HEAVY DUTY PAVEMENT – NEW ASPHALT DESIGNS MEET EXTREME CHALLENGES

BY

DIPL. ING. MATTHIAS NOELTING, GLOBAL BUSINESS MANAGER ASPHALT ADDITIVES OF SASOL WAX GMBH, GERMANY,
DIPL. ING. JENS ARNOLD, TECHNICAL MANAGER ASPHALT ADDITIVES OF SASOL WAX GMBH, GERMANY, AND
BEN JONES, SALES MANAGER ASPHALT ADDITIVES OF SASOL WAX GMBH, GERMANY

1. Summary

Air traffic and container shipping are growing globally in excess of 10% per annum. The existing airport and container port infrastructure in most countries predate this exploding development and many ports and airports are meeting the end of their capacity or the end of the life of their pavement.

Asphalt pavements are a superior alternative with view to flexibility in construction compared to concrete and due to the fast usability after being laid. The demand calls for asphalt designs that offer high durability, have a bearing capacity similar to concrete and in some cases must fulfil additional requirements e.g. resistance to high shear forces caused by vehicles or planes turning with an extremely small radius. Further the designs must enable the contractors to safely build a high quality pavement within extremely ambitious timeframes because it is impossible to close large sections of ports or airports for extended construction periods.

This paper displays data on how these targets are reached by combining binders modified with polymers and wax together with specific aggregate grading curves. Examples shown are pavements used in the Hamburg container ports and a special design for the runway of the Airbus factory in Hamburg preparing it for the A380. Further it will be shown how very similar mixes are adapted for use in perpetual pavement designs on roads with high axle loads.

2. History

Pavement construction has a very long as well as exciting history. The variety of climate, topographical and geological conditions is as diverse as surfaces of ‘natural’ pavements. Construction materials include grass, gravel, ice, sand, rocks and water. Ever increasing mobility resulted in more and larger roads, as well as increased capacity and number of vehicles. Transportation has grown immensely over the past decade and in most parts of the world the traffic growth has overtaken construction of infrastructure. Therefore, today a road has to accommodate more cars as well as more and larger trucks. An airport runway has to carry more and also heavier planes and container terminals are meeting the most extreme challenges. While a simple gravel path was sufficient for the first migrations, nowadays cars, trucks and even planes require highly stable and sophisticated constructions.

The development of pavement construction spans from the mid 18th century to the present. French road construction engineers first developed new techniques for paving roadways[1]. Roads were paved in several layers; the sub-base was born, even though both layers only contained sand and gravel. On March 13th, 1902 in Monaco, the first tar street was laid, giving people the new experience of a dust-free and smooth ride[2].

[1] Roads and Highways, Encyclopaedia Britannica 2005
[2] Docteur Goudron, W. Kämpfen, 1944

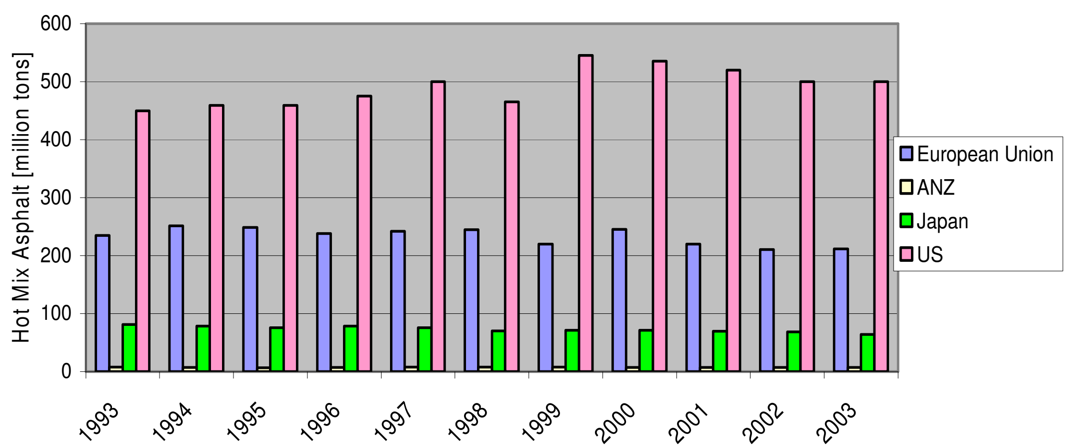
The following years engineers of all countries discussed pavement concepts and shared knowledge about tar and bitumen construction methods. Single and double layers were discussed and even ‘heavy courses’. The development went from single and double surface treatments to so-called ‘heavy courses’. The Pavement concepts were chosen to meet the then existing specific traffic requirements. By the mid 1920s the use of tar and bitumen construction was rapidly growing, mixing plants were built, steam-powered and later also motorised rollers were used.

