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In this issue

Cover picture: A high modulus asphalt (HiMA) specimen being loaded into the shear tester for the permanent deformation test (see article page 6).

Asphalt News is published by the Southern African Bitumen Association (Sabita), a non-profit organisation sponsored by its members to serve all stakeholders through engineering, service and education.

Editorial board: John Fensham and Jeanette Nichol

Higher resource prices underline need for awareness that resources are finite

Sabita CEO Saied Solomons

South Africa's economic recovery in the early part of 2011 continued somewhat stronger than many had expected, partly due to developing countries achieving reasonable rates of economic growth, while the recovery in more advanced economies remains fragile. The approaches being adopted by different countries on monetary policy varied from belt tightening to stimulus funding, although many believe the latter will ultimately challenge fiscal sustainability.

It is on the back of this scenario and the unprecedented political changes in the Arab world that resource prices trended higher, a development which contributed to South Africa's economic recovery. As a resource rich nation we must, however, become ever more mindful that the minerals we extract from the earth are finite and to continue on such a voracious path would not be sustainable.

This in broad terms is in line with the message from an expert UN panel established to deal with environmental challenges. This panel has highlighted the need to decouple GDP growth measure and resource use - the argument being that current economic measures which include resource use would not accurately reflect the true state of any country's real output. The increase in unemployment despite the current growth in GDP clearly illustrates this point.

WMA wins wider support

The asphalt industry's efforts to reduce its resource use through products like high modulus asphalt (HiMA), warm mix asphalt (WMA) and recycled asphalt (RA) is a clear indication that a wise path has been chosen. The call at the Road Pavements Forum in May for greater use of recycled asphalt again emphasises that this wisdom is being adopted by an ever widening circle of client bodies.

This is illustrated by the City of Cape Town's declaration of firm support for the use of WMA, which is now regularly specified by eThekwini Municipality. The commitment of these two major metros will spearhead even wider use after the launch of the WMA guidelines and specifications at CAPSA'11 in September.

HiMA

In this issue we cover the progress made on HiMA which includes the paving of a test section on arguably one of the country's heaviest trafficked roads - Durban's harbour entrance.

CAPSA'11

The final countdown to CAPSA'11 has commenced and the next edition of **aspaltNEWS** will cover happenings of the actual event. Appropriately, the conference will be staged under the theme *Roads of the future*, with the highly topical sub-theme *Living within the carrying capacity of our planet*.

To date more than 300 delegates have registered with a number of late registrations expected, and 61 reviewed papers and 10 bulletin papers have been submitted / reviewed. The interest has been phenomenal and the conference by all accounts should prove to be informative and enjoyable - a must to attend!


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Toll roads offer social and economic benefits

South Africa's history with toll roads began some 25 years ago with the introduction of a bill that allowed the then Transport Ministry to fund tolls roads through loans in the form of bonds.

This came about as a result of many factors, but primarily the realisation that the fuel levy, established to fund road provision and maintenance, was not keeping pace with the funds required to maintain and expand the asset so essential to South Africa's growing development needs.

It is an accepted fact that roads provide the means for economic activity, and that South Africa's exponential economic development has, in the past two decades, outstripped the ability of its infrastructure, particularly roads, to support the volumes of traffic generated by growing commercial and industrial activity. It is also an accepted fact that central governments, which face competitive demands for budget allocations, are not always able to fund large scale infrastructure projects such as the recently completed Gauteng Freeway Improvement Project (GFIP). For this reason such projects throughout the world are funded by tolls – a subject which is always contentious and invariable strongly opposed.

The GFIP toll system includes gantries such as those above, equipped with electronic equipment for reading vehicle number plates or e-tags fitted inside the windscreen. Road users can set up pre-paid accounts, to be topped up by debit orders, electronic fee transfers (EFT)or cash payments. Accounts may also be linked to credit cards. Users without accounts will be identified by means of number plates, and an invoice will be forwarded for outstanding tolls.

Yet it has been shown throughout the world that tolls, far from being the "additional tax" as they are so often labelled, offer significant economic and social benefits. The GFIP, for example, has injected about R29-billion into the provisional gross geographic product and has created nearly 30 000 jobs over its lifecycle.

Additional benefits include improved road safety, shortened travelling distances, positive impact on property values, less congestion and therefore diminished air pollution, and heightened economic activity through more efficient mobility. For instance, a study by California's Transportation Corridor Agencies estimated that the economic benefit of time saved through reduced congestion on TCA's toll roads was at least $182 million per year, not including additional savings in fuel and other vehicle operating costs. This equated to more than 10 million litres of fuel saved per year (more than $7-million) as a result of improved fuel efficiency.

Further examples of economic benefit can be drawn from the N2 Wild Coast Toll Highway. With a gross once-off investment in the area during construction totaling R4,773-billion, this project is expected to generate income from new business activity (after construction) of R1,666-billion and total investment in the area (during and after construction) of R6,439-billion.

In addition the following annual increase in income in the service area of the proposed road during and after construction is expected:

- Wages and salaries to local population R 228,8-million;
- Income increase to local industry R 171,6-million;
- Retailers R 114,4-million;
- Service providers R 57,2-million;
- Number of permanent jobs 15 880;
- Multiplier effect in zone of influence: 4 – 6.
- Tourism potential in the area:
  - Expected tourists per annum - 1 400 000;
  - Projected new room developments – 784;
  - Positive economic impact as a result of increased tourism volumes.

Toll road developments are directly funded by transparent off-budget means for which a sound business case must exist. This significantly different approach (vs. other infrastructure projects funded ex the general fiscus) not only suggests it, but demands accountability from the road agency. This is a situation that should give us all comfort.

Progress on the implementation of high modulus asphalt technology in South Africa

Benoit Verhaeghe and Erik Denneman, CSIR Built Environment

South Africa has gained an asphalt mix type that is suitable for application on the most heavily trafficked roads.

A previous edition of **asphaltNEWS** (August 2010) featured a first feedback report on the Sabita High Modulus Asphalt (HiMA) Technology Transfer (T^2) project. The aim is to introduce HiMA technology - which combines superior permanent deformation resistance, with high structural stiffness and good fatigue performance - to South Africa. Significant progress has been made since the publication of the previous article.

A preliminary mix design guideline was completed a year ago and has since been further refined based on experience gained through various HiMA implementation initiatives. The performance based mix design process for HiMA as described in the guideline is shown in Figure 1.

Performance specifications are based on the notion that mix properties should be evaluated based on the loading and environmental conditions to which the material will be subjected in the field. The intention of these specifications is to describe the performance requirements, without necessarily prescribing the composition of the HiMA mix.

Performance criteria

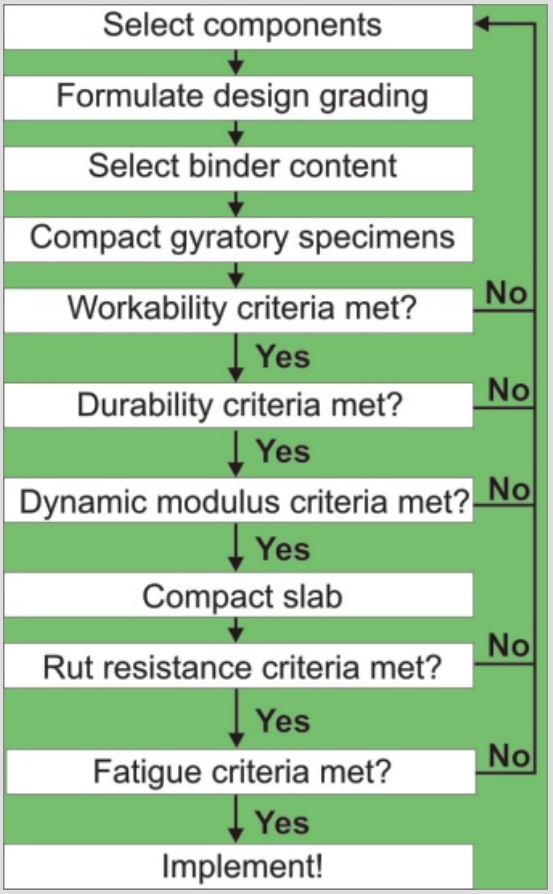

Figure 1. Mix design process

The first step in the mix design process shown in Figure 1 is to select appropriate mix components in terms of aggregate and binder. A suitable grading is developed from the different aggregate fractions. The minimum binder content is set based on a binder richness factor, similar to the film thickness conventionally used in South Africa.

Using this trial mix design gyratory specimens are compacted. A maximum air void content after a set number of gyrations has to be achieved. This is the first of the performance criteria, aimed at creating a workable mix. If the workability criterion is met, specimens are subjected to a durability test aimed at preventing stripping of the binder in the field. The remaining performance criteria relate to the

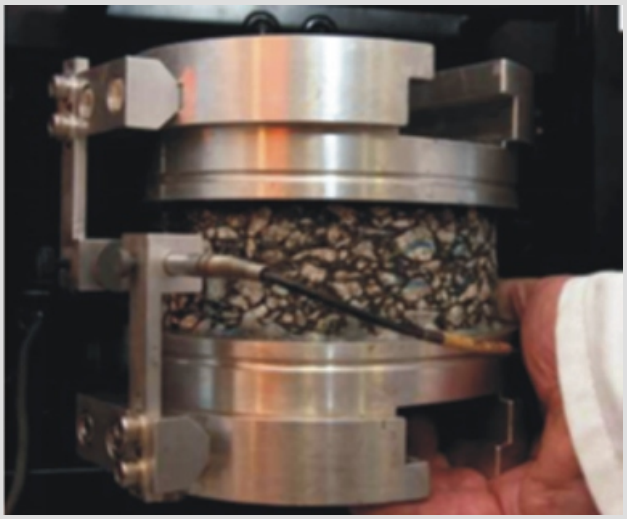

Figure 2. HiMA specimen in shear test

provision of a minimum structural stiffness, a minimum level of resistance to permanent deformation under traffic loading and, finally, a minimum fatigue life. Figure 2 shows a HiMA specimen being loaded into the shear tester for the permanent deformation test.

