Field Service report

Akzo Nobel Surface Chemistry AB

Asphalt Applications

Warm mix trials with eThekwini (Durban) Municipality, May 2009

“Leicester Road Trial”

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Introduction

In July 2008 a Warm Mix Asphalt (WMA) interest group, comprising representatives of eThekwini Municipality, road authorities, asphalt suppliers, contractors, technology suppliers, consultants, and SABITA was formed in South Africa due to the growing awareness of the technology. The group's aim was to investigate and test the available systems and work towards trials and introduction of the WMA process into South Africa. The first WMA trial (with Sasobit and not Rediset) was conducted during November 2008 (so called Brackenhill Trials) and in January 2009 it was decided to conduct a second trial. This time Rediset was selected as one of the technologies to be included and as the group required close involvement of the suppliers, support was provided at all stage of the process.
The client for these trials was eThekwini (Durban) Municipality, Much Asphalt was to be responsible for the mix design and production and National Asphalt for the paving.
A detailed report will be provided by the Interest Group with in depth information and all technical data – the following is a brief report of observations from Akzo Nobel's point of view.

Summary

The trials were very successful in that they demonstrated that asphalt could be laid at lower temperature without compromising performance. The benefits in worker environment and ease of handling the WMA were evident. Unfortunately, reductions in energy consumption were not manifested and no instrumental emissions monitoring was carried out. Advantages in ease of compaction were seen.
Interest in WMA is continuing to grow and further trials or works are likely to be carried out in the near future.

Pre-trial work

Mix design

Extensive mix design work was carried out by Much Asphalt using an eThekwini "Type D" mix (a dense graded 16mm wearing course) but with 10% RA included. The aggregate mix consisted of crushed stone (ex Afrisam quarry), crusher dust (ex Ridgeview and Plant) and sand. 1% hydrated lime was used in the Sasobit and reference mixes to address adhesion issues seen at Brackenhill but not in the Rediset mixtures due to the built in AP – bag house filler being used instead. A binder content of 5.2% 40/50 pen bitumen ex SAPREF was selected. The SAPREF refinery is a JV between Shell and BP and uses mainly Middle East crude but also takes in crude coming from Africa and Europe.

Binder production

The production of the warm mix binder was carried out by Colas at their plant in Durban. A ~30kl horizontal tank with two propeller stirrers and bottom to top circulation was used. The equipment is normally used for EVA modified binder production. Additives were dosed via a hopper into the vortex of one of the stirrers which should have ensured good initial dispersion. Rediset was added at a level of 2% on the bitumen heated to 125 to 130°C. Treated binders were transported from Colas' plant to a day tank at the Asphalt plant.

Pre-trial

Pre-trials on ~100t scale were conducted in early May to gain experience, check the plant mix design and mix behaviour and to iron out some issues from the 2008 trial. Small adjustments to the mix proportions were found necessary during further plant mix trials but all seemed to be in order and lessons were learnt and applied in planning and execution of the main trial.

Trial site

A 1km section of dual carriageway in a moderately trafficked industrial area was selected – namely a section of Leicester Road. The site was virtually flat with good kerbs and profile.

The surface had been planed out to a depth of 90mm to allow placement of a 50mm WMA wearing course on top of the existing pavement layers.

The site was divided into six sections and two sections of each mix were to be paved - with the reference mix on the Monday, Sasobit on Tuesday, Rediset on Wednesday and Thursday, Sasobit Friday and remaining Reference at the end. A plan of the site is shown below (Figure 1). What actually transpired in terms of timing was quite different for a number of reasons, but the overall result was the same. The planed off surface was sprayed with anionic emulsion tack coat.

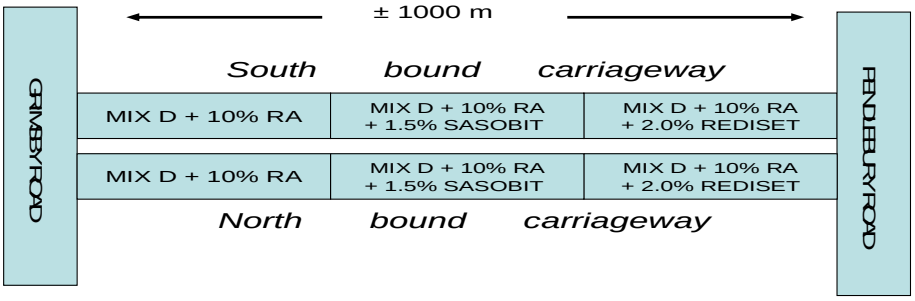

Figure 1: Leicester Road site plan

The Asphalt plant

The mix was produced in Much Asphalt's plant on Coedmore Road, on the outskirts of Durban. The mixer was a batch type pugmill with 2.5t capacity and 40s mixing time. The burner fuel consumption is monitored via a flow meter (which reads in %) and tank dipping. The pugmill's electrical power usage is monitored by two ammeters, one for each pugmill motor; however the ampage varies quite widely during normal mixing so it is hard to read ampage with any accuracy. During the trial, no reduction in burner fuel consumption was realised for the WMA production despite the burners being turned down in order to reduce temperatures. This is hard to understand and must have been due to inaccuracies in measurements. The mixer ampage seemed unchanged but this might be expected due to the reduced temperature despite the WMA additives. The delivered target temperature of the reference mix was 145 to 160°C and 120 to 140°C for the WMA mixes – the intention was to drop the temperature by 20°C.

