Performance Evaluation of Waste Fillers Admixed Asphalt Mixes

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Abstract

Ever increasing growth of various sectors has led to the continuous usage of natural resources and the generation of huge quantities of solid waste. Currently, world cities produce around 1.3 billion tonnes of solid wastes annually, which is expected to increase to 2.2 billion tonnes by 2025. Besides environmental concerns, inflation in the cost of virgin material and the gradually declining amount of natural resources have obliged the decision-makers to utilize waste/secondary materials as replacements to conventional construction materials. Global pavement network primarily consists of flexible pavements, which utilize asphalt mixes as their base and surface courses. Mineral filler is an integral part of asphalt mixes which influence mix's cost and performance against various distresses. This study investigates the suitability of seven different waste materials as fillers in place of conventional material in the asphalt concrete mix. Waste materials under consideration are; glass powder (GP), bauxite residue or red mud (RM), brick dust (BD), copper tailings (CT), dimension limestone slurry dust (LD), carbide lime (CL) and rice straw ash (RSA). Whereas, conventional dolomite stone dust was adopted as a conventional filler.

Detailed physical, geometrical and chemical characterization of fillers was carried out. Physical characterization parameters such as specific gravity, plasticity index, particle size distribution and fractional void content were assessed using a specific gravity test, plasticity index test, particle size analysis, and German filler test value, respectively. Harmful clay content was determined as per methylene blue value test. Morphological and mineralogical analysis were performed using Scanning electron microscope (SEM) and X-Ray Diffraction (XRD) techniques. Apart from these, affinity of fillers towards asphalt was assessed using the pH value and hydrophilic coefficient tests. Thereafter asphalt concrete mixes containing waste fillers and stone dust were prepared, and their Optimum Asphalt Contents (OAC) were determined. The stability, flow, volumetric and performance parameters such as the Marshall quotient (MQ) and indirect tensile strength (ITS), were evaluated to compare the performance of mixes against rutting and cracking, respectively. The resistance of the prepared mixes against moisture damage was evaluated using retained Marshall Stability ratio, active and passive adhesions test values.

At their optimum bitumen contents, all waste modified mixes delivered satisfactory mechanical and volumetric performances as demanded by paving specifications. However, the performance of each waste filler modified mixes was found to be largely influenced by the physical and chemical characteristics of the filler incorporated in it. Fillers like limestone dust and copper tailings formed economical mixes with lower OBC which was attributed to the bitumen extender action and lower porosity of these fillers, respectively. Mixes with finer fillers (red mud and limestone dust) displayed superior stiffness and cracking resistance. Similarly, carbide lime and limestone dust admixed mixes have

displayed superior adhesion and moisture resistance due to the predominance of calcium based water insoluble minerals like calcite and portlandite in their composition which ensure superior aggregate bitumen adhesion.

Keywords: Filler, Waste materials, Asphalt mixes, Sustainability, Waste management, Moisture resistance.

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