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Literature on Bitumen Modification

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A B S T R A C T

In India, flexible pavement with bituminous covering is extremely prevalent. The performance of traditional bitumen has some problems that have been exposed by a rapid increase in traffic, the overloading of industrial vehicles, and the significant daily and yearly fluctuations in temperature. For flexible pavement, initial observations of bituminous surfacing distress signs like splitting, rutting, raveling, undulations, shoving, and potholing have been recorded. A bituminous blend must be sufficiently firm at high service temperatures to prevent rutting and sufficiently pliable at low service temperatures to prevent pavement cracking. The physical characteristics of bitumen are enhanced without altering its chemical Nature, and this results in a wide range of performance-related advantages. The asphalt firm has been attempting to use non-petroleum binders as a partial or complete substitute for asphalt binders in order to lessen their reliance on petroleum-based binders. This article reviews the developments and difficulties in bitumen polymer modification for road building over the last 40 years. Although each of these polymers somewhat enhances the bitumen's properties, there are still some disadvantages that prevent further advancements in bitumen polymer modification. These include the polymer changed bitumen's high cost, poor ageing resilience, and poor storage stability. This paper presents the experimental examination of conventional bitumen and polymer-modified binder. It has been demonstrated that the bituminous concrete blend with polymer modified bitumen has greatly increased rutting resistance, indirect tensile strength, and resilient modulus.

Keywords: Flexible pavements, polymers , Bitumen, physical properties.

1. INTRODUCTION

For more than a century, bitumen has been extensively used in India to build pliable sidewalks. In India, flexible sidewalks with bituminous coverings are very common. The performance of asphalt binders has been shown to have some limitations due to exponentially rising traffic, overloaded commercial vehicles, and significant daily and seasonal temperature variations. This has resulted in the early emergence of bituminous surfacing distress symptoms like cracking, rutting, ravelling, undulations, shoving, and potholing. Bitumen's function as a visco-elastic substance in deciding many elements of road performance is significant. Extreme intricacy in bitumen chemistry and rheology is caused by a variety of crude sources and processing techniques. Furthermore, temperature and loading duration affect the change from strictly viscous to elastic. A bituminous blend must be sufficiently stiff at high service temperatures to prevent rutting and sufficiently pliable at low service temperatures to prevent sidewalk cracking. Flexible sidewalks made of traditional asphalt don't always function as they should. A variety of modifications have been looked into to help bitumen's characteristics. Among them are chemical reaction alteration, polymer modification, and compound modification. Studies have shown that by adding specific polymers, the properties of bitumen and bituminous mixtures can be enhanced to satisfy the expanding demands of paving. Polymer-modified asphalt provides a range of performance-related advantages because they enhance the material's physical characteristics without altering its molecular composition. Usually, the polymer affects the bitumen by forming a network of interconnected polymers inside the bitumen. The additional polymer's network of long-chain molecules is what changes the bitumen's physical characteristics. These compounds improve the bitumen's flexibility, lower its brittle point, and raise its softening point. In turn, this will change the mix's characteristics, causing it to behave differently depending on the temperature, showing greater rigidity at higher temperatures and high flexibility at lower temperatures. The characteristics of bituminous mixes made with traditional bitumen and polymer-modified bitumen are compared in this study. The findings of the two bitumen mixes (60/70 and PMB70) have been reviewed, and significant inferences from the experimental research have been made.

Bitumen is a virtually inert adhesive and waterproofing substance that is derived from crude oil or found in natural asphalt, is completely or almost completely soluble in toluene, and is extremely viscous or almost solid at room temperature, according to the European specification (EN 12597). It is widely acknowledged that bitumen's initial properties heavily depend on how it is produced and processed, as well as the features of bitumen crude oil. Proper distillation procedures and high-quality petroleum oils can improve bitumen's characteristics. Higher bitumen outputs are typically produced by heavier petroleum oils. Therefore, it is crucial to have a thorough understanding of the bituminous features from all angles. This information becomes even more crucial when producing and using bituminous materials for some bitumen uses becomes problematic due to issues like phase discontinuity, mal-dispersion, and instability with polymers.

