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REVIEW ARTICLE

A synthesis on utilization of waste glass and fly ash in cold bitumen emulsion mixtures

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Abstract

The generation of waste materials is a global concern and attempts are being made to utilize these wastes in the construction industry. The development of road infrastructure everywhere is going at a fast pace which increases the environmental degradation, fossil fuel consumption, global warming, and depletion of natural materials because of hot mix asphalt (HMA) usage. The detrimental effects of generation of waste in large quantities at a global scale and virgin material/energy consumption in HMA construction are of prime concern and need to be addressed. The construction/maintenance of pavement must be environmentally, economically, and socially sustainable. Use of cold bitumen emulsion mixtures (CBEMs), a type of cold mix asphalt (CMA), is a way forward for development of sustainable road infrastructure. The incorporation of wastes in CMA can be a sustainable solution to problems linked to waste generation and development of flexible pavements with HMA. This work summarizes the staging evaluation of CBEMs incorporated with waste glass (WG) and fly ash (FA) utilizing mechanical characteristics, water sensitivity and environmental impact, critical gaps in the literature, and recommendations to address those gaps. A detailed analysis on CBEMs using WG as a replacement of fine aggregate showed comparable stability/stiffness and multifold resistance to rutting than HMA. Fly ash filler in CBEMs reported extraordinary increase in stability, stiffness, rutting resistance, and water sensitivity than reference CBEM/HMA. The focus of the research area should continue on the exploration of waste materials for use in CBEMs to achieve a better environment for society and to promote sustainability in the pavement industry.

Keywords Cold bitumen emulsion mixtures (CBEMs) · Sustainability · Waste glass · Fly ash · Stability · Use of waste materials

Introduction

Environmental organizations have escalated pressure on the road industry to abandon environmentally unfriendly practices. One of the biggest challenges that the world is facing at present is global warming (Cline et al. 2004). Many of the target areas to reduce the same include opt for low carbon dioxide emissions during hot mix asphalt (HMA) manufacturing, reduced use of virgin raw materials as an aggregate and a binder, usage of waste materials/recycled materials, minimizing waste that goes to landfills, and reducing waste generation from virgin aggregate production. Major energy-consuming procedures during HMA manufacturing are heating of aggregates/asphalt and transport of prepared mixtures from a mixing plant to site (Sjöblom 2006). The concept of energy saving and enhanced safety during site work has stimulated the need for producing alternative and safer methods of production of asphalt mixtures. One of the privileged and attractive alternatives is cold mix asphalt (CMA) technology. CMA mixtures are produced at ambient temperatures (Al-Hdabi and al Nageim 2018; Needham 1998a, b; Oruc et al. 2007; Read and Whiteoak 2003; Thanaya et al. 2009). CMA mixtures require no heating during production and application process. However, CMA mixtures have been reported to have low early strength and high porosity (Al-Busaltan et al. 2017). This inadequacy can be because of the presence of water in cold bitumen emulsion (Ling

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