After WWII a new era of pavement construction began. Currency reform and an improved supply of materials allowed the ever increasing demand for bituminous mixtures to be fulfilled. Bitumen was preferred to tar due to better aging resistance and reduced temperature sensitivity. Concept and design of pavement construction were changed and optimised according to increasing requirements. Higher payloads further triggered the application of polymer modified bitumen and the design of Stone Mastic Asphalt.

3. Market Evaluation

Although most countries face strong theoretical demand for road construction and maintenance, most mature economies display the opposite. At best the infrastructures are kept at existing levels but more and more countries face an increasing backlog of maintenance and only the most necessary new roads are being built. Net assets are being consumed on a large scale. The asphalt industry in mature economies was stagnating or even shrinking in the past decade.

Total Production of Hot Mix Asphalt from 1993 to 2003, in million tons[3]



This phenomenon is triggered by cuts in public spending for government maintained infrastructure. Heavy duty asphalt constructions, however, are very often demanded for building sites that are controlled and managed by private sector companies. Asphalt demand, or more precisely: potential asphalt demand, for Ports, Container Depots, Warehousing and Transit Yards, Airports and other demanding projects is detached from the stagnation in road construction and experiences rapid growth. New challenges and opportunities await the asphalt industry to conquer market share in a much faster growing sector than public roads.

In 1938 just more than 200,000 people travelled by plane. Today the Northern runway of Frankfurt Airport alone has to accommodate more than 200,000 flight movements per year. Each year more than 1.8 billion people travel by plane using approx. 15,000 planes. In every minute of each day approx. 400,000 people are in the air.[4]

[3] European Asphalt and Pavement Association, www.eapa.org
[4] Salzburger Nachrichten, March 14th, 2002

The runways of European airports handle 8 million flight movements per year, worldwide we are looking at 30 million flight movements annually. This number is expected to even double in the next 15 years. But not only is the number of flight movements growing. New and heavier airplanes such as the new Airbus A380 have higher axle loads, requiring longer, wider and more sophisticated runways and taxiways.

Container terminals face even more challenging conditions. The container turnover is exploding worldwide. Every container terminal of the ten busiest terminals has at least doubled their container turnover over the last 10 years. Twenty years ago 50 million containers were shipped annually; in 2004 this number grew to 350 million containers.[5]

An example from our hometown: The Hamburg port authorities counted 1.8 million containers in 1989. The extensive expansion in the last years ensured that Hamburg could handle 7 million containers in 2004. The trend predicts unbroken growth. The Hamburg Port authorities expect 18 million containers per year by 2015 which means new container terminals are needed.[6] These terminals must meet the growing challenges. The demand for more sophisticated coordination, automation, larger heavier container carriers and consequently highly sophisticated pavement constructions is growing. Today's business models do not accommodate big allowances for capacity reserves. Construction and maintenance of terminal pavement must be quick and must be modular. Asphalt is the optimal material for this demand. If the necessary expansion does not take place, container terminals become the bottleneck of the world economy. China for example invests more than USD 35 billion annually to expand capacities and set the conditions for growth.[7]

4. Heavy duty pavements

4.1 Known concepts of heavy duty pavements

Heavy duty pavements have met new challenges over the past decades. Traffic frequency and axle loads have been increasing. Roads, airport pavements and container terminals can only cope with high payloads if they have excellent deformation resistance properties. The basic concept is to use a structural concept with base, binder and wearing course. Each layer is tailored to resist specific stresses.