2. LITERATURE REVIEW

Ellie H. Fini et al.(2015) , The European standard defines bitumen as an adhesive and waterproofing substance that is obtained from crude oil or found in natural asphalt, is fully soluble in toluene, and is extremely viscous or almost solid at room temperature. It is widely acknowledged that bitumen's initial properties heavily depend on how it is produced and processed, as well as the properties of bitumen crude oil. Proper distillation procedures and high-quality petroleum oils can improve bitumen's characteristics. Higher bitumen outputs are typically produced by heavier petroleum oils. Therefore, it is crucial to have a thorough understanding of the bituminous features from all angles. This information becomes even more crucial when producing and using bituminous materials for some bitumen uses becomes problematic due to issues like phase discontinuity and improper polymer dispersion [1].

Ashok Pareek et al.(2012) , The experimental analysis of traditional bitumen and polymer-modified binder is presented in this article. It has been demonstrated that the bituminous concrete blend with polymer-modified bitumen has greatly increased rutting resistance, indirect tensile strength, and resilient modulus. In India, flexible sidewalks with bituminous coverings are very common. The performance of traditional bitumen has some shortcomings that have been revealed by the exponential growth in traffic, the overloading of industrial vehicles, and the substantial daily and yearly temperature changes. For bendable sidewalks, early reports of bituminous surfacing distress signs like splitting, rutting, ravelling, undulations, shoving, and potholing have been made. A bituminous blend must be sufficiently stiff at high service temperatures to prevent rutting and sufficiently pliable at low service temperatures to prevent sidewalk cracking. The physical characteristics of bitumen are enhanced without altering its molecular makeup, and this results in a variety of performance-related advantages [2].

Michele Porto et al.(2019) , The data for this research were compiled after a careful examination of the most recent papers in the literature on modified bituminous materials, technologies, and advancements. The report is organised into two main parts for this reason. The bitumen itself is examined in the first section in terms of its molecular composition and microstructural structures. The second section of the paper concentrates on bitumen alteration from various angles in order to evaluate the efficacy of the added additives and polymers in improving the technical characteristics of bitumen in both paving and industrial applications. The findings of this research have demonstrated the significance of the chemical makeup of bitumen as a foundation for change.While some polymers and compounds may enhance some characteristics of pure bitumen, they may also cause compatibility issues during manufacturing and storing. In this regard, numerous studies demonstrated the efficacy of waxes for enhancing the compatibility of polymers with bitumen as well as some advantages regarding the creation of warm mix asphalt (WMA) [3].

Jiqing Zhu et al.(2014) , This article reviews the developments and difficulties in bitumen polymer modification for road building over the last 40 years. A detailed timeline of bitumen polymer modification is provided. The benefits and drawbacks of some common thermoplastic elastomers and plastomers used in bitumen modification are discussed, including polyethylene (PE), polypropylene (PP), ethylene-vinyl acetate (EVA), ethylene-butyl acrylate (EBA), styrene-butadiene-styrene (SBS), styrene-isoprene-styrene (SIS), and SEBS. Although each of these polymers somewhat enhances the bitumen's properties, there are still some disadvantages that prevent further advancements in bitumen polymer modification. These include the polymer-modified bitumen's high cost, poor ageing resilience, and poor storage stability. (PMB). Researchers tested a number of strategies to eliminate these disadvantages. Analysed as well is the potential growth of polymers for asphalt alteration. Since it is currently difficult to fully realise all anticipated PMB properties at once, some compromise recommendations are made in this paper, including significantly enhancing the properties at a cost that is acceptable and lowering the cost with relatively subpar properties. The emphasis is on functionalization as a potential strategy for improving the characteristics of currently employed polymers and for more successfully developing novel types of polymer modifiers in the future. Future studies on bitumen polymer alteration are advised to concentrate more on function development to improve binding with aggregates, long-term performance, and recyclability [4

3. METHODOLOGIES

Bio-oil modification of bitumen : Binders that have been bio-oil changed were created by mixing each bio-oil with clean asphalt binder at a rate of 10% by weight of asphalt binder. This paper compares four different bio-oils made from swine manure, MP, CS, and WP with respect to the change in rheological and chemical properties of a control asphalt binder before and after oxidative ageing in order to investigate the effects of various bio-oils on asphalt binder. For this research, PG 64-22 was the tidy folder of choice.

