STUDY ON MIXTURE DESIGN AND MECHANICAL PERFORMANCE OF WARM MIX ASPHALT CONTAINING RECLAIMED ASPHALT PAVEMENT

Nagaoka University of Technology Mezatio Zebaze Mickel-Sadrack
Nagaoka University of Technology Osamu Takahashi

1.0 Background

Nowadays there has been an increase in the use of recycled asphalt. Still many continue to use the conventional method of HMA, because little information is made available to recycle asphalt using the WMA approach which may offer better advantages than the conventional one.

To achieve these advantages there is a need of using an appropriate additive.

2.0 Objective

This research has for objective to produce WMA with Sasobit by adding reclaimed asphalt. Then evaluate the performance and compare to that of its equivalent HMA.

3.0 Introduction

Warm mix asphalt (WMA) is Asphalt produced at reduced temperatures of about 20℃ to 40℃ compare to the conventional hot mix asphalt (HMA).

WMA has advantages such as; Less CO2 emissions, less energy consumption, less fumes, less bitumen ageing, less wear on machines and resources.

Sasobit is a Fine crystalline long chain aliphatic hydrocarbon. Completely soluble in bitumen at 115 ℃.When added to a mixture it helps reduce the production and compaction temperatures.

It is manufactured from natural gas using the Fisher Tropsch process of polymerization.

Fig 1: Sasobit

Reclaimed asphalt (RAP) is asphalt mixture which has already been use and is reused again to produce new asphalt pavement.

Fig 2: Reclaimed asphalt

Rejuvenator is a substance used to restore original properties to aged (oxidized) asphalt binder by restoring the original ratio of asphaltenes to maltenes.

Fig 3: Rejuvenator

4.0 Methodology

Steps	Asphalt Produced Using Marshall design method				Performance Evaluation	
	Hot Mix Prd: 154-162 ℃ Com: 142-147 ℃		Warm Mix (Sasobit) Prd: 129-137 ℃ Com: 117-122 ℃		Rutting resistance	Cracking resistance
	RAP %	Binder type	RAP %	Binder type		
1st	0%	Grade: 60 - 80	0%	Grade: 60 - 80	Analyze and Recommendation	
2nd	10%	Grade: 60 - 80	10%	Grade: 60 - 80	Analyze and Recommendation	
3rd	20%	Grade: 60 - 80 + 20% Rejuv	20%	Grade: 60 - 80 + 20% Rejuv	Analyze and Recommendation	
4th	30%	Grade: 60 - 80 + 20% Rejuv	30%	Grade: 60 - 80 + 20% Rejuv	Analyze and Recommendation	
5th	40%	Grade: 60 - 80 + 20% Rejuv	40%	Grade: 60 - 80 + 20% Rejuv	Analyze and Recommendation	

Table 1: Research Methodology

5.0 Experiment

5.1 ***Determine the Aggregate gradation***

I used the excel sheet and at each steps, I kept on changing the RAP percentage content to obtain my aggregate gradation table.

5.2 ***Determine the optimum asphalt content (OAC)***

The OAC is that at which we have a satisfying quantity of asphalt content needed for our mixture.

In this research I kept the same asphalt content at each step. This by taking in consideration the old asphalt present in RAP, the percentage of sasobit added (3% by weight of OAC obtained), and the Rejuvenator added (20% by weight of old asphalt present in RAP).To obtain the **OAC** I use the parameters below.

Requirements	**Sample parameter**
Mixture type	Dense graded (20), with 10% RAP at HMA conditions
Compaction blows	50
OAC	**5.5**

Table 2: Parameters to obtain OAC

5.3 *Samples Production*

After determining the OAC, It was then used to produce samples at each step of the research.

Both samples for the wheel tracking and direct tensile test were mixed with equivalent proportion of ingredient.

For the HMA samples all ingredients were measured and directly injected into the mixing machine.

For the WMA samples, before injecting all ingredients into the mixing machine, the sasobit and/or rejuvenator were first injected into the asphalt and steered at control temperatures.

