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Prosiding

Seminar Nasional Teknik 2014

"Pengembangan Teknologi Untuk Menunjang Pembangunan Berkelanjutan"

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PROSIDING

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Purwokerto, 27 September 2014

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Prosiding Seminar Nasional Teknik (SENATEK) 2014

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Assalamu'alaikum.Wr.Wb.

Puji syukur ke hadirat Allah SWT atas segala limpahan rahmat dan karunia-Nya kepada kita sekalian. Sholawat salam semoga tetap tercurah kepada Nabi Muhammad SAW, keluarga, sahabat serta para pengikut sunnah-sunnahnya hingga akhir zaman.

Seminar Nasional Teknik (SENATEK) merupakan agenda rutin tahunan sebagai forum diskusi ilmiah tahunan yang diselenggarakan oleh Fakultas Teknik Universitas Muhammadiyah Purwokerto. Dalam SENATEK, para peneliti perguruan tinggi, praktisi industri, serta lembaga penelitian dapat menyebarluaskan gagasan serta ide-ide untuk dapat dikaji dan dikembangkan. Disiplin ilmu yang dibahas meliputi bidang Teknik Sipil, Teknik Kimia, Teknik Elektro, dan Teknik Informatika. Naskah yang diterima berasal dari seluruh wilayah Indonesia dan dikemas dalam bentuk prosiding. Naskah yang dimuat dalam prosiding SENATEK 2014 telah melalui tahap evaluasi oleh para reviewer yang kompeten dibidangnya.

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Wassalamu'alaikum.Wr.Wb.

Purwokerto, September 2014

Penanggungjawab Seminar,

Tito Pinandita, S.Si., M.Kom.

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DAFTAR ISI

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Bidang Teknik Kimia

Bidang Teknik Elektro

STONE MASTIC ASPHALT FOR BETTER FLEXIBLE PAVEMENT

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Abstract

Since the 1960s, Stone Mastic Asphalt (SMA) pavement surfaces have been used successfully in Germany on heavily trafficked roads as a durable road surfacing to resist wear from studded tyres. Because of its excellent performance characteristics, road authorities in Germany as well as major European Countries quickly adopted SMA as a standard wearing course. During the last few years, SMA has become one of the most popular asphalt pavements. The deformation resistant capacity of SMA stems from a coarse stone skeleton providing more stone-on-stone contact. Improved binder durability is a result of higher bitumen content, a thicker bitumen film, and lower air voids content. This high modified-bitumen content as binder also improves flexibility. In this paper SMA-14 using Oil Palm Fruit Ash (OPFA) used as binder was studied in the laboratory. Some tests include Marshall Stability and Flow, indirect tensile resilient modulus (M_R) test, Static Uniaxial Creep test, Wheel Tracking test, and static immersion and boiling water, as well as drain down test were conducted, and the results show that SMA-14 resistant to rutting, fatigue cracking, have high Marshall stability compare to the conventional dense graded asphalt mixtures.

Keywords: *SMA, excellent, performance, high resistance, fatigue, rutting*

Abstrak

Sejak tahun 1960, permukaan perkerasan jalan dengan menggunakan Stone Mastic Asphalt (SMA)telah berhasil dipergunakan di Jerman pada jalan dengan lalu-lintas yang berat, sebagai lapis permukaan yang tahan menahan beban kendaraan dengan tekanan ban yang besar. Karena karakteristik dan kinerjanya yangluar biasa, banyak otoritas jalan raya baik di Jerman endiri maupun Negara-negara lain di Eropa dengan cepat mengadopsi SMa sebagai bahan lapis aus perkerasan jalan. SMA telah menjadi bahan lapis permukaan perkerasan jalan yang sangat terkenal.Kemampuannya untuk menahan penurunan diperoleh dari susunan agregat kasarnya yang mempunai kontak antar butiran. Peningkatan daya tahan bahan pengikatnya didapatkan dari tingginya persentase kadar aspal. Tingginya persentase kadar aspal yang menggunakan aspal-modifikasi juga meningkatkan kelenturan SMA. Di dalam makalah ini SMA-14 dengan menggunakan aspal yang domodifikasi dengan abu kelapa sawit sebagai bahan pengikat campuran dikaji di laboratotium.beberapa pengujian seperti uji stabilitas dan leleh Marshall, uji indirect tensile resilient modulus (M_R), uji Static Uniaxial Creep, uji Wheel Tracking, dan uji static immersion and boiling water, serta uji as drain down dilakukan, dan hasilnya menunjukkan bahwa SMA-14 tahan terhadap penurunan permanen (rutting), retak lelah, stabilitas Marshall yang tinggi dibandingkan dengan campuran aspal konvensional dengan menggunakan aggregate bergradasi padat.