Compaction equipment

In addition to trialing of WMA technologies, a 9.2t Bomag "intelligent compactor" was being assessed and later two Hamm's with variable vibration modes. Experts from Bomag and Wirtgen were present and were eager to demonstrate the capabilities of their equipment. The Bomag machine monitors density during rolling and adjusts vibration amplitude and frequency settings to optimise compaction. The two Hamm rollers (9.2t and 7.2t) were used for the later stages of the trial. It was interesting to see this equipment in operation but its inclusion lead to some loss of control over the compaction regimes. At some stages compaction turned into a trial of the equipment rather than assessment of the compaction

behaviour of the WMA. In addition to counting of roller passes there was subjective feedback from the Bomag and Wirtgen guys on how the mixes compared. A 22t PTR and a 2.5t small steel roller compactor were used as finishers.

A wax emulsion product from Sasol that prevents pick up on the rollers was used in place of water throughout the trials. It appeared to be quite effective at lower usage levels than water.

On site monitoring
In order to ensure good monitoring in the field, a special task group was set up to record mix arrival and paving temperatures at all stages using temperature gauges as well as IR hand guns and thermal imaging. Densities were recorded during compaction with several Troxlers together with the details of rolling/compaction cycles.

Trial Report

Structured but very open planning meetings were held each day at the plant between the whole team, before work started and post-mortem at the end of each day's work. These were very effective in planning the day's activities and demands and solving any arising issues.

Day 1 - Monday May 25. Reference mix
It was planned to pave 270t of reference mix. The average mixing temperature was 159ºC and paving and compaction was carried out from an average of 149º and 145°C. The target air voids was 3% to 6% but densities appeared to be difficult to achieve with 6 passes of the Bomag. The blower motor in the bag house on the mixing plant broke down during the afternoon so the trial was halted when only 180t had been paved.

Post-mortem Meeting
Problems included delayed arrival of trucks on site causing stop-start paving, compaction of the mix was not easy, and the Bomag had problems setting the correct amplitude level, all of which slowed down the paving rate. More than the planned number of passes were used and response of the Bomag was not as hoped for. It was decided that a transport route to site would be specified for Tuesday, and the trucks arrival sequence monitored closely. The Bomag settings would be decided and set. Compaction results from the Troxler units did not look good; there was some doubt about the equipment so additional units were requested. National committed to have some core density results ready for the morning.

Day 2 – Tuesday May 26. Reference mix
Density results from the previous day's cores from NA showed densities were actually OK – so the Troxler had been giving erroneous results.
Paving of the remaining reference mix continued. Average mix production and laying temperatures were 155 and 160°C respectively and production, transport and paving all ran smoothly

Post mortem Meeting
It was determined that the first two loads of asphalt were loaded at 160 °C and probably loaded into the paver too hot. It was noted that the reference mix – which had been difficult to pave the day before - was still moving under compaction at 90 °C. It was agreed that temperatures would be closely monitored from now on, and trucks made to stand until the temperature of the load was in spec. Temperatures would be more critical for the WMA mixes. Monitoring of the paving had improved, and arrival of trucks to site was better. The Bomag performed better today using both drums and a set vibration mode, and achieved required density in 7 to 8 passes.

Day 3 – Wednesday May 27. WMA with Sasobit
This was the first section with Sasobit modified binder. The average mix production temperature was 134ºC, and paving at 135ºC and falling - compacted at 125°C. The paving proceeded smoothly and all required data captured. There was a clear reduction in visible fumes compared to the reference. Subjectively, the Sasobit mix paving paved better than the reference and target densities seemed to be achieved more rapidly with less (~5) passes of the Bomag with medium amplitude vibration on back and front rollers as the optimum. Consequently, the mat seemed to cool more slowly. It was noted that the PTR roller created significant rutting at times due to the mix being tender at rolling temperature so the PTR would be kept further behind the Bomag from now on.

Post mortem meeting:
In general, all went well. Some concern was raised about the edges of the mat which had a more open appearance, which could lead to water penetration.
It was decided that all monitoring was going well, and that nothing would be changed for tomorrow's Rediset trial.

Days 4 and 5 – Thursday 28, Friday 29 May
Due to a burst in a large water main and resulting damage to the trial site, no paving was carried out on these days. The repair work was carried our over the weekend and laying of the first Rediset section scheduled for Monday.
The Rediset binder had been manufactured on Thursday 28th as planned. It was shipped to the Coedmore plant storage tank and held at ~100°C with circulation over the weekend.

