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GREEN ROAD ENGINEERING: RECYCLING PET WASTE INTO ASPHALT MIXTURES FOR SUSTAINABLE ROAD CONSTRUCTION

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Abstract

Managing plastic waste, particularly that derived from polyethylene terephthalate (PET), stands as one of the most critical environmental challenges of the 21st century, owing to the large volume of unrecycled materials and their significant impact on the environment.

This paper investigates the utilization of recycled PET fibers in four representative asphalt concrete mixtures used in pavement structures, classified according to EN 13108-1 – Asphalt Concrete: AC 22.4 binder 50/70 with chippings, AC 22.4 binder 50/70 with crushed gravel, AC 22.4 base 50/70 with chippings, and AC 22.4 base 50/70 with crushed gravel. The PET fibers were incorporated using the dry process, at proportions of 2% and 4% by weight of the bitumen binder. The mechanical performance of the mixtures was evaluated through dynamic creep testing, stiffness modulus determination, and fatigue resistance testing. The results demonstrated significant mechanical and environmental improvements, including a reduction in permanent deformation by 18–61%, stiffness increase by 36–47%, and fatigue life extension up to 1,000,000 cycles. From an ecological perspective, bitumen consumption decreased by 0.5–1%, while CO₂ emissions were reduced by 15–25 kg per ton of asphalt mixture, supporting the integration of PET fibers within sustainable road construction strategies. The analysis of the environmental contribution indicates a reduction in bitumen binder consumption and a decrease in CO₂ emissions, which supports the integration of PET fibers within circular economy strategies and the concept of sustainable road infrastructure. These findings confirm the technical feasibility and environmental benefits of utilizing PET fibers in asphalt mixtures designated for modern pavements.

Key words: asphalt mixtures, dynamic performance, pavement, recycled PET fibers, sustainability

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