Since the introduction of the HiMA design guideline, HiMA has been considered for a number of projects. A challenge has been to design a mix that meets the stringent performance criteria within the often limited lead time for projects. For the initial designs the availability of a suitable binder was an additional challenge that needed to be overcome.

Table 1 shows the main characteristics of the binders used in the HiMA T^2 project thus far. The European specifications for these properties in terms of a 15/25 penetration grade binder, which would be the typical binder class used for HiMA, are shown in the column on the right. Binder 1 was produced at a South African refinery and sent to a laboratory in France, where a mix design was created using South African aggregates. This mix design was later tested at the CSIR in Pretoria to develop criteria for HiMA that could be satisfied using locally available equivalent test methods.

Figure 3. Current condition of a road surfacing outside Durban harbour, where HiMA will be put to the test

Binder 2 in the table was created by modifying a 40/50 penetration grade bitumen at a time when HiMA binder was unavailable. This development was sponsored by Much Asphalt, as were a number of mix design iterations. The binder was never used in an actual project because binders 3 and 4, produced at two South African refineries, became available.

Time consuming

The results thus far show that the binder properties have a strong influence on the performance of the mixes produced and tested in the laboratory. As an example, a mix design that meets permanent deformation criteria when containing binder 4 did not meet those criteria when the binder was substituted with binder 3. This is possibly related to the lower softening point and viscosity of binder 3.

Well over twenty design iterations have been performed thus far. Meeting the specifications of a performance based design method was found to be a time consuming process. At this stage two viable HiMA mix designs have been developed, one for Gauteng and one for KwaZulu Natal. These mixes perform better on the performance criteria than the original reference mix developed in France.

Table 1. Binder properties

Binder No.	1	2	3	4	15/25 spec
Pen (10^{-1} mm)	25	29	23	22	15-25
Softening point (^{o}C)	62,8	64,4	57,2	62,2	55-71
Viscosity @ 60^{o}C (Pa.s)	2713	1318	832	2375	>550
After RTFOT					
Softening point (^{o}C)	69,2	68,2	61,6	67,6	Orig. (Min +2)
(Retained Pen (10^{-1} mm)) % of Orig.	(19) 69	(20) 69	(18) 78	(16) 72,7	55

The KwaZulu Natal mix design will be used in a full scale trial section on a road belonging to the eThekwini Municipality. The road, which provides access to the Durban Harbour, carries extremely heavy traffic. The condition of the current asphalt surfacing is shown in Figure 3.

The design will feature a HiMA base layer of 70 mm thickness, with a thin overlay. The performance of the section will be monitored as part of the Sabita HiMA T^2 project.

Further work planned for the HiMA T^2 project includes accelerated pavement testing on one of the optimised mixes. The latest findings from the project will be presented in a paper that has been accepted for CAPSA'11.

SAICE's infrastructure report card for SA slightly better than similar study in 2006

While South Africa's national road system, administered by the South African National Roads Agency Ltd (SANRAL), remains in excellent condition and its provincial roads in acceptable condition although requiring new investment, its local municipal and rural roads are either not coping with demand or are poorly maintained, with some failing or on the verge of failure.

These are some of the findings of the South African Institution of Civil Engineers (SAICE) after a three year Infrastructure Report Card (IRC) study which concluded that South Africa's overall infrastructure earned a rating of C-, a slight improvement on a similar study conducted in 2006, in which the country's infrastructure was awarded a D+ rating. The study examined ten infrastructure sectors, divided into 27 sub-sectors. This article will focus only on the conclusions related to road infrastructure.

The study awarded the following gradings for the country's various road categories:

- B- for national roads: infrastructure is in good condition and properly maintained. It satisfies current demands and is sufficiently robust to deal with minor incidents;
- D- for paved provincial roads: infrastructure is not coping with demand and is poorly maintained. It is likely that the public will be subjected to severe inconvenience and even danger without prompt attention;
- C- for paved metropolitan roads: infrastructure condition is acceptable although stressed at peak periods. It will need investment in the current Medium Term Expenditure Framework period to avoid serious deficiencies.
- D- for paved district and local municipal roads (see above);
- E- for all provincial, metropolitan and municipal gravel roads: infrastructure has failed or is on the verge of failure, exposing the public to health and safety hazards. Immediate attention is required.

The national road network is in the good to excellent range, with the proportion of roads in poor to very poor condition never exceeding the international benchmark of 10%. SANRAL demonstrates expert knowledge, world-class management and excellent monitoring and maintenance systems.

Close to 80% of the network has exceeded its 20-year structural design lifespan. SANRAL's current success in maintaining the national road network will see its responsibilities and network allocation expand further. These will be severe challenges.

Less than 10% of the paved metropolitan roads are in poor to very poor condition.

Skills shortages

The paved provincial road network has deteriorated significantly over time. Shortages of skilled personnel in provincial departments, inadequate funding and outdated systems, and the lack of routine and periodic maintenance, have contributed to the current condition. Generally, these roads are still in a satisfactory condition.

Less than 10% of the paved metropolitan roads are in poor to very poor condition. However, balancing the need for the upgrading of township roads with the necessity to perform routine and periodic maintenance remains a challenge given the limited resources at their disposal.

In general, municipalities lack capacity, skilled resources and funding to efficiently and effectively manage their road networks.

Reliable condition data is scarce. Few municipalities make use of pavement management systems to prioritise their needs. Capacity improvements amount to much less than that required, especially with high urbanisation rates. Based on the limited data available, the paved road network on average, nevertheless appears to be in a fair condition.

Maintenance of gravel roads, which constitutes 75% of the total length of the proclaimed South African road network, has been neglected, and approximately 50% of the provincial gravel roads and 30% of the municipal gravel roads, for which condition data is available, are in a poor to very poor condition.

Road networks and condition

The study notes that South Africa has a road network of 747 000 km (of which 140 000 km is unproclaimed), and responsibility for this network is shared amongst all three spheres of government.

Condition data is available for only 37% of the classified road network, 75% of which is unpaved. Of the classified paved roads, 16 200 km are national roads managed by SANRAL for the Department of Transport (DoT).

Approximately 185 000 km are provincial roads, with 66 000 km under metropolitan management and the rest managed by municipalities. There is extreme variation in the availability of information and condition of roads both between spheres of government and between geographical areas.

SANRAL has more than doubled its inherited network of 7 200 km, much of which was in poor condition when the Agency was created in 1998. Despite this backlog, it has extended the road network and maintained and upgraded existing roads with great consistency. The company deserves praise for its management of national roads, which are classified in the good to excellent range according to Visual Condition Index (VCI) information. Its management practices are in line with World Bank guidelines (no more than 10% of roads under management are in a poor to very poor condition at any time).

Road condition data is available for 82% of provincial roads, but extrapolation suggests that well over half of these roads have exceeded their design life, rendering them highly susceptible to rapid, costly deterioration in many sections. VCI suggests that the overall provincial road network - 74% of which consists of gravel roads - is deteriorating.

For metropolitan roads, condition data is available for only 64% of the network - 80% of which are paved roads in a fairly good condition, and only 12% of which are gravel roads.

Management problems

Municipal roads are not well managed, with road condition data available for only 4% of these. There is also much confusion regarding municipal coordination and responsibility. It appears that paved roads are in a fairly good condition, while gravel roads are poor to very poor. However, the lack of data suggests serious management problems and the possible inability of many municipalities to maintain and extend their road networks, a suggestion corroborated by extreme skills shortages and lack of capacity in most municipalities.

A 2007 DoT survey observed that many municipalities lacked the capacity simply to answer the survey questionnaire, implying that they would be similarly incapable regarding roads maintenance and management. Further, of the municipalities that did reply, only 36% indicated that some form of a road management system was in use.

Municipal roads are not well managed

One major consideration is loss of service – a function of capacity and delays. The current lack of capital expenditure on capacity improvements, including additional infrastructural and signal upgrades, is symptomatic of poor service delivery.

Authorities (excepting SANRAL) are slow in rolling out new projects. There is a general inability to plan and manage funds appropriately; however the National Land Transport Transition Act (NLTTA) requires the development of integrated transport plans, which must include an infrastructure development component. Further, as per the NLTTA, district and local municipalities must agree on division of planning functions in order for

National Treasury to release funds. The absence of this information (again, excepting SANRAL) is indicative of the lack of technical skills and knowledge plaguing our public sector.

SANRAL asserts that there is currently a R50 billion backlog on strategic (national and provincial) roads, with an associated maintenance budget of R12 billion annually. As noted in South Africa and internationally, road maintenance delayed for five years increases repair costs between 6 and 18 times – aside from other direct and indirect costs. Direct costs include a proven positive relationship between road deterioration and vehicle maintenance costs, as well as the cost of time and wasted fuel spent driving on congested or deteriorating roads. Indirect costs include the impact on non-drivers, such as increases in food prices owing to wasted fuel and time spent on congested or deteriorating roads.

