its ability of straining means that this turns on an important parameter that must be taken on account in the design of bituminous mixtures.

A greater toughness means a more ductile behaviour of the mixture, i.e., it can stand greater strains before completely break. This effect allows to identify the most proper bitumen for a given temperature.

The results point that employment of modified conglomerants in this kind of mixtures improves the fracture energy at extreme temperatures, depending on the type of modificator used, while for temperatures nearing 10 ºC conventional bitumen is the one which exhibits a greater toughness.

It is remarkable the major improvement of toughness that represents the use of the modified bitumen BM-3c at low temperatures, which is of the order of six times greater than that of the remainder of bitumens tested.

An environmental solution to the problem of disposal of pneumatic rubber is the use of BM-pn at high temperatures, since its toughness is similar to that of BM-3c and higher than that of B-60/70.