The base course is designed to resist fatigue cracking. The binder course must be designed to carry most of the traffic load (figure 1). It must be highly stable as well as durable. The wearing surface must also be resistant to rutting and has to protect the asphalt system against temperature variations, water, moisture and UV-light.

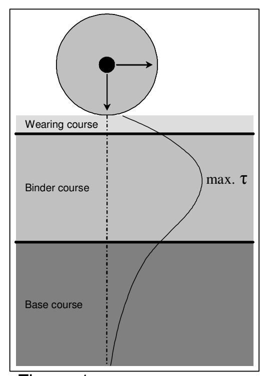


Figure 1

The key issue has always been to design stable and durable asphalt.
One of the requisites for stable asphalt are hard bitumen grades. When no hard bitumen grades were available, stable asphalt mixes could only be achieved by formulating with relatively low mortar content in order to maximise load bearing of the mineral skeleton and to eliminate negative effects caused by deforming soft binders. The resulting high void content due to missing mortar endangers the durability of the asphalt. Accelerated aging due to UV-light, water and air penetrating the asphalt mix are often limiting the life of the construction. The asphalt designs were in tendence leaning towards enhanced stability but had to sacrifice durability.

In conventional asphalt design sufficient void content is always necessary to allow relaxation of the asphalt system to avoid permanent deformations (rutting). A too low void content in combination with a relatively soft binder and heavy traffic loads results in permanent deformations.
Increasing traffic density and higher payloads have triggered the application of various additives and new bitumen grades.

[5] www.hafen-hamburg.de
[6] www.hafen-hamburg.de
[7] International Maritime Organization, www.imo.org

Additives such as natural bitumen (e.g. Gilsonite or TLA) resulted in much stiffer bitumen grades, the amount of mortar could be increased again. The void content was decreased, resulting in more durable asphalt mixes. However, the disadvantage of modification with natural bitumen is that they are difficult to compact and quite expensive.

With the arrival of the PmB technology another window opened. But the first PmBs were based on relatively soft base binders. The polymer content, in Europe approx. 3%, made possible the formulation of asphalt with less voids because the relaxation was taken over by polymer. However the first materials did not show the required deformation resistance for container depots or other very demanding uses.

The next step forward was the introduction of PmBs of the second generation such as very hard PmBs (PEN between 20-30) and PmBs of increased polymer content with much higher deformation resistance. Asphalt systems with these binders fulfil stability and durability requirements but are very viscous systems. The asphalt must be mixed at temperatures above 175°C for good handling and safe compaction. Such asphalt is sensitive to adverse circumstances such as low ambient and substrate temperatures. They need strict management of logistics to guarantee arrival with sufficient temperature reserve on the building site. High temperatures require high energy input, may cause fuming and can impair the polymer properties.

4.2 New concept "Black Concrete"

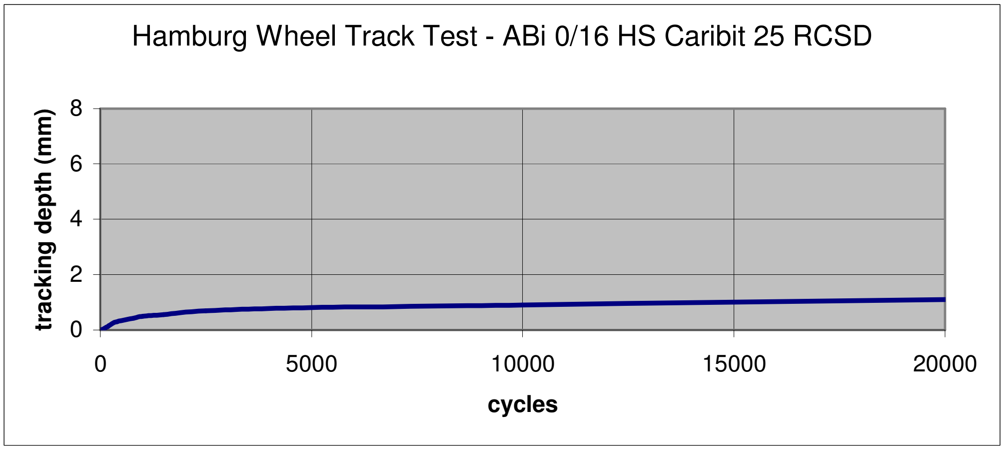
The last decade has seen the introduction of many new asphalt additives. Amongst these additives is Fischer Tropsch Paraffin. The commercially available product Sasobit® is used to lower viscosity of bitumen and thus asphalt in the hot phase. The unique characteristics of the material also provide additional deformation resistance[8]. The combination of very hard PmBs with Sasobit® eliminates all the problems encountered with hard PmBs and the system is further enhanced by Sasobit®'s induced stability. A PEN 20-30 PmB combined with 3% Sasobit® yields a PmB somewhere in the range of PEN 15 with a significantly reduced viscosity at mixing and paving temperature compared to the original PEN 20-30 material. Such a system combines various advantages such as elastic properties of PmBs, the stability/stiffness of PEN 15 bitumen and superior workability.