Budget constraints

Reliable and conistent data on road conditions is a prerequisite for the urgently required shift to routine maintenance. This data permits planning, prioritisation of targets and adequate budgeting for maintenance and extension. An example is SANRAL, which consistently prioritised spending according to data while its budget was less than required for comprehensive maintenance of all its roads. Capacity strengthening, especially at municipal level, is crucial for collection of this data.

A comprehensive municipal skills survey was undertaken by SAICE in 2007. Of all 283 municipalities surveyed, 83 had no civil engineers, technologists or technicians. A further 48 employed only one civil technician, and municipalities with civil engineering staff reported 35% vacancies (over 1000 professionals), often owing to budget constraints. The allocation of maintenance funding is, with very few exceptions, simply not sufficient, especially in circumstances where it is expected to cater for a maintenance regime that has led to neglect. All too frequently the inadequacy of the allocation is compounded by poor management, which results in these meagre funds going unspent.

Stressing the importance of functioning and well maintained infrastructure, the study notes that “in the global economy, the state of a nation’s physical infrastructure provides one of the best indicators of its likely prosperity. Profitable economic activity requires efficient and functioning systems of transport, energy, water and waste management, and social infrastructural services.

Conclusions

The study concludes: Although government’s infrastructure-related deficiencies have been outlined above, all South African citizens are responsible for sustainability, and urgently need to recognise this. Infrastructure is human-made and subject to technological advances multiplying its quantity and quality; however it is built on a foundation of scarce natural resources that are not infinite. We must therefore take ownership of our infrastructure in order to ensure its sustainability, e.g. through water conservation, recycling and recognition of the necessity of “user pays” systems, despite the inconvenience or difficulties associated with this change. This is, in effect, recognition of the importance of demand-side management in all sectors by government, which must be supported by the public through an urgent change in behaviour.

Badly managed and maintained municipal and provincial roads, often potholed, offer a stark contrast to SANRAL'S world-class management of its national road network

Routine use of warm mix asphalt now a reality in South Africa

Tony Lewis and Krishna Naidoo

As reported in previous editions of **asphaltNEWS**, extensive trials using warm mix asphalt (WMA) have been carried out in the Durban area over a period of two years, from November 2008 to December 2010. Following the successful completion of this work the eThekwini Municipality has taken the decisive step of approving the routine implementation of WMA on future projects, establishing an historic precedent in South Africa's asphalt industry.

The three WMA trials that gave the eThekwini Municipality the confidence to proceed with the routine use of this process on their road rehabilitation projects were probably the largest and most complex of their kind to be undertaken in South Africa. The full spectrum of testing was undertaken on the warm mixes used in these trials, and their quality was found to be similar to that of equivalent hot mixes asphalt. This facilitated the decision to use WMA, and by the end of June 2011 a total of about 35 000 tons of WMA had been paved.

Reclaimed asphalt

At this time two WMA technologies have been used on a routine basis, the first consisting of a locally developed foamed bitumen technology, which was used in the asphalt base mix on the Route M5 where it passes through Durban's suburb of Malvern. The other, a rheology modifyer polymer hybrid type WMA technology, is currently being used as an asphalt surfacing mix in the Greyville area. The mixes used in both projects contained 15% of reclaimed asphalt (RA). A 40/50 penetration grade bitumen was used in the Route M5 mix while a 60/70 penetration grade bitumen was used as the base binder in the mix used in the Greyville project.

The mixes on both projects have been produced in National Asphalt's asphalt plant. This consists of a double drum continuous type plant where the aggregate is fed into the heating and drying drum. Once dried and heated, the aggregate passes into the second drum where it is mixed together with the binder. The RA is also added into this drum, which enables thorough mixing without any exposure of the RA to the burner flame. The special foam generator, which converts the hot binder to a foam, is installed in this part of the plant. Temperature reduction required to produce the WMA is achieved by reducing the fuel flow to the burner.

Foamed bitumen WMA

In the case of the Route M5 project, where the foamed bitumen WMA Technology, NA Foamtec™ was employed, the temperature of the 40/50 penetration grade bitumen was raised to between 170°C and 180°C before use. The elevated temperature of binders used in foamed bitumen technologies ensures foam properties that enable complete coating of the aggregate at signficantly lower mixing temperatures. The rehabilitation work on the portion of Route M5 where the WMA base was used consisted essentially of milling out the existing distressed, aged asphalt and replacing it with 80mm asphalt base and 40mm surfacing.

National Asphalt's Mike Walsh and SSI's Peter Jerome discuss paving of WMA base in Malvern with a paving crew member

The normal manufacturing temperature for this base of mix, containing 40/50 penetration grade bitumen, is between 165°C and 175°C. However, an average temperature of 144°C of the "warm" mix was measured at the mixing plant - a temperature reduction in the order to 25°C. The results of all the tests conform to the specified requirements.

The average temperature of the mix at the paving site was 135°C; the fact that the specified

compaction limit of minimum 92% voidless density could be achieved is evidence of the success of the foamed bitumen WMA technology.

Modified polymer hybrid WMA

On the Greyville roads project, Sasolwax Flex™ was blended into the 60/70 penetration grade bitumen to create an A-E1 quality binder. The benefits of this technology include enhanced asphalt performance characteristics due to the addition of the polymer, as well as the ability of the mix to be manufactured and paved at significantly lower temperatures compared to conventional HMA polymer modified mixes. The usual manufacturing temperature limits for A-E1 modified mixes are between 165°C and 175°C.

SAT members inspect WMA paving on a road in Greyville, Durban

For the mix used on the Greyville roads project an average 144°C manufacturing temperature was recorded, with the average temperature at the paver slightly lower, at 140°C. A temperature reduction of between 25°C and 30°C is therefore being achieved using this rheology polymer-modified WMA technology.

Conclusions

This short article outlines the first routine use of WMA in South Africa, a historic milestone in this country's asphalt industry. The results of this work show that asphalt can be manufactured and paved routinely at temperatures at least 25°C below those of similar hot mixes, while achieving performance characteristics and quality standards at least as good as those of HMA. This work also demonstrates that reclaimed asphalt can be readily incorporated in warm asphalt mixes.

There is no doubt that the success achieved in the routine use of WMA in the Durban area will soon spread to other areas as the benefits of this process in terms of reduced cost, as well as improvements in environmental and working conditions, become more widely known.

WMA guideline put under the SAT microscope

The compilation of a best practice guideline for warm mix asphalt (WMA), as well as an interim stand-alone specification, is nearing completion following SAT workshops in the three major regions to overview these documents.

SAT Eastern Region workshop

The first of these workshops, which were organised to gather comments and to attend to queries about the guideline and specification, was held in Durban on 14 June, giving SAT an ideal opportunity to visit the Greyville roads project (see page 11). About 70 delegates gathered to watch the mix being laid by National Asphalt, the company responsible for producing and paving the country's first routinely manufactured WMA. The group watched as the warm mix, which used Sasolwax Flex to produce an A-E1 modified binder, was paved at a temperature around 25°C below that of conventional polymer-modified hot mix asphalt. After the inspection everyone then retired to the club where the *WMA Best practice guideline and specification* was thoroughly workshopped.

SAT WMA workshop delegates inspecting compaction of warm mix, Greyville, Durban

SAT Southern Region workshop

The WMA guideline and specification document was once more under the spotlight at a second SAT workshop held in Cape Town on 21 June, where the two facilitators, Krishna Naidoo and Tony Lewis, took the 45 delegates through the documents, noted comments and fielded a number of questions. From the discussions it appeared very likely that WMA would soon be launched in the Western Cape.

SAT Central Region workshop

The final SAT workshop to gather comments for incorporation in the *WMA Best practice guideline and specification* took place at Much Asphalt's Benoni site, where these documents were thoroughly analysed by the large number of delegates.

The 120 delegates were then treated to an excellent demonstration of WMA usage. Herman Marais and Brian Neville explained the workings of the Aztec Double Barrelled mixing plant, and then led the group to a prepared area where a WMA mix, using foamed bitumen and containing 35% of reclaimed asphalt, was paved successfully. The excellent workability of WMA at temperatures of less than 110^{o}C, was immediately apparent in a demonstration of hand laid asphalt, and it is evident that this process has a great future.

SAT delegates view hand placing of WMA

Conclusions

With the workshops and demonstrations of WMA in various parts of the country completed, the final leg in the compilation of the *WMA Best practice guideline and specification* has begun. All the comments from the workshops will be collated and subjected to both local and overseas peer review, after which the guideline will be published in time for its launch at CAPSA'11.

The introduction, trialling, and routine implementation of WMA in South Africa within a period of less than three years is a remarkable achievement and a tribute to an innovative asphalt industry as well as to all the hard work and energy extended by the WMA Interest Group.

Revised Sabita manuals now available in CD format

In line with its policies of sustainability and optimised resource utilisation, new, updated and revised Sabita publications are now being published in CD format. The most recently issued include:

Sabita Manual 8: *Guidelines for the safe and responsible handling of bituminous products*. The scope of this manual has been revised to incorporate international best practice in respect of the methodology used for hazards and effects management, and draws on the most up-to-date information, knowledge and experience.

Sabita Manual 28: *Best practice for the design and construction of slurry seals* has been prepared to provide practitioners with information and guidelines to select the appropriate type of slurry for specific applications and to assist in the design and construction of slurry mixes to ensure good performance.

