STORAGE STABILITY AND PHYSICAL PROPERTIES OF ASPHALT MODIFIED WITH NANOCLAY AND WARM ASPHALT ADDITIVES

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Introduction

Asphalt is manufactured from crude oil and traditionally regarded as a colloidal system made up of asphaltenes micelles covered by a stabilizing phase of polar resins, which however, forms the interface with a continuous oily maltenic medium [1-3]. In spite of this traditional application, today only about 10% of asphalt is used as roofing material, for thermal and acoustic insulation, humidity and corrosion protection components of paints and varnishes, etc., while the remaining 90% is used for paving. Asphalt binder constitutes only a small but crucial part of any paving mix [4]. Physical properties and temperature susceptibility characteristics of the asphalt binder influence pavement performance at low and high field operating temperatures [5].

Recently, warm mix asphalt (WMA) has become popular where this technology allows reduction in fuel consumption and emissions in plants by addition of warm asphalt additive (WAA) [6-8]. During the ‘‘in life” service of asphalt binders, there are many types of failures, e.g. rutting, fatigue cracking and thermal cracking, which can reduce the quality and performance of pavements. Polymer modified asphalt (PMA) are blends of asphalt and one or more polymers, usually added in percentages ranging from 3% to 7% by weight, and were developed to overcome, or at least reduces, such problems. A various number of polymers have been used to produce PMA, but only a few are satisfactory from both the performance and the cost points of view [9].

Nowadays, researchers had put their interests on nanoclay which is a polymer that commonly used because it’s environmentally friendly and readily available. The proper selection of modified clay is essential to ensure effective penetration of the polymer into the interlayer spacing of the clay and so resulting in the desired exfoliated product [1, 5, 10-11]. Literature review has shown few studies investigating the effects of nanoclay upon binder incorporating WAA. Prior to investigating the properties of nanoclay modified binders containing WAA, the modified binders with the additives need to be studied in detail. The main objective of this study was to evaluate the method of preparation and storage stability properties of nanoclay modified binders containing WAA.

Experimental

Material and preparation of sample

The asphalt binder used was 60/70 penetration grade bitumen (AC60/70) from EXXON MOBIL, one of major sources in Malaysian mixing plant operations. The modified binders were manufactured with nanoclay and two different WAA, Rediset® and Cecabase®.

The modification of asphalt and WAA (Cecabase® or Rediset®) was performed by heating the original asphalt up to 160^{0}C (viscosity is approximately 170,000 Pa.s), subsequently with WAA added, shear force was applied by special cog-disk blade with mechanical stirrer at speed of 6000 rpm for 30 minutes. Then, 5 % of nanoclay was added with the same speed of rpm for another 60 minutes to disperse the nanoclay modified asphalt containing WAA.

Method

Storage stability test

Hot storage test was conducted to evaluate the high temperature storage stability of modified asphalt. An aluminum tube (25 mm in diameter and 140 mm in height) was filled with about 50g of hot nanoclay modified asphalt incorporating WAA. Then, sample was maintained in a vertical vessel at 163 ± 5°C for 48 ± 1 hour. After that, it was take out and cool in a freezer -6.7 ± 5 ^{0}C for a minimum of 4 hours to solidify the sample completely. Finally, the tube was cut into three equal sections. The two ends (top and bottom) were analyzed further according to ring and ball softening point test (ASTM D 36), to evaluate possible differences in characteristics. If the difference between softening point of the top and the bottom sections of the tube is less than 2.2 ^{0}C, the sample could be regarded as storage stable blend which is a very important parameter of initial properties on modified asphalt (ASTM D5926).

Physical properties test

The physical properties of asphalts, including softening point, penetration and viscosity were measured in accordance with ASTM D36, D5, and D4402.

Results and discussion

Storage stability

Results show that the difference between softening point of the top and the bottom sections of control sample are 0.47% (asphalt + Rediset) and 0.46% (asphalt + Cecabase). Meanwhile, results for nanoclay modified asphalt with WAA are 0.86% (Rediset) and 0.98% (Cecabase). It can be seen that the sample could be regarded as storage stable blend which is a very important parameter for modified polymer asphalt.

Physical properties

The physical properties of the nanoclay modified asphalt incorporating WAA indicates stiffer compare to original asphalt binder. The results can be summarized that the softening point, penetration index (PI), and viscosity of that modified asphalt increased and the penetration declines correspondingly with the addition of nanoclay indicating that the initial rheology properties of modified binder is improved.

Increasing PI indicate increasing temperature susceptibility. The original asphalt (control) has PI value of -0.50. After modification of binders, the values was increase to 0.00 (2% Rediset), 0.37 (5% nanoclay) and 0.49 (combination of both material).

Conclusion

1. Results showed that the softening point and viscosity of the modified asphalt were increased.
2. Results showed that the presence of WAA in nanoclay modified asphalt meet the PMB Specification (ASTM D5926) without adverse effect on other properties of it.
3. Based on PI, the presence of WAA in nanoclay modified asphalt improves temperature susceptibility of the asphalt.
4. They, moreover, improve the physical properties of asphalt containing WAA because they can be mixed with the nanoclay.

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