The combination of hard PmBs and Sasobit® allows a significant reduction of the void content. Relaxation of the asphalt system becomes less important as the new binder system is much stronger. The target is to design and compact asphalt to a void content of 3-4%. These voids and the elastomer component in the system provide the still necessary elasticity and relaxation. The minimal void content in this asphalt leads to a reduction in aging and stripping sensitivity. An asphalt skeleton with a low void content is attained if some of the larger aggregates are replaced by finer ones. In past decades the reduced amount of large aggregates would result in less stability of the asphalt system but the new, very hard bitumen systems more than compensate for the effects of the necessary shift to more fines in the grading curve. Consequently this results in extremely stable and durable asphalt compositions.

A realistic and demanding test method for durability and deformation resistance of pavement is the classical Hamburg Wheel Tracking Test which measures the tracking depth. A specimen is exposed to a standard load bearing steel wheel passing in 20,000 cycles over the exact same specimen area that is submerged in a water bath at 50°C. It has been demonstrated consistently that SMA produced using a C320 bitumen without Sasobit® showed rutting of approx. 6.5mm whereas the same mix containing bitumen modified with 3% Sasobit® showed under identical test conditions only approx. 2.3mm (i.e. a decrease of 4.2mm or 65%).

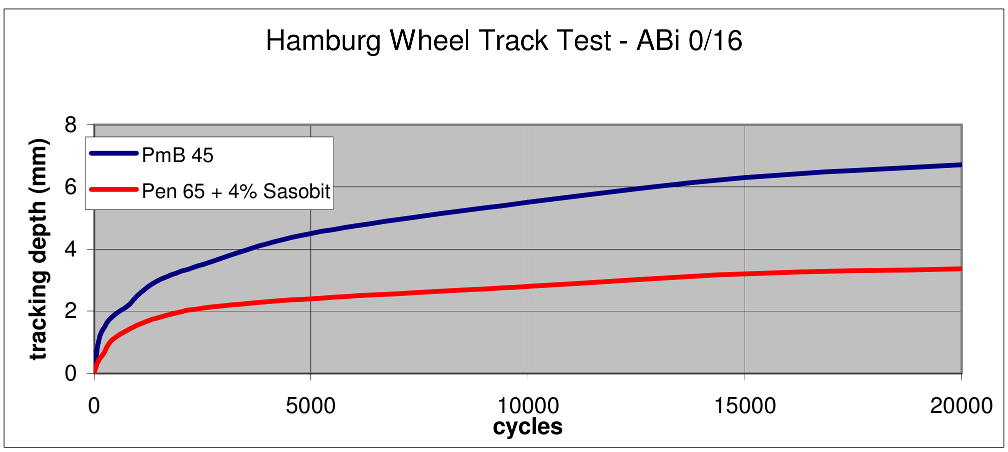
The following graphs show test results of Hamburg Wheel Track Tests carried out on slabs of three different binder courses.

