EFFECT OF FILLERS ON AGING BEHAVIOUR OF PAVING GRADE BITUMEN: A REVIEW

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ABSTRACT

Age hardening is one of the important variable from many variable that affect the viscoelastic properties of bitumen with timing. Age hardening of bitumen is an irreversible process, which significantly affect the durability of pavements and eventually increases the maintenance cost. When the bitumen is age hardened, the asphalt mixture will become brittle and its ability to support traffic-induced stresses and strains may significantly decrease. The main mechanisms of aging of bitumen are oxidation and loss of volatiles during asphalt mixture production (short-term ageing) and in-place service period (long-term ageing). Both are cause an increase in viscosity (or stiffness) of the bitumen. The aging of bitumen is one of the principal factors causing the deterioration of asphalt pavements. . The aging modes of failures includes fatigue, thermal induce cracks, and raveling. This review paper carried out on the present studied to examine the effect of aging on bitumen binder using different filler materials. Studies have shown that the neat bitumen binder has more aging effect than modified bitumen.

Keyword : - *Bitumen, Penetration Test, Softening Test, Dynamic Shear Rheometer, TFOT, RTFOT.*

1. INTRODUCTION

For Transportation is the key infrastructure of a country. Development of a country depends on the connectivity of various places with adequate road network. Roads are important assets for any nation. In India, Highway construction activities have taken a big leap since last decade. Construction of highway involves huge outlay of investment. There are various type of pavements which differ in their suitability in different environments. Each type of pavement has its own merits and demerits. The purpose of highway pavement is to provide smooth surface over which vehicles can move safely from one place to another.

Basically, all road pavements fall into two broad categories namely flexible and rigid. Flexible pavement is that pavement which is surfaced with bitumen material with no reinforcement. Bituminous pavement which is more economical and reliable compared to rigid (concrete) pavements. The ingredients of the mixture include dense grading of coarse aggregates, fine aggregates, fillers and bitumen binder. In India, 98% roads are having flexible pavements which having bituminous layers A precise engineering design of a flexible pavement may save considerable investment; as well as reliable performance of the in-service highway pavement can be achieved. Pavement industry has developed rapidly all over the world during the last few decades, especially in developing countries like India. Following the rapid development and population growth, increased traffic load, higher traffic volume, and insufficient maintenance led to many severe distresses (e.g. rutting and cracking) of road surfaces. And

also due to climate change flexible pavement resulting bleeding, rutting, reveling and unevenness which makes the pavement unsuitable for use and leading to failure of pavement.

Bitumen aging is one of the main reasons for asphalt pavement failure. Bitumen, like any organic matter, is affected by factors like presence of oxygen, ultraviolet rays and changes in temperature. These factors are responsible for hardening of bitumen. Hardening results in

- Decrease in penetration value
- Increase in softening point temperature and
- Increase in penetration index (PI).

For increased life of bituminous pavement it is essential that excessive hardness does not take place.

There are various mechanisms that affect the viscoelastic properties of asphalt mixtures in time, among which age hardening can be considered to be an important one. Age hardening of asphalt mixtures is an irreversible process, which contributes to a reduction of the durability of pavements. Even though bitumen is only one component of asphalt mixtures, the overall performance of the asphalt pavement is largely dictated by the viscoelastic properties of the bitumen (Allen et al., 2012).

Recently, large number investigations have demonstrated that bitumen properties (e.g. viscoelasticity and temperature susceptibility) can be improved using an additive or a chemical reaction modification. The quality and durability of bituminous road is influenced by the type and amount of filler material is used. Fillers play an important role in engineering properties of bituminous paving mixes. Various materials such as cement, granite powder, stone dust and fine sand are normally used as filler in bituminous mixes. Cement, granite powder are expensive and used for other purposes more effectively. In this study lime, concrete dust finer than 0.075 mm sieve size use as filler material.

2. LITREATURE REVIEW

In year 2003, Mahrez and Rehan evaluated the effects of three different rubber concentrations (3%, 9%, and 15%). According to this research work the unmodified bitumen showed an improvements of about 1.5 times in G* value after a rolling thin film oven test (RTFOT). This study have shown that G* value an increase of about 2.5 times in the rubberized sample with 3% and 9% rubber, and the sample of 15% rubber showed an increase of about 1.5 times compared to their original unaged values.