Sabita Manual 30: *A guide to the selection of bituminous binders for road construction* has been compiled to facilitate the correct selection and use of bituminous binders for road construction, and covers the role and function of bitumen in road layers, the types and grades available in South Africa, standard specifications and technical requirements. The CD will be available in August 2011.

Sabita Manual 31: *Guidelines for calibrating a binder distributor and ensuring satisfactory performance* sets outs procedures to ensure the proper functioning of a binder distributor able to deliver the required uniform application of binder during construction of bituminous seals and other spray applications.

All CDs are may be ordered from Sabita at a price of R50 for members and R100 for non-members. Please browse www.sabita.co.za to order, or email info@sabita.co.za.

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The CAPSA'11 countdown has begun

The spectacular scenic wonderland of the Champagne Sports Resort, the venue for CAPSA'11

The countdown to CAPSA'11, one of the most prestigious and eagerly awaited events on southern Africa's roads industry calendar, has begun in earnest.

To be held at the picturesque Champagne Sports Resort in the Central Drakensberg mountains of KwaZulu-Natal from 11 – 14 September 2011, this year's conference will be staged under the theme *Roads of the future* with the sub-theme *Living in the carrying capacity of our planet* and will focus on the following focus areas:

- Reducing energy consumption in the construction of bituminous layers;
- Reducing the impact of road building activities on the environment;
- Designing for extended performance of bituminous layers;
- Flexible pavement systems for extended life;
- Asset management.

In line with previous CAPSA conferences, the 61 reviewed papers and 10 bulletin papers currently accepted for the conference will be organised into a series of plenary presentations in the respective focus areas, interspersed with parallel workshops and seminars to facilitate and maximise delegate discussions, participation and interactions on many of the technical issues that are currently challenging the roads industry.

The resort's impressive and spacious central banquetting hall, where plenary sessions will be held

Social programme

A full social programme has also been organised to maximise networking opportunities and includes an ice breaker function on Sunday 11 September, an exhibitors' braai on the Monday evening, and the gala dinner on the Tuesday evening which promises to be a spectacular occasion for all delegates and partners. The conference will end on the evening of Wednesday 14 September, but it is recommended

that delegates only leave on Thursday morning in order to attend the social function being arranged for that evening as part of the conference.

A full partner programme has also been organised for the three days of the conference at a cost of R2 500 (excl. VAT), and includes visits and sightseeing trips during the day and attendance at all the evening social events.

Another highlight of the conference will be opportunity for organisations to interact with delegates in the exhibition area, which will host all refreshment breaks, lunches and the exhibitors' braai. Of the 40 exhibition stands being planned only a few remain available, and any companies still interested in exhibiting their products or services should contact the CAPSA'11 secretariat (patloots@iafrica.com).

One of the resort's many tasteful and comfortable lounging areas

Late registration

More than 300 delegates and exhibitors were registered by the end of June, but the date for closure of the standard registration rate of R8 750 (ex VAT) was extended to 31 July 2011. Late registration fees between 1 August and 5 September have been increased to R10 000 (ex VAT), and any registration after 5 September will incur an additional penalty with an increase to R 12 000 (ex VAT). So don't leave it too late to register.

All registrations, invoices and payments are managed through the CAPSA'11 web site at www.capsa11.co.za. Those still wishing to register for the conference should visit the web site and follow the on-line instructions.

Accommodation should be organised directly with Champagne Sports Resort (reservations@champagnesportsresort.com) which offers a variety of options from hotel rooms to four and six-bed chalets.

CAPSA'11 again promises to follow in the unique tradition of the conference in providing excellent technical interaction backed up by a varied social programme providing ample opportunity for networking, catching up with old friends and meeting new ones. We look forward to seeing you there.

Resolutions of the Road Pavements Forum, May 2011

Resolution 1

- The RPF recognises the need to review the roads industry's procurement systems;
- The sponsors will request that the RCB establish a task team to explore alternative procurement approaches for the roads sector, and that feedback be provided at the next RPF meeting in November 2011.

Resolution 2

The RPF identified the need for:

- information on predicted road material usage, based on expenditure forecasts for the road sector, to be used as a planning tool;
- Better communication on road material availability (e.g. advance notice of refinery shutdowns).

Resolution 3

The RPF supports the initiative that engages the DoE to classify bitumen as a strategic resource and that it be regulated.

Resolution 4

That the Labour Enhanced Construction guidelines of the GPDRT be finalised by the inclusion of the outstanding ASPASA component, and be made available to the industry.

Resolution 5

That the RPF website (www.csir.co.za/RPF) provides guidance and links to all industry documents.

SA publishes its own, customised measurement standard for civil engineers

A Southern African edition of *Civil Engineering Standard Method of Measurement* (CESMM3) has recently been published, following inputs from local industry stakeholders. It is a regional customisation of a well-established standard for the preparation of bills of quantities for civil engineering work, developed by the Institution of Civil Engineers (ICE) in London.

The current methodology for measuring civil engineering quantities is contained in Clause 8 of the SANS 1200 *Standardised specifications for civil engineering construction* and the South African Institution of Civil Engineering's (SAICE) *Civil engineering quantities* (1990). The SANS 1200 series of standards, which were developed and last updated during the 1980s, was designed for use with SAICE's General Conditions of Contract.

In line with modern drafting requirements for documents embodied in the Construction Industry Development Board's (CIDB) *Standard for uniformity in construction procurement*, SABS has published the SANS 1921 series of standards for construction and management requirements for works contracts, and most of the SANS 2001 series of technical standards for construction works. The Southern African edition of CESMM3 is compatible with these standards and is suitable for use with international, national, organisational, industry and bespoke standards, and most standard forms of contract.

Logical choice

According to Dr Ron Watermeyer, chairman of ICE-SA (a joint division of ICE and SAICE): "CESMM3 became a logical choice as a base document to succeed the current system of measurement embodied in the SANS 1200 standardised specifications, since it is a document founded on the same thinking and philosophy as the system that has evolved in South Africa. It is widely used in Africa, is well understood by the international community, and is a well tried and tested document that is adequately supported by a range of comprehensive handbooks and texts."

Referring to the southern African edition of CESMM3 Peter Becker, who was intimately involved in the development of the current system of measurement and under whose guidance the new system was developed, drew attention to the following:

- No reference is made to any standard form of contract as the terms and text are aligned with standard forms of contract commonly used in the region;
- The terminology is aligned with the provisions of the CIDB's *Standard for uniformity in construction procurement* and South African national standards or international standards;
- Adjustments have been made to items and terminology to reflect southern African practices;
- The fabrication of structural metalwork items needs to be supported by separate bills of quantities developed in accordance with SAICE's system of measurement;
- Classes EA - Additional Earthworks and RA - Additional Roadworks (and items within these classes) have been introduced to provide flexibility to accommodate regional earthwork practices i.e. to enable interim operations to be measured.

The southern African edition of CESMM3 is suitable for use with international, national, organisational and bespoke standards using most forms of contract. It is priced at R500 including VAT, but excluding postage, and may be obtained from:

- The Association of South African Quantity Surveyors, Tel +27(0)11 315 4140;
- Consulting Engineers South Africa, Tel +27(0)11 463 2022;
- Engineering Contract Strategies, Tel +27(0)11 803 3008;
- The South African Federation of Civil Engineering Contractors Tel +27(0)11409 0900; and
- The South African Institution of Civil Engineering (SAICE) Tel +27(0)11 805 5947.

eThekwini's integrated approach to road asset management

Shaun Moodley

The recently published SAICE Infrastructure Report Card for South Africa 2011 rates the current condition of paved metropolitan roads as a C minus, and perhaps the main culprits responsible for this below par performance are lack of capacity, lack of skilled resources and insufficient funding to efficiently and effectively manage road networks. Contributory factors are the lack of reliable condition data and proper pavement management systems (PMS) to prioritise rehabilitation needs.

None of the above apply to the eThekwini Municipality in KwaZulu-Natal, which has, for almost a decade now, used its PMS to achieve arguably one of the best maintained metropolitan road networks in the country!

Human element

eThekwini's PMS is managed by a small group of enthusiastic professionals, and is organisationally located within the Pavement and Geotechnical Engineering Branch of the Roads Provision Department. Support is provided by Aurecon and the various consultants who carry out the network level inspections on a bi-annual basis. Since its inception in 2003, the PMS has embraced the principles of capacity building and skills transfer, training and accrediting in excess of one hundred assessors and assistants. A recent training and accreditation workshop was attended by approximately sixty delegates, highlighting the importance of the PMS in the local civil engineering industry.

Network analysis

A network level analysis is done every two years using pavement condition data collected in accordance with the TMH9 (Technical Methods for Highways) standard visual assessment manual for flexible pavements (1992), and the municipality's visual assessment manuals for rigid and block pavements. Defects recorded are used to determine the current condition of the network and to determine a historic trend of pavement performance. The system also conducts a life cycle cost analysis to predict the consequences of any budgetary constraints or maintenance policy. For example, eThekwini is able to determine the budget required to eliminate the backlog over a certain number of years or to maintain the network condition at desired levels.

A huge advantage of the PMS is the compilation of a multi-year preventive maintenance and rehabilitation (M&R) programme for the current and future needs of eThekwini's roads. Predictive analysis offers choices for the best course of action for treatment within several user-defined parameters. The mammoth task of implementing the projects on the M&R programme is the responsibility of the Roads Rehabilitation Branch.