Kata kunci: *SMA, Kinerja, ketahanan yang tinggi, fatigue, rutting.*

1. INTRODUCTION

SMA is a mixture of crushed coarse aggregate, crushed fine aggregate, mineral filler, bitumen, and stabilizing agents. The stabilizing agent is used to prevent drain down of the bitumen and typically consists of fibers and/or polymers (Robert, F.L.et.al 1995 and Jabatan Kerja Raya 2008). The SMA mixtures are designed to have a high coarse aggregate content (typically 70-80%) a high bitumen content (typically over 6%) and high filler content (approximately 10% by weight) (Robert, F.L.et.al. 1995). Using high coarse aggregate content results in stone on stone contact that produces a mixture which have highly resistant to rutting. A view of a typical SMA mixture and for comparison a typical dense-graded mix is shown in Figure 1. Notice the high stone content for the SMA mixture and the coarse aggregate in the dense-graded mixture appear to be floating in the fine aggregate matrix. The SMA mixture is more resistant to rutting since coarse aggregate can develop more shear strength than the fine aggregate.

There are two typical gradations requirements for SMA mixture. One has maximum particle size 9.5 mm and designation as SMA 14, while the other one has maximum particle size 12.5 mm and designation as SMA 20 (Jabatan Kerja Raya 2008)..In this study SMA 14 is used.

Mineral filler shall be added as part of the combined aggregate gradation. Limestone dust, hydrated lime or ordinary portland cement shall be used as filler (Jabatan Kerja Raya 2008).. The material shall pass 75 µm sieves by not less than 70% by weight. The amount of the filler to be added shall be not less than 8% by weight of the combined aggregates, where if cement is used it shall not exceed 2% by weight of the combined aggregates.

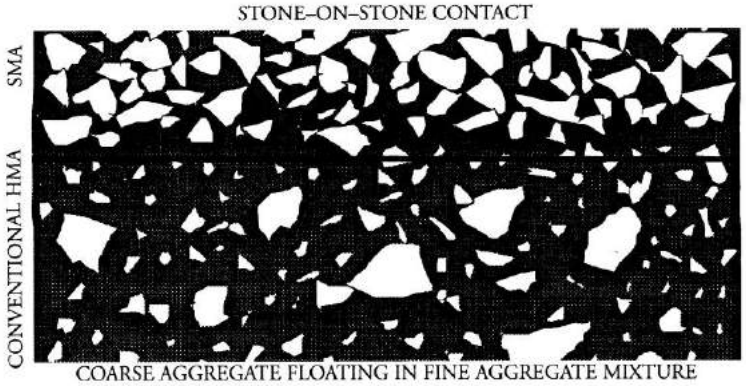

Figure 1: Cross-sectional view of a typical SMA and a dense-graded HMA [3]

2. METHODOLOGY

Materials and mix design of SMA-14

Binder to be used in this study was oil palm fruit ash (OPFA)-modified bitumen pen. 80/100 and hereinafter called OPFA-MB. Rheological test show that type of OPFA-MB similar to the PG 70-22 binder.

Optimum binder content of SMA-14 in this study was 6.8%, was determined by averaging of four optimum bitumen contents in accordance to (Jabatan Kerja Raya 2008)..The specimens are compacted using 50 blows/face using Marshall compaction. As soon as the freshly compacted specimens had been cooled to room temperature, the bulk specific gravity of each test specimen was determined in accordance with ASTM D2726 (American Society for Testing and Materials – ASTM, 1992). The stability and flow value of each test specimen was then determined in accordance with ASTM D1559 (American Society for Testing and Materials – ASTM, 1992). After the completion of the stability and flow test, specific gravity and voids analyses were carried out for each test specimen to determine the percentage of air voids in mineral aggregate (VMA) and the percentage air voids in the compacted mix (VIM).

Tests to be performed

Some tests were performed to know the properties of SMA mixture. Those tests were Marshall Stability, Indirect tensile resilient modulus (M_R), Static Uniaxial Creep, Wheel tracking, Static-immersion and boiling water, and drain-down test.

3. RESULT AND DISCUSSION

- Marshall Stability
  Marshall Stability test result was 8049 MPa show above the minimum requirement that was 6022 MPa.
- Indirect tensile resilient modulus
  Indirect tensile resilient modulus (M_R) test was conducted in accordance with the ASTM D4132-82 (American Society for Testing and Materials – ASTM, 1987)., by using three test temperatures 5, 25, and 40°C, two loading frequency 0.5 Hz or 500ms and 1.0 Hz or 1000ms, as well as peak loading force 1000 N. The Poisson's ratio of 0.25 was set for test temperature of 5°C and Poison's ratio of 0.40 was set for test temperature 25°C and 40°C. The test results were showed in Table 1.

Table 1. The results of M_R test of SMA mixture (MPa)

Mixture	Loading frequency 500ms			Loading frequency 1000ms		
	5°C	25°C	40°C	5°C	25°C	40°C
Dense Graded	8114	1755	441	7671	1443	324
SMA-14	6627	3112	504	5347	2822	446

Resilient modulus is the ratio of stress to resilient strain (as opposed to viscous strain) in an asphalt mixtures sample (Malik, R.B. and Tahar, E.K., 2009)..Anothermeaningofthis definitionis that if thestrain ofasphalt mixturesis low,then theasphaltmixturehas a high resilientmodulusand it is noteasilycracked if it loaded.