[8] K. Damm, J. Abraham, T. Butz, G. Hildebrandt, G. Riebesehl: Asphalt Flow Improvers As ‚Intelligent Fillers' For Hot Asphalts – A New Chapter In Asphalt Technology, Bitumen 1/2002



Test 1: asphalt-labor Arno J Hinrichsen, Test 4259S/04, 27/09/04

The test displayed above was carried out by the laboratory asphalt-labor in September 2004. After 20,000 cycles in a 60℃ water bath (the standard is 50℃), the tracking depth was very low, only 1.1mm. This asphalt formulation was used for the binder course of the container terminal Tollerort in Hamburg (see 5.1 case studies - Tollerort).
The binder of the asphalt is Caribit 25 RC SD which is a co-modified Shell PmB with increased polymer content and 4% Sasobit®.



Test 2: Asphalta Prüf- und Forschungslaboratorium GmbH, Test 806099, 31/03/98

The second test was carried out by the laboratory Asphalta in March 1998. The tracking depth of the binder course 0/16 after 20,000 cycles was respectively 6.7mm (PmB 45) and 3.4mm (Pen 65 + 4% Sasobit®).

It should be noted that these ruts are deeper than the tracking depth displayed in the graph Test 1 even though Test 1 was conducted at 60℃, a much more demanding temperature, whereas the second test was carried out at 50℃.

The three wheel track tests support that highly stable binder courses require hard bitumen grades. The combination of Sasobit® and hard PmBs show by far less deformation after 20,000 cycles even though the hard co-modified asphalt was tested at pavement temperatures of 60℃ instead of 50℃.

These very dense and stable binder courses require a much thinner wearing course because the design already provides superior rut resistance. The function of a wearing course on top of these binder courses is to seal and protect the system against environmental impacts like water, UV-radiation, etc. rather than to contribute to the stability of the asphalt package.

A well protected deformation resistant binder course is expected to last 40 years or even more, under the assumption that the wearing course is well maintained and/or replaced once or twice during that period. The wearing course can be reduced to 2.5-3.5cm. Thin layers are almost completely rut resistant so the system gains in stability compared with conventional systems. However, if thin wearing courses are being built, a few essential rules have to be considered:

1. A very good tack coat must be faultlessly applied
2. A hard bitumen must be used
3. Thin courses do not tolerate any compaction failures
4. The binder course must be very hard and sufficiently dimensioned. It must not rut.

Most thin layers fail because of lack of compaction.

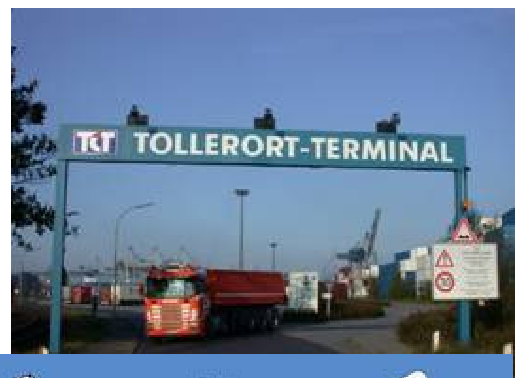
5. Case Studies

Sasobit® modified heavy duty binders have been used in numerous large projects in Germany. A selection of projects is described below. The new binders were used in more conservative designs as well as in designs that completely replaced the wearing course with a seal only.

<u>5.1 Tollerort Container Terminal (Hamburg)</u>

The existing terminal area of currently 377,000 m² will nearly be doubled up until 2008. The present capacity lies at 950,000 TEU p.a.

In summer 2004, a surface of 70,000 m² was built using a very hard PmB with Sasobit®. The subgrade was newly reclaimed ground (sand) with a compacted layer of coarse unbound gravel (0/32 mm). A very restrictive budget of the port authority allowed an asphalt layer of max. 14 cm thickness.



Previous surfaces had been built with a highly SBS modified binder produced by the Dutch company Ooms. The authorities agreed to innovate the binder because of deformation problems in the last built surfaces. They wanted to keep the basic design, using an 8cm binder course and a 6cm SMA overlay since the Hamburg wheel tracking tests for both mixes with the new binder were far superior than those with the Ooms binder.