Day 6 – Monday 1st June. WMA with Rediset. Prem Naidoo present
The Rediset WMX mixes were produced at 132 °C on average with no hydrated lime and 2% Rediset WMX in the binder. The average temperature at paving was 131°C and compaction was at 125°C. Target density was achieved with just 4 passes of the Bomag roller operated on medium amplitude on front and back rollers.

Key Highlights:
There were no visible fumes and fewer odours during paving. The mix looked very well coated and rich, went through the paver easily and appeared to be somewhat more workable. Density was achieved more easily despite the mix being slightly lower in temperature. There was no pick up or sticking of the mix on the Bomag or PTR rollers at any stage. The mix wanted to stay down and wanted to compact. The Bomag experts commented that the mix was easier to compact – it was able to take high amplitude and responded in a good way. The finish texture of the mat was excellent. A fully laden container truck was seen to cross over and manoeuvre on the newly laid and compacted mat within 10 minutes. The mat stayed intact with no rutting.

Day 7 – Tuesday 2nd June. WMA with Rediset. Jenny Philips present
The binder content was reduced by 0.1% due to some fat spots on the Monday. The average mixing temperature was 133°C and 129°C in the paver – temperature during compaction was again 125°C. During initial hand-work at the intersection the crew noticed enhanced workability of the mix.
Mixes were delivered and paved at similar temperatures to the previous day. The large HAMM roller was used for the first time but quickly established a suitable pattern and achieved densities easily. The last truckload of mix was used to pave the 2 accesses between the concrete islands dividing the carriageways. Most of this was laid by hand and compacted by the HAMM unit and the smaller steel roller.

Post mortem meeting:
275mt of asphalt was paved, completing both sections of the Rediset trial.
It was noted that ambient temperatures were slightly lower at 28°C compared to Monday which hovered around 30°C. Despite initial concerns all agreed that the HAMM Oscillator unit performed well, born out by the recorded density levels.
Truck-control had been good, all units arrived on time and in sequence, and all loads were delivered to site at between 130 -135°C.
It was agreed that the paving had gone well – in line with the experience yesterday.
Densities were in line with the levels achieved by the Bomag unit, raking had been the same – and it seemed that the PTR unit was used less. It was decided that a normal roller unit would be used in tandem with the HAMM on tomorrow's paving, when the 2nd section of the Sasobit trial will be put down.

It was the conclusion of this meeting that Rediset had performed beyond their expectation, and that Akzo/ Chemimpo had delivered in terms of technical, moral and financial support.
It was felt that Rediset had offered some additional benefits due to the active adhesion component (improved coating) and extra workability.

Days 8 and 9 – 3rd and 4th June. Remaining WMA with Sasobit and reference mix
No one from Akzo Nobel was present on these days but info can be found in the IG's report.

Tests on samples taken during trails

Asphalt properties
In general there we no big differences between the properties of the reference and WM asphalts. Details can be found in the IG report.

Binders
The pen value of the base binder varied slightly during the period of the trial but the SP remained stable. The pen, softening point and dynamic viscosity at 60°C of the binder were not affected by addition of Rediset but there was a decrease in the dynamic viscosity at 135°C. The binders were aged in a RTFOT and tested again. Pen and softening point were not greatly affected and only changed by a few points/°C - the Rediset binder behaved similarly to the reference. The dynamic viscosity at 60°C of the Rediset binder did not increase as much as the reference.

Discussion

Mix production
Production of WMA mixes did not present any problems in the conventional HMA plant.
Temperature readings demonstrated the 20°C target reduction in temperature of the WMA s was achieved. It was unfortunate that no energy savings (reductions in fuel consumption or ampage were recorded) but they should be seen over longer term production runs. Notably, the moisture contents of the WMA's were well within the spec of 0.5% max which was one concern.

Workability
With 2% Rediset in the binder, the temperature of the WMA could have been reduced by more than 20°C. This higher than necessary temperature is probably the reason why the Rediset mix was noticeably more workable and easier to compact. In future it should be possible to work at lower temperatures and at reduced dosage.

Emissions
It was decided not to carry out any instrumental measurement of emissions during these trials but a dramatic reduction in visible fumes and odour was evident on the WMA sections.

Compaction
In general, a lower number of roller passes were used on the WMA sections to achieve the specified densities. More consistent use of known equipment and better understanding from the driver might have shown up a clearer benefit.

Conclusions
The aim of the trials was to demonstrate that WMA could be manufactured and laid in the same way as conventional HMA and perform at least as well. These objectives were achieved and the work will form an excellent basis for further trials and introduction of the technology into South Africa. Future trials could demonstrate greater temperature reductions and additional benefits of WMA such as reduced emissions and energy consumption that will enhance interest further.