Application of nano-TiO_2 and micro-PTFE on Recycled Asphalt Mixtures for Superhydrophobic Functionalization

Iran Rocha Segundo
Salmon Landi Jr., Elisabete Freitas, Manuel Filipe Costa, Vasco Teixeira, Behzad Zahabizadeh, Vítor M.C.F. Cunha, Graça Soares, Jorge Santos and Joaquim Carneiro
Centre for Territory, Environment and Construction (CTAC), Institute for Sustainability and Innovation in Structural Engineering (ISISE), Centre for Textile Science and Technology (2C2T), and Centre of Physics of Minho and Porto Universities (CF-UM-UP), University of Minho, Guimarães, Portugal
iran_gomes@hotmail.com

The main objective of this research is to improve the efficiency and durability of the superhydrophobic capability on asphalt mixtures. In general, the benefits of this capability on materials are several, for example, water-resistance, anti-icing, antibacterial, contaminant-free, self-cleaning, anticorrosive, among others [1]. Through this type of functionalization, road engineering researchers seek to improve water repelling and resistance, and prevent ice formation on pavements [2–4]. Additionaly, it generates the self-cleaning ability, relevant to remove remove dust from the surface. All these aspects are mostly related to the mitigation of friction decrease caused by water, ice, or even dust over the surface of the pavements. The superhydrophobic capability is achieved when the Water Contact Angle (WCA) between a water droplet and the material surface is higher than 150° [1]. In this research, three asphalt mixtures, type AC 10, were functionalized: R (reference), without any recycled material; F, with 30% reclaimed asphalt pavement (RAP); and A, with 30% steel slags (SS). The functionalization process consisted of two successive spraying coatings: i) spraying of a diluted resin epoxy and ii) spraying of a solution composed of nano-TiO_2 and micro-PTFE (under ethyl alcohol medium with a concentration of 4 g/L of each solute). The epoxy resin was diluted using butyl acetate with a proportion of 1:1 in mass. The cut asphalt mixture samples (25 x 25 x 15 mm^3) were sprayed with 0.25, 0.50, 1, and 2 g of the diluted resin, resulting in a covering ratio of 0.1, 0.2, 0.4, and 0.8 mg/cm^2, and with 8 mL/cm^2 of the particles' solution both at room temperature. The wettability of the mixtures without any treatment, with only resin spraying coating and with both spraying coatings (resin and particles) was assessed by the Water Contact Angle (WCA). The results showed that F and R present similar initial WCA, 108° and 115° respectively, while mixture A presented a much higher WCA (131°). The spraying of the resin decreases the WCA, the higher resin content lead to lower WCA. The superhydrophobic capability was achieved for R and F samples with 0.25 and 0.50 g of resin spraying with particles. The mixture A achieved the superhydrophobicity only with 0.25 g of resin spraying with particles.

REFERENCES

[1] Zhu, H.; Guo, Z.; Liu, W. Chemical Communications, 50 (2014), 3900–3913
[2] Arabzadeh, A.; Ceylan, H.; Kim, S.; Gopalakrishnan, K.; Sassani, A. Transportation Research Record, 2551 (2016), 10–17
[3] Nascimento, J.H.O.; Pereira, P.; Freitas, E.; Fernandes, F. at 7th International Conference on Maintenance and Rehabilitation of Pavements and Technological Control (2012), Auckland, New Zealand
[4] Rocha Segundo, I.; Ferreira, C.; Freitas, E.F.; Carneiro, J.O.; Fernandes, F.; Júnior, S.L.; Costa, M.F.; Landi Júnior, S.; Costa, M.F. Constrution and Building Materials, 166 (2018), 36–44