The paved road network within eThekwini consists of roads that belong to the municipality, the South African National Roads Agency Limited, the KwaZulu Natal Provincial Department of Transport as well as private entities such as Transnet and private residential developments. The extent of the network under eThekwini's ownership is approximately 6000 km and consists of flexible, concrete and block pavements, the majority of which are flexible.

Functional heirarchy

eThekwini's roads are classified based on a functional hierarchy. The road categories are A (freeways and arterials), B (bus and industrial routes), C (urban access collectors) and D (residential roads). The majority of the paved road network (49%) consists of Category D roads providing mobility and access in a local residential context. Category A roads make up only 1% of the network while Category B and C roads constitute 25% and 18% of the road network respectively.

Network level inspections were conducted by trained assessors on the paved road network during 2003, 2005, 2007 and 2009. The surfacing, structural and functional distresses recorded are used to calculate a Visual Condition Index (VCI) for each paved road segment. The VCI is a percentage index ranging between 0 and 100 where 0 represents a road segment in very poor condition and 100 represents a road segment in very good condition. To ensure that the road network delivers an acceptable level of service, the following performance criteria have been agreed upon:

- No roads in any of the categories may deteriorate below a VCI of 30;
- No category A and B roads may deteriorate below a VCI of 50;

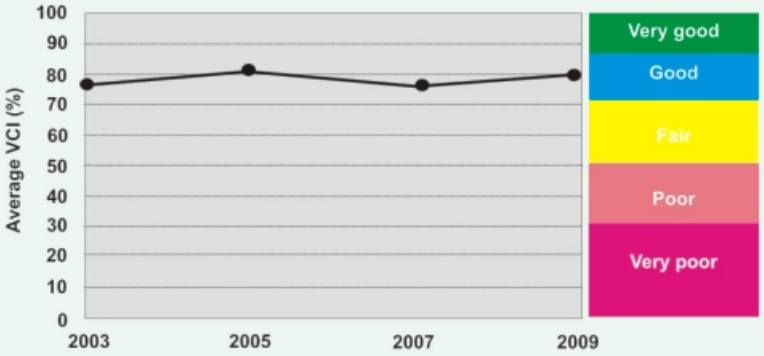

Figure 1: Average VCI for paved roads, 2003 -2009

- Less than 10% of category C and D roads may deteriorate below a VCI of 50;
- The average VCI of the entire network must remain greater than 70.

Since 2003 the average condition of eThekwini's surfaced roads fluctuated between 76% and 80% (Figure 1).

PMS and GIS

eThekwini's PMS has proved to be an invaluable strategic tool in making cost-effective decisions on pavement management issues. The integration between the PMS and Asset Management has influenced Council to increase its funding allocation for pavement rehabilitation. For example, the PMS has been largely instrumental in securing approximately R400 million for the 2010/2011 M&R programme. The PMS has also proved to be a strategic communication tool when dealing with public queries. There is increased confidence in the way the city is run, with public funds being properly used.

The integration of the PMS with the Geographic Information System (GIS) has also simplified the dissemination of technical information to other departments, management and councillors. For example, the average condition of the network per ward can be computed fairly easily and the information can be presented in colour-coded maps and graphs. Another advantage is that coordinate-based data such as Falling Weight Deflectometer (FWD) tests can be plotted on the GIS and integrated with other PMS data. The projects on the M&R programme and the various treatments are plotted spatially, assisting the Roads Rehabilitation Branch with their project level planning.

Network level inspections

Prior to any network level inspections being carried out, teams of assessors and assistants are subjected to five days of rigorous calibration, testing and accreditation. The workshop hosted by the Roads Provision Department includes lectures, photographic analyses and mock inspections. This is followed by theory and practical tests covering all aspects of the inspection process. Paper-based theory tests have been replaced by electronic multiple-choice questions. The huge advantage is that marks are now available almost instantaneously!

During the practical assessment, teams assess pre-selected road links and calculate the VCI for them (Figure 2). The same road links are assessed by an independent expert assessor whose VCIs are used as the control. The accreditation that the assessors and assistants receive after passing may be utilised by other road authorities. This initiative has helped increased the skills base in an important field of pavement management.

Figure 2. Practical assessments

Moving forward

In 2011 it's "good-bye paper forms" and "yebo electronic tablets"! The use of GPS enabled electronic tablets will improve data collection and expedite the inspection process quite significantly. A huge spin-off is that the M&R programme will now be available at least two months earlier, thereby allowing the Roads Rehabilitation Branch to implement more projects in a single financial year. In accordance with international best practice, the visual inspection data will be supplemented by non-destructive tests such as FWD, skid resistance and texture depth. There are also plans to integrate the PMS with other maintenance management systems.

Conclusion

The success of eThekwini's PMS may be attributed to the interaction of three fundamental components: Processes, People and Technology. eThekwini has developed an 'asset management mindset' having implemented processes that are geared towards managing the road network at optimal levels. The professionals responsible for the PMS ensure that sufficient funding is available for data collection, system upgrades and skills development. Introducing the latest technology to improve data collection, analysis and integration has further enhanced the PMS. In the long term, eThekwini's R 34,6-billion road network is in good hands!

Sabita manuals and DVDs

Manuals

Manual 1	*Technical guidelines: Construction of bitumen rubber seals*
Manual 2	*Bituminous products for road construction and maintenance* (earmarked for revision)
Manual 5	*Guidelines for the manufacture and construction of hot mix asphalt*
Manual 7	*SuperSurf - Economic warrants for surfacing roads*
Manual 8	*Guidelines for the safe and responsible handling of bituminous products* (CD only)
Manual 9	*Bituminous surfacings for temporary deviations* (to be consolidated with Manual 10)
Manual 10	*Appropriate standards for bituminous surfacings* (under review)
Manual 11	*Labour enhanced construction for bituminous surfacings*
Manual 12	*Methods for labour intensive construction of bituminous surfacings* (CD only)
Manual 13	*LAMBs - The design and use of large aggregate mixes for bases*
Manual 17	*Porous asphalt mixes: Design and use* (CD only)
Manual 18	*Appropriate standards for the use of sand asphalt*
Manual 19	*Guidelines for the design, manufacture and construction of bitumen rubber asphalt wearing courses*
Manual 20	*Sealing of active cracks in road pavements*
Manual 22	*Hot mix paving in adverse weather*
Manual 23	*Code of practice: loading bitumen at refineries* (CD only)
Manual 24	*User guide for the design of hot mix asphalt*
Manual 25	*Quality management in the handling and transport of bituminous binders* (under review)
Manual 26	*Interim guidelines for primes and stone precoating fluids* (under review)
Manual 27	*Guidelines for thin hot mix asphalt wearing courses on residential streets*
Manual 28	*Best practice for the design and construction of slurry seals* (CD only)
Manual 29	*Guide to the safe use of solvents in a bituminous products laboratory* (CD only)
Manual 31	*Guidelines for calibrating a binder distributor to ensure satisfactory performance* (CD only)

New manuals in publication process

Manual 30	*A guide to the selection of bituminous binders for road construction* (CD only)
Manual 32:	*Best practice guideline and specification for warm mix asphalt* (CD only)

Technical guidelines

TG1:	*The use of modified binders in road construction*
TG2:	*Bitumen stabilised materials*
TG3:	*Asphalt reinforcement for road construction*

DVDs

DVD 100:	*Test methods for bituminous products*
DVD 200:	*Training guide for the construction and repair of bituminous surfacings by hand*
DVD 300:	*Manufacture, paving and compaction of hot mix asphalt*
DVD 410	*The safe handling of bitumen*
DVD 420:	*Treatment of bitumen burns*
DVD 430:	*Working safely with bitumen*
DVD 440:	*Firefighting in the bituminous products industry*

Please browse the Sabita website www.sabita.co.za for a complete list of Sabitas technical material to order

Local and international events

Local events - 2011

Materials Testers Course - Module 5 - Bituminous binder testing
1 - 5 August, Cape Town (AsAc course)

Latest developments in asphalt technology
11 August (AsAc course held by SARF)

Polymer modified binders seminars
16, 17, 18 August, SAT regions

Interpretation of test results
29 - 31 August (AsAc course held by SARF)

Overview of hot mix asphalt
1 - 2 September (AsAc course held by SARF)

Best practice in the use of surface treatments
6 September, Cape Town (AAPA/SAT seminar)

Best practice in the use of surface treatments
8 September, Pretoria (AAPA/SAT seminar)

Materials Testers Course - Module 6 - Asphalt testing
5 - 8 September, Pretoria (AsAc course)

10th CAPSA - CAPSA'11
11 - 14 September, Drakensberg, South Africa

Latest developments in asphalt technology
29 September (AsAc course held by SARF)

SAT seminars on Sabita Manual 31: *Guidelines for calibrating a binder distributor and procedures for checking site spray performance*
September/October (dates and venues to be advised)

Materials Testers Course - Module 6 - Asphalt testing
11 - 14 October, Durban (AsAc course)

Testing and testing procedures
20 October, SAT Southern Region (date may change)

Material Testers Course - Module 6 - Asphalt testing
7 - 10 November, Cape Town (AsAc course)

Road Pavements Forum
8 - 9 November, CSIR ICC, Pretoria

Sabita Board and Council meeting
9 November (after conclusion of the RPF), Pretoria

International events - 2009

14th International flexible pavements conference
25 - 28 September, Sydney, Australia

24th PIARC World Road Congress
26 – 30 September, Mexico

2nd International conference on WMA
11 - 14 October, St Louis, Missouri, USA

9th International fair of municipal infrastructure
15 - 17 November, Warsaw, Poland

Czech conference on asphalt pavements 2011
22 - 23 November, Ceske Budejovice, Czech Rep.