- Static Uniaxial Creep
  The test was conducted by referring to the (Texas Department of Transportation (February 2005). Static loading stress 200 kPa was applied at temperature 40°C. The results of rutting and strain form creep test are shown in Table 2,

Table 2. The creep test result

Mixture	Strain (%)			Permanent Deformation (mm)		
	Test 1	Test 2	Avg,	Test 1	Test 2	Avg.
Dense graded	0.54	2.15	1.35	0.36	1.45	0.91
SMA-14	0.14	0.60	0.37	0.10	0.60	0.35

- Wheel tracking
  Permanent deformation or rutting was also measured by using the wheel tracking test. Test was conducted by using Wessex Wheel Tracker and carried out at temperature 50°C, with 18.4 kg of load and 1000 cycles. Summary of test results are given in Table 3.

Table 3. The results of Wheel Tracking test

Mixture	Specific Gravity	Sample thickness (mm)	Number of cycles	Rut depth (mm)
Dense graded	2.19	55	1000	6.6
SMA - 14	2.18	55	1000	4.2

- Static-immersion and boiling water
  The results of static immersion test show that both SMA-14 and dense graded mixture possessed good adhesion. After 48 hours immersed into distillation water at temperature 25°C, the percentage of the aggregate in the mixtures remained coated was 100% as shown in Figure 2 and 3.

  In boiling water test, the similar result was found as the one of static immersion test. The test results show that the dense graded was slightly loose from the aggregate but there were more than 95% still coated aggregate. SMA-14 binders still remained coated after observation. Figure 4 shows the results of boiling water test for SMA mixture. The test results of static-immersion and boiling water showed that SMA had a good adhesiveness.

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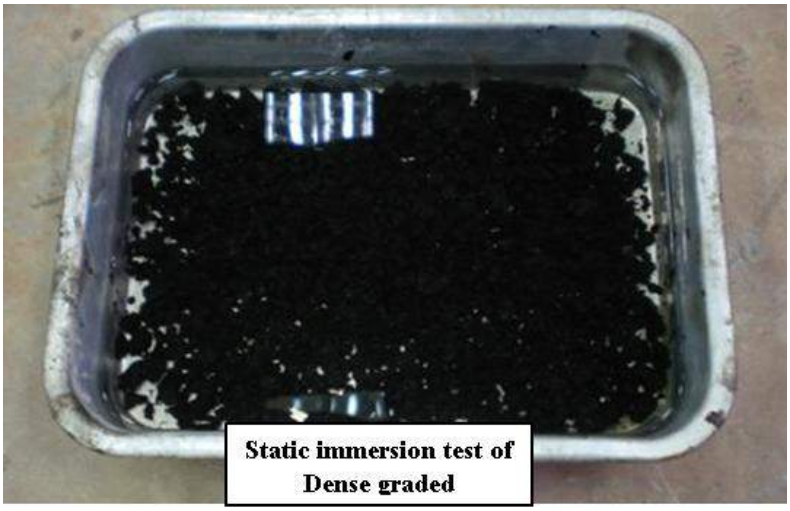

Figure 2. Static immersion test result of dense graded mixture

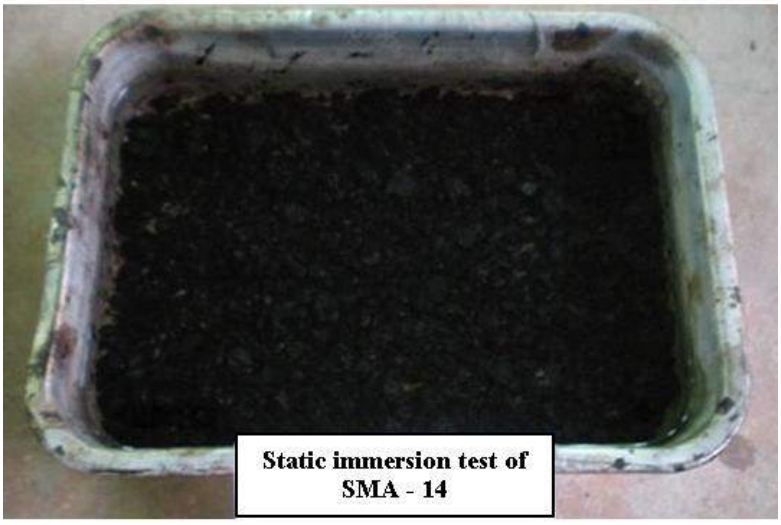

Figure 3. Static immersion test result of SMA-14 mixture

Figure 4. Boiling water test result of SMA-14 mixture

- **Drain-down test**

  Standard Specification requires the maximum binder drain-down from the loose mix is 0.30% at the test temperature. The test results of drain-down are shown in Table 4.

Table 4. The drain-down test results

Mixture	Drain-down (5)		
	Test 1	Test 2	Average
Dense graded	0.18	0.22	0.20
SMA-14	0.12	0.11	0.12

4. CONCLUSIONS

From the results as obtained in this study, the following conclusions can be drawn.

1. SMA mixture has Marshall stability higher compare to dense graded mixture.
2. SMA mixture also can resist permanent deformation or rutting better than dense graded mixture.
3. SMA mixture also exhibits good adhesive to the aggregate.

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