Modification of a transparent binder for road pavements using TiO_2 nanoparticles

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Light and heat are relevant factors for road pavements since they promote the aging of the asphalt surfaces [1], and a large amount of heating can intensify the Urban Heat Island (UHI) effect [2]. Contrariwise, the lack of light strongly affects visibility conditions, reducing safety [3]. The conventional black color of asphalt pavements absorbs light and stores a large amount of thermal energy, which can be reduced opting by the application of light-colored pavements using, for example, a transparent binder [3]. Industrial activities and road traffic are the main sources of pollutant emissions, mostly SO_2 and NO_x, which are hazardous atmospheric pollutants. There are several consequences at different scales caused by these harmful gases, such as intensification of the greenhouse effect, acid rain, and public health problems. With the use of nano-TiO_2 into/over asphalt mixtures, and consequently with the functionalization process considering the photocatalytic and self-cleaning properties, road pavements become the ideal places to mitigate environmental pollution due to proximity to the emissions [4]. If a transparent binder modified with nanoparticles of TiO_2 is used, pavements will present multifunction effects and benefits when submitted to high solar irradiation. The production at laboratory-scale of such pavements is presented in Figure 1. First, the transparent binder was modified with nano-TiO_2 (0, 0.5%, 3.0%, 6.0% and 10.0%). Binder's workability was confirmed. It presented similar behavior as a polymer modified binder. In these binder samples, the addition of high contents of nano-TiO_2 increased the rutting resistance, but it seemed to reduce fatigue life, except for the 0.5%. Also, the nano-TiO_2 modification had a slight effect on the chemical functional indices. The best percentage of TiO_2 was 10.0% considering rutting resistance and 0.5% concerning fatigue life.

REFERENCES

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FIGURES

a) b) c) d)

Figure 1: a) Binder Modification with nano-TiO_2; b) asphalt mixture production; c) asphalt mixture compaction; d) slab sample of a light-colored pavement.