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Use of End-Of-Life Footwear Polymer EVA (Ethylene Vinyl Acetate) and PU (Polyurethane) for Bitumen Modification

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Abstract : The footwear industry is an essential fashion industry, focusing on producing various types of footwear, such as shoes, boots, sandals, sneakers, and slippers. Global footwear consumption has doubled every 20 years since the 1950s. It is estimated that in 1950, each person consumed one new pair of shoes yearly; by 2005, over 20 billion pairs of shoes were consumed. To meet global footwear demand, production reached $24.2 billion, equivalent to about $74 per person in the United States. This means three new pairs of shoes per person worldwide. The issue of footwear waste is related to the fact that shoe production can generate a large amount of waste, much of which is difficult to recycle or reuse. This waste includes scraps of leather, fabric, rubber, plastics, toxic chemicals, and other materials. The search for alternative solutions for waste treatment and valorization is increasingly relevant in the current context, mainly when focused on utilizing waste as a source of substitute materials. From the perspective of the new circular economy paradigm, this approach is of utmost importance as it aims to preserve natural resources and minimize the environmental impact associated with sending waste to landfills. In this sense, the incorporation of waste into industrial sectors that allow for the recovery of large volumes, such as road construction, becomes an urgent and necessary solution from an environmental standpoint. This study explores the use of plastic waste from the footwear industry as a substitute for virgin polymers in bitumen modification, a solution that presents a more sustainable future. Replacing conventional polymers with plastic waste in asphalt composition reduces the amount of waste sent to landfills and offers an opportunity to extend the lifespan of road infrastructures. By incorporating waste into construction materials, reducing the consumption of natural resources and the emission of pollutants is possible, promoting a more circular and efficient economy. In the initial phase of this study, waste materials from end-of-life footwear were selected, and plastic waste with the highest potential for application was separated. Based on a literature review, EVA (ethylene vinyl acetate) and PU (polyurethane) were identified as the polymers suitable for modifying 50/70 classification bitumen. Each polymer was analysed at concentrations of 3% and 5%. The production process involved the polymer's fragmentation to a size of 4 millimetres after heating the materials to 180 ºC and mixing for 10 minutes at low speed. After was mixed for 30 minutes in a high-speed mixer. The tests included penetration, softening point, viscosity, and rheological assessments. With the results obtained from the tests, the mixtures with EVA demonstrated better results than those with PU, as EVA had more resistance to temperature, a better viscosity curve and a greater elastic recovery in rheology.

Keywords : footwear waste, hot asphalt pavement, modified bitumen, polymers
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