Binder course: 8 cm, 0/16 S

Bitumen: Caribit 25 RC SD, a PEN 25 PmB binder of Shell with increased polymer content and 4% Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%]	
			actual value	nominal value
0.0 – 0.09	9.2	9.2	filler 9.2	≥ 7.0
0.09 – 0.25	3.5	12.7		
0.25 – 0.71	5.3	18.0	sand 18.9	rest
0.71 – 2.0	10.1	28.1		
2.0 – 5.0	15.1	43.2	> 2mm 71.9	≥ 70.0
5.0 – 8.0	10.4	53.6		
8.0 – 11.2	11.8	65.4		
11.2 – 16.0	31.2	96.6	max. size 34.6	≥ 25.0
16.0 – 22.4	3.4	100.0		

Wearing course: 6 cm, SMA 0/16

Bitumen: Nypol 25 HR, PEN 25 PmB binder of Nynas with increased polymer content and Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%]	
			actual value	nominal value
0.0 – 0.09	12.2	12.2	filler 7.9	–
0.09 – 0.25	3.3	15.5		
0.25 – 0.71	4.4	19.9	sand 16.2	–
0.71 – 2.0	8.5	28.4		
2.0 – 5.0	6.3	34.7	> 2mm 71.6	
5.0 – 8.0	2.1	36.8		
8.0 – 11.2	14.2	51.0		–
11.2 – 16.0	44.1	95.1	> 5mm 65.3	
16.0 – 22.4	4.9	100.0		

This is an example of a more conventional design where the 0/16 mm SMA is designed in a way that it is a vital contributor to the stability of the whole asphalt package.

5.2 Container terminal Eurogate (Hamburg)

The Eurogate Terminal area of presently 1.4 million m² will be expanded by 350,000 m² until 2010. The current handling capacity is 4 million TEU per annum

This terminal alone anticipates 18.5% growth in 2005. Because larger ships require faster handling, the actual storage capacity will be doubled from 300,000 to 600,000 TEU by extension and reorganization of the terminal.

In the reorganisation phase the terminal will be equipped with new container bridges for Post Panamax Ships. In 2005 50,000 m² of old concrete pavement was replaced by asphalt. Eurogate had challenged the industry in early 2005 by issuing a tender allowing both concrete and asphalt. The Tender was won by an asphalt concept.

The design is revolutionary because it uses 50% RAP in a heavy duty project. The RAP is a graded RAP coming from one single source and has therefore no variation in its composition and also the binder content in the RAP has been found to show constant properties across samples taken during all stages of the milling process. The budget for the project does not accommodate any polymer modified binders. The RAP is "married" with virgin material mixed with a PEN 50/70 binder modified with 4% Sasobit®.. A batch plant with double drum is used to produce the mix. The effective binder in the asphalt binder contains 2% Sasobit® and has a PEN between 25 and 30. This binder course material has a Marshall stability of 22kN and is overlaid with 3cm asphalt concrete.

Binder course: 15 cm, 0/22 incl. 50% RAP

The virgin bitumen added is a PEN 50/70 neat bitumen with 4% Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%] actual value		w/w [%] nominal value
0.0 – 0.09	8.4	8.4	filler	8.4	2.0 – 12.0
0.09 – 0.25	10.3	18.7			
0.25 – 0.71	14.7	33.4	sand	36.1	rest
0.71 – 2.0	11.1	44.5			
2.0 – 5.0	9.1	53.6	> 2mm	55.5	50.0 – 65.0
5.0 – 8.0	8.2	61.8			
8.0 – 11.2	9.3	71.1			
11.2 – 16.0	13.9	85.0	> 11mm	28.9	≥ 20.0
16.0 – 22.4	14.2	99.2			
22.4 – 31.5	0.8	100.0			

Wearing course: 3 cm, Asphalt concrete 0/8 incl. 20% RAP

Virgin bitumen: Nypol 25 HR, PEN 25 PmB binder of Nynas with increased polymer content and Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%] actual value		w/w [%] nominal value
0.0 – 0.09	9.2	9.2	filler	9.2	8.0 -
0.09 – 0.25	5.7	14.9			
0.25 – 0.71	8.1	23.0	sand	27.3	rest
0.71 – 2.0	13.5	36.5			
2.0 – 5.0	31.3	67.8	> 2mm	63.5	50.0 -
5.0 – 8.0	29.1	96.9	max. size	32.2	≥ 15.0
8.0 – 11.2	3.1	100.0			

This project has maximised the use of a highly stable binder. Polymer modification was not essential because the subgrade is a well settled base enhanced by a hydraulically bound top layer.

