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A Novel Polymer Composite from Recycled Polyethylene and Ugandan Red Dune Sand for Traffic-Calming Applications: Cost Analysis and Impact on Road Safety in Gaborone

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| Abstract

The accumulation of plastic waste and the need for affordable road safety interventions present concurrent challenges in many urban African settings. Speeding in residential areas is a particular concern in Gaborone, Botswana. This research investigates a dual-purpose solution by developing a sustainable construction material that utilises waste plastic and a locally abundant mineral resource. This study aimed to develop and characterise a novel polymer composite from recycled polyethylene bags and Ugandan red dune sand, to assess its suitability for fabricating speed bumps, and to evaluate the installation costs and road safety impact of its deployment in Gaborone neighbourhoods. Composite samples were produced by melt-blending shredded polyethylene with varying proportions of red dune sand. Key mechanical properties, including compressive strength and abrasion resistance, were tested. A full-scale prototype speed bump was installed in a residential area. The installation costs were documented, and speed-related accident data were collected from periods before and after installation for comparative analysis. The optimal composite formulation exhibited a 40% greater compressive strength than standard concrete. The installed speed bump reduced vehicle speeds at the site by an average of 30%. During the monitoring period, speed-related accidents in the immediate vicinity decreased by 50%. The composite's material and installation costs were approximately

25% lower than those for conventional concrete speed bumps. The composite of recycled polyethylene and red dune sand is a mechanically robust and cost-effective material for traffic-calming infrastructure. Its application presents a sustainable engineering solution that addresses plastic waste and leverages a local mineral resource. Municipal authorities should consider piloting this composite material in traffic-calming projects. Further research is warranted to evaluate its long-term durability under diverse climatic conditions and to develop standardised production protocols for broader application. polymer composite, recycled polyethylene, red dune sand, traffic calming, road safety, cost analysis, sustainable construction This research provides original evidence for the engineering viability and socio-economic benefit of a novel, sustainable composite material for road safety infrastructure, contributing to the fields of polymer science and civil engineering within an African context.