13th Colloquium on asphalt and bitumen
24 - 25 November, Bled, Slovenia

International events - 2012

World of Asphalt 2012
13 - 15 March, Charlotte, North Carolina, USA

Transport Research Arena (TRA) 2012
23 - 26 April, Athens, Greece

5th Eurasphalt & Eurobitume congress
13 - 15 June, Istanbul, Turkey

7th RILEM Int. Conference on cracking in pavements
20 - 22 June, Delft, Netherlands

Int. seminar on asphalt emulsion technology (SAET)
9 - 12 October, Crystal City, Virginia, USA

Sabita welcomes new member Neil Sobotker and Associates cc

New Sabita member Neil Sobotker and Associates Consulting Services cc, specialists in the design, documentation and project management of civil engineering and small building projects, has experience, expertise and resources to focus on;

- Routine road maintenance;
- Smaller road rehabilitation contracts;
- Resealing of surfaced roads;
- Labour intensive road maintenance and construction;
- Drainage works and erosion protection;
- Gravel road construction and maintenance;
- Smaller geotechnical investigations;
- Project documentation including Expanded Public Works Programmes;
- Project supervision, administration and management of conventional and labour intensive projects;
- Smaller traffic studies.

Neil Sobotker, a registered civil engineering technologist, handles all contract management, procurement and staff deployment, while Charmaine Sobotker is responsible for statutory and legal requirements, recruitment, accounts and general administration. Other staff includes a registered technologist, a registered candidate technologist, two registered engineers, three candidate technicians and an administration assistant.

The company's head office is in Kraaifontein, with site offices in Blackheath and Suider Paarl.

Measuring a pavement's carbon footprint: beyond the buzzwords and marketing gimmicks, a new science is emerging.

Howard Marks, Ph.D. (NAPA), Richard Willis, Ph.D. (NCAT)

The past decade has seen a number of different attempts to measure the carbon footprints of pavements, each with varying levels of complexity and boundaries.

These public and private analyses started in Europe, where public agencies have been increasingly required to address greenhouse-gas emissions and carbon footprints associated with pavement construction. One company has recently utilised a European-style analysis in the U.S. to help make more environmentally sustainable decisions on pavement design and selection. Some of these analyses have focused on comparing different asphalt pavement technologies, including warm mix and high RA content, and some have compared asphalt and concrete pavements.

Carbon footprint is a term that can be confusing and controversial. Generally, the carbon footprint of a material is seen as the total amount of greenhouse gas emissions associated with its production. Utilising a life-cycle analysis approach, one can also assess the life-cycle carbon footprint of pavement material taking into account the maintenance and repair of the material over its life cycle. A carbon footprint is often measured in terms of carbon dioxide equivalent (CO_{2e}) because there are other gases beside carbon dioxide that have been identified as greenhouse gases (see Figure 1).

Most of the greenhouse gases expended to produce a material occur as a result of energy consumption. Some of this consumption is direct, such as from combustion of fuel to dry the aggregate in the asphalt mixing process or from the use of electricity to run a pavement production plant or mixer. There are also greenhouse gases emitted from certain chemical reactions such as the calcination reaction when limestone is converted to portland cement.

An environmental life-cycle analysis is sometimes confused with carbon footprints. In fact, life-cycle analysis covers all of the inputs and outputs from a pavement structure's life cycle. The outputs may include carbon dioxide emissions, but may be limited to energy, or other environmental or economic factors. A carbon footprint

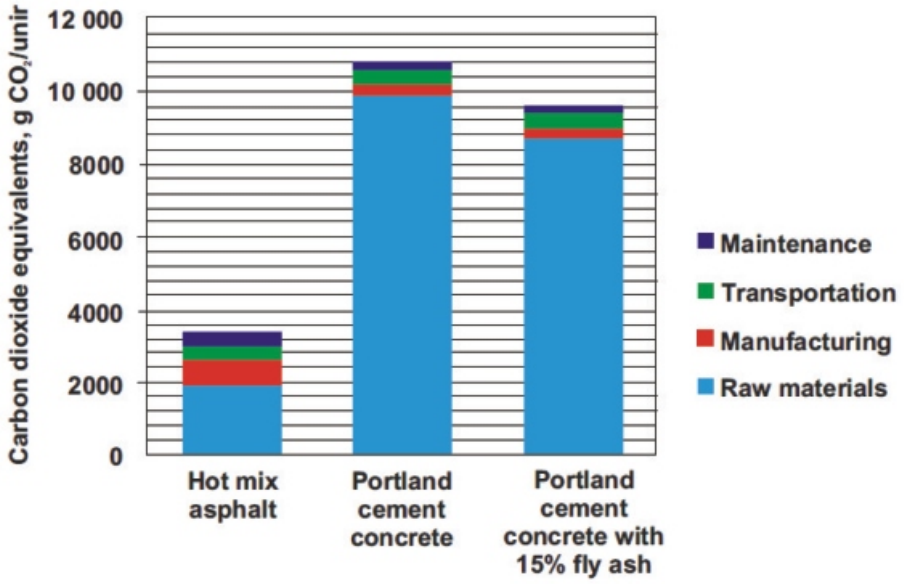

Figure 1. Data from Prowell's 2008 study of various parking lot pavements using BEES software shows that hot mix asphalt has a very low carbon footprint relative to other pavements.

life-cycle analysis is highly specific; it includes all greenhouse gas emissions associated with a pavement life cycle. It does not include the emissions or energy associated with the use of the material, such as the emissions of vehicles traveling over roadways, in the case of pavements.

More than a decade ago, the U.S. National Institute of Standards and Technologies (NIST) developed a software model, "BEES" (Building for Environmental and Economic Sustainability), for comparing the sustainability of different materials based on consensus standards. Different pavement materials have been analysed using the BEES software and in 2008 Brian Prowell, a professional engineer and researcher, established that for parking lots, the life-cycle carbon footprint of asphalt pavements is approximately 30 percent that of concrete pavements.

Athena Institute, a not-for-profit consulting agency, conducted a life-cycle analysis comparing concrete and asphalt pavements in 2006 under the sponsorship of the Cement Association of Canada. The Institute compared embodied primary energy of both pavements and found that their carbon footprints were relatively similar. However, this study's criteria counted asphalt's embodied feedstock energy—that is, the caloric potential of the unburned asphalt cement and its potential carbon emissions—as a major portion of its carbon footprint, even though that energy could not be used as a fuel. Asphalt binder embedded in asphalt pavement would be an impractical fuel source, and therefore, the exclusion of potential emissions associated with the asphalt binder's feedstock energy is customary and appropriate. A more accurate measure of life-cycle greenhouse gas emissions would focus on process-related energy (e.g., energy required to make the material) and process-related green house gas emissions (such as emissions from the portland cement calcination reaction), and exclude embodied feedstock energy if the material is not used as a fuel.

In fact, if the Athena Institute study findings are reviewed in this light, one sees that the results are very similar to the majority of life-cycle carbon footprint analyses comparing pavement materials: Asphalt pavement's footprint is approximately one-third that of concrete pavement.

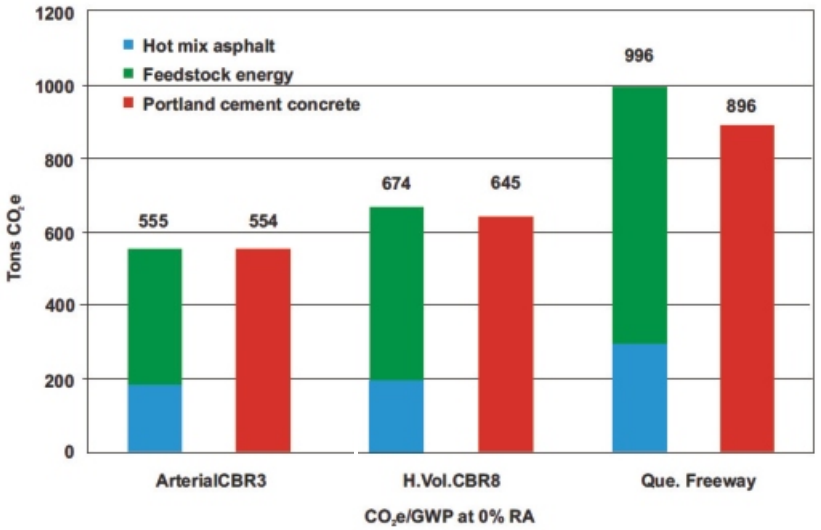

Figure 2. Comparison of pavement carbon footprints (from Chappat and Bilal, 2003)

Asphalt binder should be considered sequestered indefinitely and perpetually as it is continuously recycled and never used as fuel. In fact, the US Department of Energy considers asphalt to be a major source of petroleum carbon sequestration, meaning that it does not emit carbon dioxide (EIA, 2005). Therefore, when feedstock energy is removed from the analysis, asphalt pavements produce significantly less greenhouse gases than concrete pavements, as seen in Figure 2.

The Colas analysis of greenhouse gas emissions in pavement life cycles, from the mining of raw materials to the final disposition of the pavement, shows that asphalt pavements are an environmentally attractive choice.

Some highly sophisticated life-cycle analysis tools include the Colas model (M .Chappat and J. Bilal, 2003), the Granite Construction model (C. Robinette and J. Epps, 2010), and the most recent model/software, sponsored by the UK Highways Agency, termed "asPECT" (Matt Wayman, et al, 2009).