Polymer modification of bitumen : In the current research, an experimental investigation was conducted using PMB-70 polymer modified bitumen and PMB-60/PMB-70 traditional bitumen. The goal of the current research is to compare the performance of bituminous concrete mixtures made with traditional and polymer-modified bitumen. The combined classification of coarse and fine aggregates and filler must stay within the set parameters. In addition to improving the bitumen's physical characteristics without altering its molecular composition, modified bitumen with polymer provides a number of performance-related advantages. According to reports, these changed bituminous binders create softer mixes at low service temperatures to reduce thermal cracking not caused by loads. Additionally, the bituminous mixtures' enhanced fatigue resistance, general better performance in adverse weather and high traffic conditions, and shorter life cycle .The pavement's expense has also been documented in the books.

Thermoplastic Elastomers Modification of Bitumen : Thermoplastic elastomers can withstand irreversible deformation over stretching and return to their original shape elastically after being relieved of pressure. Typically, block copolymers of mono- or di-olefins are used as stabilisers in flexible elastomers. Styrene is used as a mesomer as a mono-olefin unit, whereas butadiene or isoprene is typically used as a diolefin. Styrene butadiene styrene (SBS), styrene isoprene styrene (SIS), and styrene-ethylene/butylene-styrene are the equivalent elastomers. (SEBS). Weak inter-chain linkage and a typically straight structure are characteristics of thermoplastic elastomers. But radial SBS copolymers are frequently employed as asphalt modifiers.

4. CONCLUSIONS

The need for substitute binders and bio-modifiers to be used as a partial substitution for asphalt binder has been driven by the rise in the price of asphalt binder and the depletion of its resources. It should be noted that each bio-modifier has distinct effects on the physical, chemical, and morphological characteristics of asphalt, particularly when that material is subjected to oxidative ageing; these effects primarily rely on the bio-modifier's source and manufacturing processes. In order to compare the effects of various bio-modifiers (bio-oils/BBs) produced from swine manure, MP, CS, and WP on the surface, rheological, and chemical characteristics of base asphalt before and after oxidative ageing, the findings of this research are presented in this article.

The elastic recovery of polymer modified bitumen is observed to be considerable (79%). Better age resilience qualities are present in modified asphalt. When heated in a thin layer oven, weight loss is 6 times greater than when bitumen that is 60/70 percent standard is heated. The polymer modified bitumen has a considerably greater resilience to rutting.

Due to their elastic component, thermoplastic elastomer copolymers are typically more effective than plastomers for modifying asphalt in paving uses. The degree of modification varies from low (3% polymer content) to high (7% polymer content). As the most widely used elastomer, styrene butadiene styrene (SBS) has many advantages over other materials, including better thermal susceptibility, higher softening point, and a small drop in penetration value at 25 °C. Additionally, it has been found that SBS can reduce the rigidity rise brought on by oxidation processes.

Further research is necessary to be able to fully integrate the aspects related to bitumen functionality and come to conclusions regarding many challenges on this subject. This is especially true given the variety of conclusions, particularly regarding the bitumen's chemical characteristics and related engineering properties.

5. FUTURE SCOPE FOR RESEARCH

Due to bitumen's increasing cost, resource loss, and severe environmental impact, the world needs a replacement binder for flexible paving. The term "bio binder" refers to the concept of a bio-based alternative to traditional bitumen. As more chemicals are used, less bitumen is produced from petroleum, and pollutants increase. This improves road efficiency, reduces expenses, and helps the environment. Research is being done to develop a replacement for bitumen used in road construction. Only a few probable sources—bio-based sources and sources from waste products—have been identified by researchers. Cooking oil, vegetable oil, palm oil, biomass, and swine manure are some of the sources of bio-oil. Waste materials, such as waste coconut oil, waste engine oil, waste polymer, and desiccated sewer discharge. The world needs a viable supply of energy to ensure a clean environment and avoid future generations having to deal with a shortage of fuel. To accomplish this, alternative bio-based supplies are needed. In order to execute the use of bio-binders in the construction industry, the industries must advance. The use of modifiers is becoming more common because of the cost, energy, and environmental advantages it offers. Research is being done to find the most efficient renewable source of binder to fully replace bitumen.

6. REFERENCES

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