Fig 4: Injection of sasobit into asphalt

5.4 *Wheel tracking test (WT)*

Wheel tracking test evaluate the plastic flow resistance of asphalt concrete (rutting resistance). It was carried out in the following conditions

Item	Condition
Dimensions	300x300x50
Number of compactor rolling (time)	15
Temperature (°c)	60
Curing time (min)	360
Test time (min)	60
Number of round trips (time)	1260
Wheel load (N)	686
Wheel material	Solid rubber

Table 3: Condition for WT test

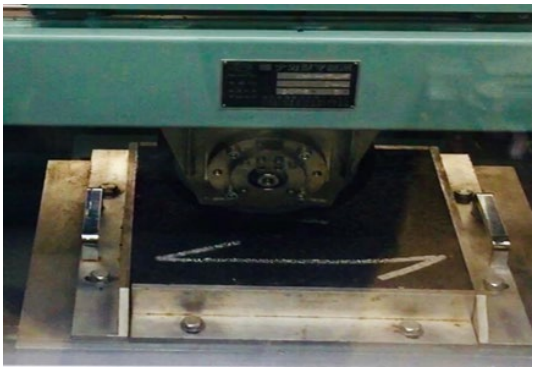

Fig 5: Wheel tracking test setup

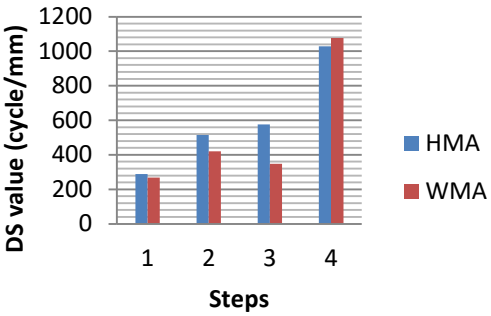

Fig 1: Wheel tracking test results

From the result of my Wheel tracking test, the DS value of both HMA and WMA samples increases as RAP percentage increases but there was an exception in step 3 for the WMA sample. Also it was notice that the DS value of HMA is higher than that of WMA from step 1 to step 3. At step 4 (30% of RAP) we noted a slight increase in DS value for WMA to HMA.

5.5 *Direct tensile test*

The direct tensile test shows the cracking resistance of asphalt concrete. This test evaluates the displacement of the specimen when it is subjected to force in the axial direction. The stress and strain of the sample are also obtained from this test.

item	Condition
Specimen Dimensions (mm)	40x40x240
Test temperature (°c)	20
Displacement ratio (mm/min)	1
Curing time	5hours or more

Table 4: Condition for Direct tensile test

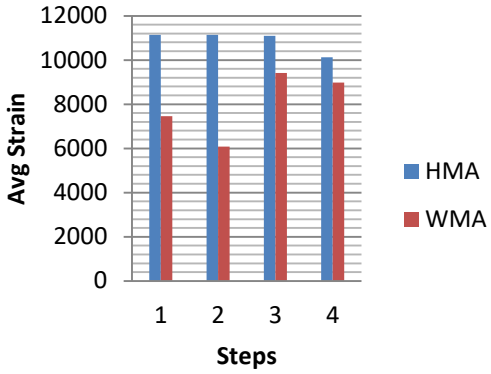

Fig 2: Direct tensile test result

From my direct tensile test results, the average strain shows higher cracking resistance of HMA than WMA samples at all the steps. Also it was noticed that as the RAP percentage increase the cracking resistance （average strain） of HMA decreases while that of WMA increases.

6.0 Conclusion

In a nutshell after conducting this research up to this level, we can say that the performance result due to rutting for HMA are greater than that of WMA when RAP content is low (up to 20% RAP content). When the RAP content is high as in step 4 (30% RAP content) the tendency tern to change with better rutting resistance for WMA than HMA. Concerning the cracking resistance, we can say that the HMA samples gave greater performance than the WMA. We can also say that it might be possible to have greater cracking resistance for WMA than HMA at higher RAP percentage content.