All three models provide consistent and similar results for different asphalt pavement technologies. This is important, because it shows that similar and appropriate inputs have been chosen for each of these independent analyses.

Summary

Environmental life-cycle analyses have become the new buzzword in environmental sustainability metrics. This type of metric is useful in measuring the amount of carbon or greenhouse gas emissions associated with a manufactured

material. Because infrastructure and construction materials have a large mass and are relatively expensive projects, this type of analysis is increasingly being used as a "green" metric. However, because there are alternatives associated with each type of construction material, this metric has also become a marketing or promotion tool. When comparing the carbon footprints of two materials the boundaries of the analysis must be consistent or the results will not be comparatively accurate.

The asphalt pavement industry has spent considerable time studying how the environmental sustainability or carbon footprint of asphalt pavements can be improved. Life-cycle analyses comparing such technologies as warm mix and increased RA content are useful in understanding how each technology can impact a pavement's carbon footprint. The asphalt industry has, and will continue to improve on the impact that asphalt pavement materials have on the environment.

Terminology

The authors stress that it is vital to understand the terms associated with energy and carbon footprints, and also the boundaries imposed by varying life-cycle analyses.

Understanding energy and carbon footprint terms

It is vital in conducting carbon life-cycle analyses to be clear about what is used as energy and carbon inputs, how the inputs are defined, and what the analyses outputs actually measure. Here are some of the more common terms that are being used to identify and describe energy requirements when conducting a carbon life cycle analysis.

- Primary energy: The total amount of energy (BTU) required to produce a material. Energy in its raw form (e.g., petroleum, coal, uranium), generally measured by its lower or higher heating value (Santero, 2010).
- Secondary energy: Primary energy transformed into a different energy type (e.g., hydrogen, electricity) (Santero, 2010).
- Process energy: Primary energy consumed during the manufacturing of a product. Considered as part of the embodied energy (Santero, 2010). May or may not include secondary energy.
- Energy footprint: Energy to make the material, not counting process-related energy such as that created in portland cement calcination.
- Carbon footprint: Total amount of greenhouse gas emissions associated with the life cycle of a material from its creation to its final disposition.

Setting life-cycle analysis boundaries

Dramatic differences in life-cycle analysis outcomes can be obtained by utilising different inputs. Listed below are common inputs that should be considered when conducting a life-cycle carbon footprint analysis on pavement materials.

Greenhouse gas life-cycle analysis is preferable to an energy-only analysis as this is the true measure of a carbon footprint. An energy-only analysis often overlooks the greenhouse gases released when limestone is converted to cement, a major part of portland cement's carbon footprint.

Life-cycle inputs all have dramatic effects on life-cycle analysis. Definitions of life-cycle terms and events should be scrutinised. These include time of first maintenance, time to first major rehabilitation, and pavement longevity. In these areas, milling and overlays should be classified as expected maintenance activity associated with asphalt pavement, not major rehabilitation. Similarly, the life cycle of a pavement should be considered 100 years—that is the standard life-cycle analysis timeframe.

Pavement impacts on external energy requirements should not be included in life-cycle inputs. This includes such issues as lighting requirements, urban heat island effects, associated building energy requirements, and vehicle fuel economy, each of which can be reviewed separately.

ISO life-cycle standards do not define boundaries of a life-cycle analysis, they just provide a framework on how to account for greenhouse gas emissions. Stating that a life-cycle analysis has been conducted in accordance with ISO standards does not validate its credibility or appropriateness. The boundaries of that analysis must be scrutinised.

COLAS PAVING THE WAY FORWARD WITH HEALTH AND SAFETY

- The Sabita BitCert Certificate acknowledges the commitment of companies to ensure that they are legally compliant with the occupational health and safety laws of South Africa during the handling and application of bituminous products.

  During December 2010, the facilities at the Colas Epping plant were audited for compliance with the Sabita Health, Safety and Environmental (HSE) Charter requirements and were duly awarded the prestigious BitCert Certificate. This certification is applicable to specific facilities where companies handle, manufacture or transport bituminous products. It is the first step towards qualifying for the HSE Award. In addition, it underscores the internationally accepted principle that the ongoing improvement of mechanisms to ensure the wellbeing of workers and conservation of the environment is an obligation, not a choice.

  We are continually striving to ensure that all staff members at our various Colas sites understand the importance of safety procedures. We all need to appreciate that health and safety is everyone's business and everyone's responsibility.

Anthony Petersen, Safety Manager, and Peet Smith, Cape Town Branch Manager, proudly displaying the Sabita flag at the Colas Epping plant.

Colas Cape Town on their Safety Day held on 21 and 22 June 2011.

Every year each branch allocates two days to Health and Safety, with all the employees participating. This includes medical screening, product safety training, hazards and risks, exercises, environmental awareness and many more activities.

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- *www.colas.co.za*

COLAS

The road forward

First phase of new premix design manual completed

An inception report, representing the first phase in a multi-faceted project to develop a comprehensive premix asphalt design method for South Africa, has been completed, and outlines the scope and objectives of the project, including the management structure to be adopted for the forthcoming aspects of the overall undertaking.

Commissioned by Sabita and authored by Erik Denneman and Benoit Verhaeghe of the CSIR Built Environment, the inception report lists the components to be managed by various groups of experts, and also provides details on the background, scope, challenges and proposed methodology in the various technical fields.

Background

The design methods for asphalt mixtures in South Africa have traditionally focused on the design of hot mix asphalt (HMA). The most recent update of the HMA design method was published in the form of an interim design guide by Taute *et al* (2001), supplemented by Sabita Manual 24: *User guide for the design of hot mix asphalt*. The interim design guideline came about as a response to changes in traffic loading, design practise, and mix types since the introduction of the Marshall-based design described in TRH8:1987.

An important new aspect in the interim guideline document was the shift towards performance based specifications, a trend that has found much support both locally and internationally. The interim guidelines, as the name implies, were intended as a preliminary product, to be updated as the proposed methodology was validated. Significant developments in premixed asphalt technology have taken place since the publication of the interim design guidelines almost a decade ago, but these have not yet been translated into a holistic review of the design methodology in South Africa. A need exists to update the South African design methods for asphalt mixtures, particularly in the light of the following developments:

- The revision of the *South African Pavement Design Method* (SAPDM) currently underway. The revised SAPDM will allow for direct linkages between asphalt mix design, structural design and field performance in terms of resilient response and damage evolution. In current South African practice the design of asphalt mixes and the mechanistic-empirical design of the pavement structure are generally treated separately;
- The increase in the application of mix types that cannot be classified as conventional hot mix asphalt and require alternative design methods, such as warm mix, cold mix, reclaimed asphalt mixes, and high modulus asphalt (HiMA). This is the reason for the shift in focus in this document from HMA to premixed asphalt in general;
- International and local advances in asphalt technology;
- Increase in volumes of heavy vehicles on South Africa's roads;
- A demand for higher performance mixes, often leading to more sensitive mix designs.

Furthermore, the methodology proposed in the interim design guide has never been properly validated. A need was identified for a consolidated design manual containing well-validated methods to replace the existing guidelines.

The project has been structured in four phases:

- Phase I: Establishment of a project management structure (Inception Report);
- Phase II: State-of-the-art review with recommendations;
- Phase III: Experimental work and development of the design manual; and
- Phase IV: Dissemination and entrenchment into practice.

The scope and methodology of the manual will cover all premixed asphalt types currently used in South Africa, including bitumen rubber mixes, large aggregate mixes for bases (LAMBS), dense graded mixes, porous asphalt, cold mix, stone skeleton mixes (SMA), ultra thin friction courses (UTFCs), HiMA and warm mix technology.

For some of these mix types, the existing design methods may be adequate, for others a laboratory study will be required to improve the design method and to set relevant performance criteria.

Inputs from industry

The key issues that need to be resolved by the experimental study will be based on inputs received from the industry, complemented by the outcomes of a detailed literature study. In Phase II of the project a concise evaluation of the effectiveness of the design methods currently employed by industry will be conducted. Apart from a literature study to identify areas of improvement, experts in the industry will be consulted to identify areas in the current design methodology requiring improvements. Based on the findings from literature and outcomes of the survey, an experimental plan will be developed, which will be executed in Phase III of the study.

The objective of Phase III is to execute the experiment plan in order to validate the mix design methodologies proposed in Phase II. In parallel with the experimental programme, the drafting of revised guidelines on mix type selection, aggregate packing, binder selection, volumetric design and performance testing, will be conducted based on the state-of-the-art studies in asphalt design and the integration of local experience in the mix design system.

The guidelines and protocols will also cover performance evaluation, building in the concept of risk, as well as guidelines on quality assurance, quality control and pro-forma specifications. As part of the revision of SAPDM the performance of mix designs in the field will be assessed. This can serve as a basis for the validation of the methodologies and specifications devised in this project.

A simple schematic of the proposed project management structure is given in Figure 1. At this stage, it is proposed that the process be driven by Sabita members and that it should not be incorporated into the structures of the Road Pavement Forum (RPF). Rather, it is foreseen that healthy interaction should be established with this forum for the purpose of periodic appraisal of outputs and, ultimately, to facilitate implementation.

The lead group will comprise Sabita's Technology Development Focal Point.

A team of experts from the CSIR BE has been identified and project leaders appointed for the 10 components of Phase II, and a questionnaire will be developed to be used in a survey of industry experts. In addition, a pool of 43 industry experts has been identified for possible inclusion in the industry survey, and this group may also be approached for reviewing processes throughout the project.