5.3 Airport Berlin Schönefeld, Runway 07R/25L

The runway had to be renovated because of deformations and the advent of stone loss in its anti-skid layer. The total size of the runway is 135,000 m². The renovation consumed 40,500 tons of asphalt.

The existing asphalt was milled out down to the base course and a new very dense binder was put down. Remarkable to note is that the ambient temperature during paving was between -2℃ to 5℃!

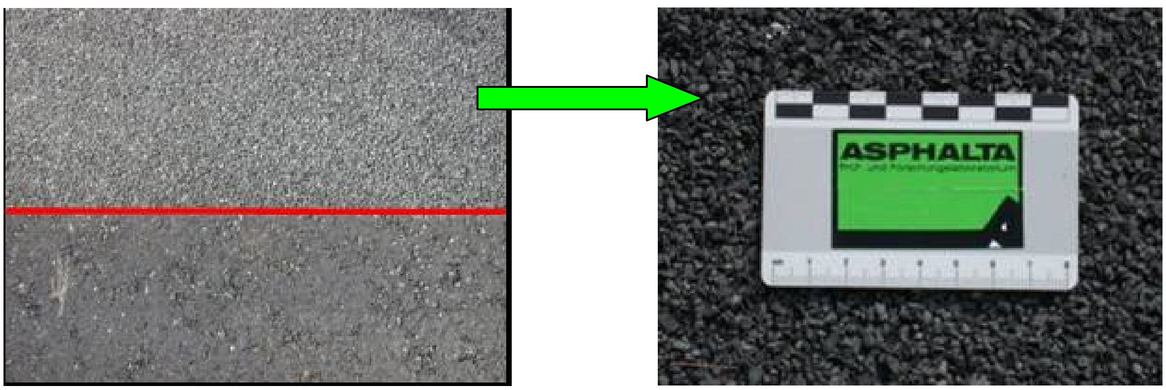
The 12 cm Binder course was paved in two layers with an Epoxy resin based 3 mm anti-skid overlay.

Binder course: 12cm, 0/16 S (PmB PEN 45 + 3% Sasobit®) paved in two layers

Following asphalt composition has been applied:

5.3% bitumen
4.0% filler
36.0% high quality crushed sand 0/2
14.0% high quality coarse aggregates 2/5
14.0% high quality coarse aggregates 5/8
10.0% high quality coarse aggregates 8/11
22.0% high quality coarse aggregates 11/16

3 mm Antiskid-overlay



The design engineer maximised the load bearing capacity of the construction by replacing the wearing course completely with an epoxy based seal which dually serves as adhesive for the anti-skid grit layer.

Remarkable is that the requirement for evenness of the surface allows a deviation of max. 3mm measured across a 4m distance. The asphalt layers had to be constructed with that evenness since the anti-skid coat has no capability of compensating for any mistakes. Once again it must be emphasized that the asphalt was laid in ambient temperatures with max. 5°C and that the mix was no hotter than 175°C!

5.4 Airbus Terminal Finkenwerder (Hamburg) – Runway

This case study shows that heavy duty asphalt is not necessarily restricted to use in a full structural asphalt design.

Airbus Industries build their planes in two locations: Toulouse, France and Hamburg, Germany. To prepare the Hamburg production site for the A380 the concrete runway of the factory had to be renovated. The runway is quite short for the giant planes and an extension is blocked by unwilling landowners who are not prepared to sell the necessary ground. Airbus reacted by covering the existing concrete runway with highly skid resistant asphalt.

