Effect of mixture gradation and thickness on the cooling process of hot mix asphalts

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One of the most important factors affecting the design and performance of asphalt (HMA) pavements is to ensure an adequate compaction of the mixture, since it controls the resulting quality of the pavement (*e.g.*, high durability, absence of irregularities). In this sense, several parameters influence the compaction process, such as pouring temperature, base typology and bitumen content. Among them, temperature is of major concern, since it governs the compaction process and therefore highly determines the final quality of the product.

Nevertheless, given that mixture temperature is generally much higher than ambient one, it tends to rapidly decrease (especially for the case of thin asphalt layers), thus shortening the available compaction time [1]. Moreover, the cooling process does not take place homogeneously along the entire HMA thickness, being more accelerated on the lower layers (*i.e.*, those located right over the base) than near the free surface [2]. In this regard, the thermal properties of the mixture, which strongly depend on its gradation [3], can be modified in order to increase the cooling time and therefore ease the compaction process.

Hence, the purpose of this research work is to analyse the effect of varying the layer thickness and mixture grading on the cooling process of an HMA pavement. To this aim, a 3D FEM model has been developed within ANSYS commercial software, and 6 different combinations (two mixture gradings and three pavement thicknesses) have been modelled. Concerning the HMA mixtures, two typologies with very different grading have been studied: i) a stone mastic asphalt (SMA), which is a gap-graded HMA designed to maximize deformation resistance and durability by using a structural basis of stone-on-stone contact; and ii) an asphalt concrete (AC) with a 90% 16 mm passing aggregate (AC16). On the other hand, the selected thicknesses for the pavement layer are 2 cm, 4 cm and 5 cm, placed in all cases over a 22 cm deep base made of reinforced soil with cement and a 60 cm deep embankment (see Fig. 1). Moreover, the model is 2 m width (*i.e.*, in the transversal direction of the represented road) and 5 m long (*i.e.*, in the longitudinal direction).

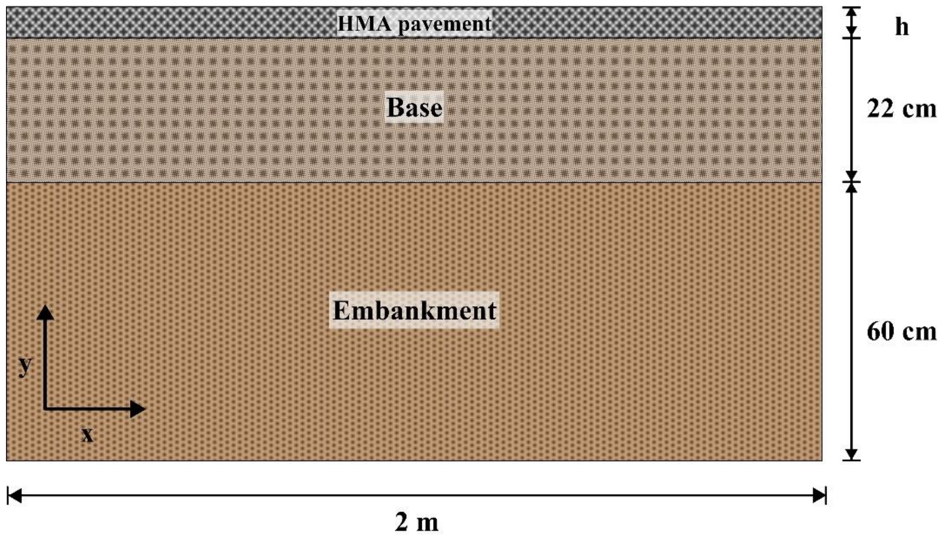

Fig. 1. Road section modelled in ANSYS

Tri-dimensional 8-node elements SOLID70 with thermal conduction capability have been used for modelling the solid materials; while the HMA-air interface is reproduced by means of bi-dimensional SURF152 elements. A transient analysis has been carried out with a total cooling time of 5 h; and the initial temperatures for both the mixture and the soil-air environment have been set to 140 ºC and 25 ºC, respectively.

References

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