It is expected that in the later phases of the project, more than one project team will have to be established to undertake studies in areas such as:

1. Component materials:
   a. Aggregates;
   b. Binders.
2. Volumetric and packing considerations and mix type selection.
3. Performance characteristics and structural design.
4. Construction.
5. Quality assurance/control.

The inception report notes that once its findings and proposed management structure are ratified by the client, the experts and stakeholders will be informed of the project plan by the project team so that Phase II of the study can begin.

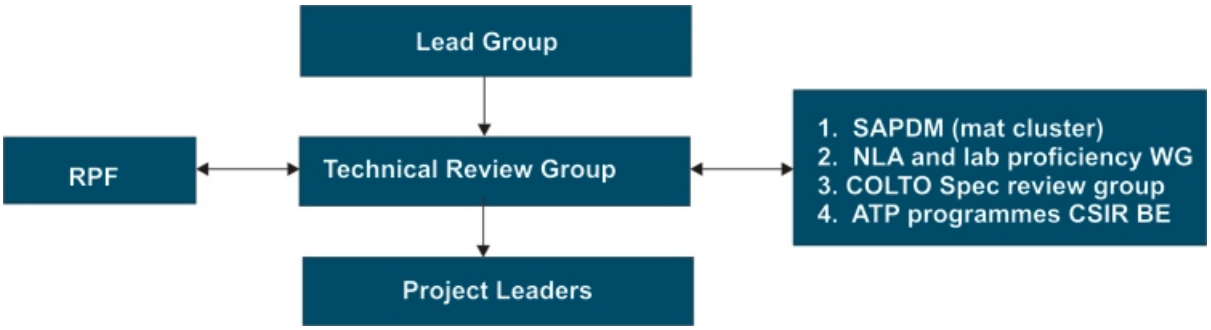


Figure 1. Proposed management structure

Strategy outlined to implement a national transport master plan

Rob Tarboton, Pr Eng., SSI Engineers and Environmental Consultants

In the face of an expanding and rapidly urbanising population, increasing traffic volumes on all modalities, linked to increasing capacity shortfalls in road, rail, port/pipeline and airport infrastructure, a far-reaching National Transport Master Plan (NatMap 2050) has been developed to guide transport development in South Africa up to the year 2050.

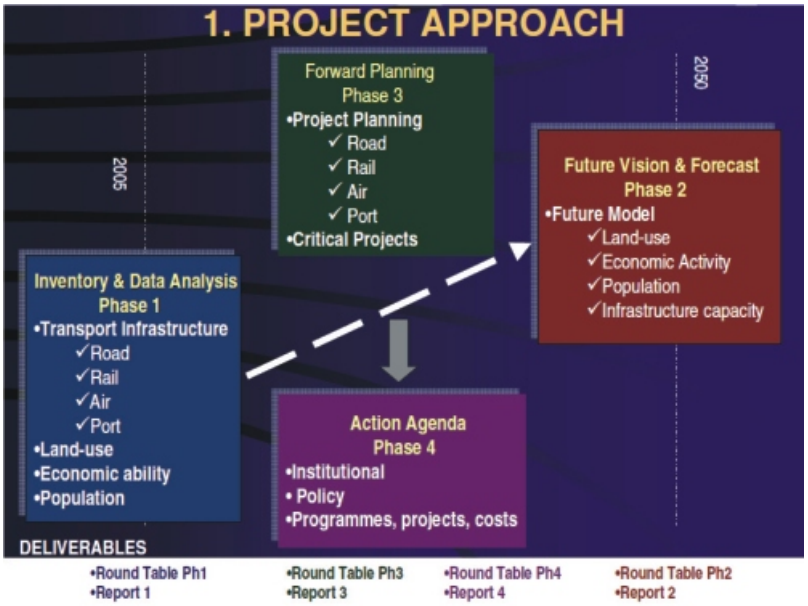
Undertaken by the Department of Transport in cooperation with the nine provinces and other stakeholders (including SANRAL, Transnet, PRASA, and ACSA, amongst others) the goal of this master plan is "to develop a dynamic, long-term, sustainable land use/multi-modal transport system framework for the development of networks, infrastructure facilities, interchange termini facilities and service delivery."

Three consortia were appointed to develop NatMap 2050, i.e. SSI Engineers and Environmental Consultants, Aurecon, and Ingérop. Another group of consultants, coordinated by Econ e Pele Consultants, synthesised the provincial plans for integration into the national plan. The development was project managed by Lanfranc Situma of the Department of Transport.

Four phases

NatMap 2050 was developed in four phases:

- The Phase 1 inventory report identifies the status quo relating to the supply and capacity of transport, the main demand side drivers, such as population distributions, land use and economic activity, as well as problems and deficiencies;
- The Phase 2 report analyses the data from phase 1 and identifies possible scenarios in terms of demographics; economics; energy supply and demand; passenger transport operations; freight transport operations; and transport infrastructure as well as issues and problems arising;
- The Phase 3 Forward planning report translates the future demographic, socio-economic and land use characteristics into transport demand and considers the impact on infrastructure and operations to accommodate the projected future demand. Specific actions were recommended for implementation to cater for future demand;
- The Phase 4 report outlines an action agenda for the identified projects. Financial, institutional and legal requirements for the successful implementation of the National Transport Master Plan are also provided.



The status quo:

Roads: While SANRAL's road network is generally fair to good, the remaining roads demand both maintenance and upgrading, and issues such as the rise in heavy vehicle traffic, overloading and road safety remain critical;
Rail: The mainline rail infrastructure is generally fair to good, but the network is generally under-utilised, rolling stock is old and the narrow gauge in current use is outdated;

Airports: Mostly in good condition, but some airports will reach saturation before 2050;
Ports: Container throughput is approaching capacity in respect of both port facilities and land transport infrastructure;
Pipelines: Pipelines are operating at capacity, diverting freight to the road network.

Analysis shows that South Africa's population is expected to rise from 47-million to 67-million by 2050, linked to significant immigration to Gauteng. World oil scarcity is inevitable and transport costs can be expected to rise significantly. Imperative transport strategies to be developed should include:

- integrated, high quality public transport, developed within a framework for further refinement;
- functioning linkages between all major towns and cities using optimal modal mix;
- extension of the integrated rapid public transport network for intra-city travel.

NatMap 2050 recommendations:

1. Road maintenance:

- Focus on the strategic network, i.e. roads of national importance;
- Eliminate the maintenance backlog of about R50-billion;
- Institute periodic and routine maintenance (about R12,6-billion/year.
- Capacity upgrades - add lanes when roads become heavily congested;
- Promote public transport investment;
- Develop public transport;

2. Rail network:

- Improve regional freight and passenger services (take passengers and freight off the roads);
- Institute vertical separation of infrastructure and operations;
- Institute a Rail Infrastructure Agency;
- Provide access for private operators;
- Phase in standard gauge for high speed rail;
- Monitor and plan for new developments in respect of greenhouse gases, fuel, electricity and ore exports.

3. Airports:

Capacity upgrades to include at least one other major airport in Gauteng before 2050, and plan the same for Cape Town and Durban from 2040/2050 respectively.

4. Ports:

Integrated future planning to include the ports of Durban (Bay of Natal and Durban South) and Richards Bay, and the location of container terminals, including an inland container port.

5. Pipelines:

A new multi-purpose pipeline between Durban and Johannesburg to be completed by December 2012, and the Kendal-Matala pipeline due for completion within the next year.

Institutional changes

The above will require the following selected institutional changes:

- Establishment of a multi-modal policy forum in the DoT;
- Expansion of the DoT's strategic policy responsibilities to include rail, marine and aviation divisions;
- The formation of a Transport Economic Regulator responsible for all modes with specialised units per mode to allow for regulated competition;
- Establishment of a road weight distance charging entity;
- Formation of a Rail Infrastructure Agency to manage all rail networks and allow fair access to more passenger and freight operators;
- Allowance for more competition between operators;
- Evaluation of the effectiveness of entities such as the provincial departments of roads or agencies to determine whether any changes need to be effected;
- Reorganisation of the DoT for regulated competition.

Revised funding strategies and new revenue collection systems - including user charges using intelligent transport systems - will need to be devised to fund the implementation of the NatMap 2050 recommendations.

SPONSOR MEMBERS

BP SA (Pty) Ltd

P.O. Box 1806, Durban 4000
Tel 031 2758867 Fax 031 2652701

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ORDINARY MEMBERS

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ASSOCIATE MEMBERS

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Namibia Technical Services cc	P.O. Box 30623 Windhoek Namibia	Tel +264 61 215324 Fax +264 61 215327
Neil Sobotker & Assoc. cc	P.O. Box 521 Kraaifontein 7569	Tel 021 863 2020 Fax 086 5539719
PD Naidoo & Assoc. (Pty) Ltd	P.O. Box 7786 Roggebaai 8012	Tel 021 4182929 Fax 021 4186440
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AFFILIATE MEMBERS

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Chemimpo SA (Pty) Ltd	P.O. Box 1378 Randburg 2125	Tel 011 2932048 Fax 011 7873513
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SA Road Federation	P.O. Box 31577 Braamfontein 2017	Tel 011 4035604 Fax 011 4037736

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National Asphalt Pavement Association (NAPA)
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Southern African Bitumen Association (Sabita)
Postnet Suite 56, Private Bag X21
Howard Place 7450
South Africa

Tel: +27 21 531 2718
Fax: +27 21 531 2606

email: info@sabita.co.za
www.sabita.co.za