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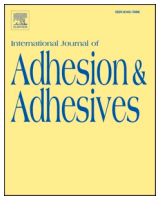

A comprehensive review of the utilization of alternative binding properties in the construction of asphalt pavements

Rashida Ferdaus, Khairil Azman Masri *, Kamrul Hasan, Ramadhansyah Putra Jaya

Faculty of Civil Engineering Technology, Universiti Malaysia Pahang Al-Sultan Abdullah (UMPSA), Lebuh Persiaran Tun Khalil Yaakob, 26300, Kuantan, Pahang, Malaysia

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ABSTRACT

Asphalt pavement construction has traditionally relied on conventional binders; however, growing concerns over environmental sustainability and performance have catalyzed a shift towards exploring alternative binders. This paper presents a thorough review of the burgeoning impact of alternative binders in asphalt pavement construction. Investigated alternative binder properties include polymers, waste cooking oil (WCO), waste engine oil (WEO), resin, and others, all of which show promise as modified asphalt binders. The review underscores the potential of alternative binders to transform asphalt pavement construction, offering sustainable, cost-effective, and high-performance solutions. Benefits include reduced reliance on fossil fuels, enhanced durability, improved rutting resistance, and a diminished environmental footprint. Moreover, the paper emphasizes the necessity for ongoing research and collaboration among researchers, practitioners, and policymakers to fully relalize the advantages of alternative binder properties in fostering greener and more resilient transportation infrastructure. This research signals a pivotal shift towards environmentally conscious practices in pavement construction, focusing on sustainable solutions to meet contemporary infrastructure demands while minimizing ecological impacts.

1. Introduction

Due to the rapid growth of urbanization, developments in material science, and the global expansion of roads and highways, the worldwide demand for asphalt pavement has increased. There are 64,285,009 km (39944853 miles) of roads on the globe overall. Presently in use are 63,873,156 km (39,688,939) of regular roads, including paved and unpaved, and 411,853 km (411854 mi) of expressways [1]. Bitumen is by far the most commonly used binder in road construction globally. Most paved roads, highways, streets, and airport runways rely on bitumen as the binder in asphalt pavement. However, the negative impacts of using bitumen as a binder in road construction primarily revolve around environmental and health concerns. The production of bitumen involves the extraction and refining of crude oil, which contributes to carbon emissions and climate change [2]. When bitumen is heated to 165–200 °C, it releases a vapor that contains volatile components and greenhouse gasses that are poisonous and chemically distinct from the original material. Therefore, addressing this issue by employing alternative binders instead of bitumen could be viewed as a sustainable approach, both from environmental and economic standpoints.

In recent years, the construction industry has witnessed a growing interest in exploring alternative binders as substitutes for conventional bitumen in various pavement and road construction applications. By incorporating these alternative binders either as modifiers or partial substitutes for traditional petroleum-based asphalt. It becomes feasible to use less asphalt sourced from fossil fuels in pavement applications [3]. Among the standard alternative binders are materials such as polymer for example virgin and waste, waste engine oil (WEO), waste cooking oil (WCO), kinds of bio-oil, resin, and others. There are three key bituminous pavement properties stiffness, rutting resistance, and cracking resistance are used to assess the performance of mixtures. When the alternative binder or additive is added to the asphalt binder, the viscosity decreases, and the combination of the asphalt mixture may gradually become softer. As a result, rutting issues arise since the asphalt binder is soft and has oil in the mixture.

According to Costa et al. [4] research, alternative binders, specifically those incorporating waste polymers like ethylene vinyl acetate (EVA) and virgin styrene-butadiene-styrene (SBS), have demonstrated

* Corresponding author.
E-mail addresses: rashida.umpmy@gmail.com (R. Ferdaus), khairilazman@umpsa.edu.my (K.A. Masri), kamrulhasan5262@gmail.com (K. Hasan), ramadhansyah@umpsa.edu.my (R.P. Jaya).

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