In year 2007, Bianchetto, Miro, Perez-jimenez, Martinez carried out research work on "Effect of calcareous fillers on bituminous mix aging." In this study hydrate lime and calcium carbonate used as a filler material and 70/100 penetration grade bitumen as a binder. DSR method carried out for properties of aged and unaged bitumen binder and also carried out the Universal de Caracterización de Ligantes tests (UCL) for aging.
Yero et.al. Presented paper in year 2012 on "Effect of aging on bitumen properties modified with SBS polymer." In this study used 76-22 penetration grade bitumen and SBS as filler. Viscosity test, Penetration test and Softening Point test method for properties of aged and unaged bitumen binder is carried out. The aging was simulated using the rolling film oven (RTFOT) and pressure aging vessel (PAV) for short-term and long-term aging.
In year 2012, Seyed Abbas Tabatabaei presented a paper on "Evaluate aging effect of SBS modified bitumen." In this study used 70-100 penetration grade bitumen and SBS as filler. Carried out Fourier Transform Infrared (FTIR) spectroscopy, Viscosity test, Penetration test and Softening Point test methods for properties of aged and unaged bitumen binder. Bitumen and SBS modified bitumen aged according to the rolling thin film oven test (RTFOT) and pressure aging vessel (PAV), respectively.
In year 2012, Maninder Singh et al. presented paper on "Evaluating the Effect of Polymer Modification on Physical and Rheological Properties of Conventional Bitumen" In this paper VG30 bitumen and two polymers: Styrene Butadiene Styrene (SBS) block copolymer and Ethylene Vinyl Acetate (EVA) polymers were used as modifiers.

Carried out DSR method, Viscosity test, Penetration test for physical properties of aged and anaged bitumen binder. Also carried out thin film oven test (TFOT) for short term aging.
In year 2012, Afifa Rahman et al. carried out experiments to study Effect of Fillers on Bituminous Paving Mix. In this study cement, lime and stone dust are used as fillers. Marshall Stability test was carried out for determining the optimum bitumen content and the test specimens were prepared by adding varying percentages of bitumen from 4.5% by weight of aggregates to 6.5% with an increment of 0.5% for each type of fillers.
In year 2013, Marek Iwanski et al. prestented paper on "Hydrated Lime as the Anti-aging Bitumen Agent" In this study penetration grade50/70 and hydrate lime is used as filler and SBS polymers is also used as modifier.
In year 2014, Prajapati Harshad et al. presented paper on "A Study on aging Behaviour of Paving Grade Bitumen using Filler Material" In this study cement is used in various percentages (0%, 1%, 1.5%, and 2%) as modifier in 60/70 penetration grade bitumen. carried out penetration test, viscosity test, and softening point test for physical properties of aged and an aged bitumen binder. The binders are aged using Thin Film Oven Test (TFOT).

3. CONCLUSIONS

This review on effect of different filler material on properties of modified bitumen are discussed. The effect of aging on rheological and physical properties are discussed in this chapter. Bianchetto et al. concluded that the use of hydrated lime and calcium carbonate as filler reduced the aging effect on rheological properties of the bitumen binder. Yeroetal. Concluded that Modified bitumen with SBS show greater resistance to aging than neat bitumen. Manindar singh et al. concluded that the use of EVA, SBS and CR binder reduced the aging effect on rheological and physical properties of the bitumen binder. Iwański et.al. Concluded that the hydrated lime acts as an anti-oxidant and in parallel it decreases the stiffness of the bitumen (for combination: bitumen D70 + 4% SBS polymer) of SMA providing required resistance to the water and frost during 12 years of service life. Rahman et al. concluded that brick dust can be successfully utilized in the production of bituminous concrete mixes for the highway construction.
Seyed Abbas Tabatabaei concluded that the use of SBS bitumen binder reduced the aging effect on physical properties of the bitumen binder. FTIR result shows aging causes oxidation of bitumen and forms the carbonyl and oxide sulphate structures in bitumen. Aging in modified bitumen by SBS has been less than base bitumen.
From all above literatures it can be concluded that the modified bitumen has higher rutting resistance than neat bitumen. It reduces the aging effect on rheological properties and physical properties of binder.

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