Innovative Use of Crumb Rubber and Silica Fume in Hot Mix Asphalt: A Material Properties Study

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Abstract

A significant percentage of road pavements suffer from cracking and rutting, primarily owing to poor asphalt mixture characteristics and heightened traffic loads. Subsequently, they acquire defects such as creep, fatigue, and rutting. To address these issues, this study explores the use of crumb rubber (recycled tyres) and silica fume (by-product of silicon alloy production) as modifiers for enhancing asphalt performance. Asphalt mixes were prepared with varying amounts of crumb rubber (5–10% by weight of bitumen) and silica fume (5–10% by weight of fine aggregate). Aggregate tests (Aggregate Impact Value Test, Aggregate Crushing Value Test, Los Angeles Abrasion Value Test, and water absorption), bitumen tests (penetration, softening point, and ductility), and mechanical performance tests (resilient modulus, dynamic creep, and Scanning Electron Microscopy analysis) were performed. Results revealed that the mixture containing 10% crumb rubber and 5% silica fume exhibited a 25% increase in resilient modulus and a 30% reduction in permanent strain compared to the conventional mixture. This combination modification method is unique in integrating both

crumb rubber and silica fume at optimized levels to enhance the performance for both mechanical and morphological properties simultaneously. It can be concluded that the utilizing of these materials significantly improves pavement lifespan and reduces environmental impact while also improving sustainability and durability.

Author keywords

Crumb rubber; green pavement; hot mix asphalt; modified asphalt; silica fume

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