Wearing course: 5 cm, AC 0/11S

Bitumen: Shell PmB Caribit 45 plus 2.5% Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%] actual value		w/w [%] nominal value
0.0 – 0.09	7.1	7.1	filler	7.1	–
0.09 – 0.25	5.2	12.3			
0.25 – 0.71	10.0	22.3	sand	35.1	Rest
0.71 – 2.0	19.9	42.2			
2.0 – 5.0	28.5	70.7	> 2mm	57.8	
5.0 – 8.0	13.5	84.2			
8.0 – 11.2	14.3	98.5	max. size	15.8	15.0 -
11.2 – 16.0	1.5	100.0			

After construction in 2004 the asphalt was cut at the underlying concrete seams and re-sealed with a highly polymer modified elastic crack filler. The AC has to withstand high braking forces. A side requirement for the asphalt was that it had to be viscosity reduced to be absolutely weather tolerant during construction. The paving window was only a single defined day. The runway cannot be closed for longer because Airbus flies components for planes in and out by transport planes and cannot disrupt this supply for longer than a day. The feat was to lay 12,000 mt of asphalt in 18 hours regardless of weather!

In 2004 Airbus had not renovated the so called turning area of their landing strip. Unlike larger airports this airfield has no system of taxiways. The planes enter the runway, taxi to its end and complete a 180° turn with almost no radius.
Only after long discussions did Airbus agree to also overlay this area with asphalt designed for ultimate shear stability.

Wearing course: 5 cm, AC 0/11S

Bitumen: Nypol 25 HR, PEN 25 PmB binder of Nynas with increased polymer content and Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%] actual value		w/w [%] nominal value
0.0 – 0.09	11.1	11.1	filler	11.1	6.0 – 10.0
0.09 – 0.25	5.0	16.1			
0.25 – 0.71	9.3	25.4	sand	30.1	rest
0.71 – 2.0	15.8	41.2			
2.0 – 5.0	20.9	62.1	> 2mm	58.8	50.0 – 60.0
5.0 – 8.0	16.3	78.4			
8.0 – 11.2	19.8	98.2	max. size	21.6	15.0 – 30.0
11.2 – 16.0	1.8	100.0			

This AC is mixed with an unusually high binder content of 6.4% as a very low void content was required to accommodate the necessary shear stability. 2kg of fibres per ton were added.

5.5 Highly frequented Industrial Road (Veddeler Damm – Hamburg)

The last case deals with the use of heavy duty construction in road design. Especially in focal points of a road network the Asphalt has to withstand incredible numbers of axles per day. This particular road is located in the port of Hamburg. After reunification of Germany, Hamburg suddenly became the Atlantic port for former East Germany, Poland and most of Czechia and Slovakia. Containers arrive and are forwarded by truck. Due to a barrier in the river Elbe all Container Terminals are in the west of Hamburg. All eastbound heavy traffic uses Veddeler Damm, a four lane road in the port to reach the eastbound Highways. Veddeler Damm is one of the 10 most and heaviest frequented roads (Autobahn excluded) in Germany. The situation is aggravated by the fact that the traffic is not flowing but often interrupted by intersections with traffic lights.

Because plans for a desperately needed new east-west connection are not proceeding Veddeler Damm was renovated in 2001 using a 3.5 cm SMA 0/8 thin overlay with PmB PEN 45 + 3% Sasobit® and an 8.5 cm binder course 0/16 with PmB PEN 45 + 3% Sasobit®. The designers were hesitant to utilize PEN 25 grades because of a difficult subgrade which shows shrinkage and swelling relative to moisture content. After 4 years the road shows zero deformation where it is built with the described design. Other sections built the year before without Sasobit® display 4-8 mm rutting.

Targets:

- Increased rutting resistance
- Workability improvement (many places with hand labour)
- Extended working window

Binder course: 8.5cm, 0/16 HS

Bitumen: PMB PEN 45 with increased polymer content + 3% Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%] actual value		w/w [%] nominal value
0.0 – 0.09	8.0	8.0	filler	8.0	≥ 5.0
0.09 – 0.25	3.8	11.8			
0.25 – 0.71	6.5	18.3	sand	20.1	rest
0.71 – 2.0	9.8	28.1			
2.0 – 5.0	12.0	40.1	> 2mm	71.9	≥ 70.0
5.0 – 8.0	11.2	51.3			
8.0 – 11.2	16.9	68.2			
11.2 – 16.0	29.2	97.4	max. size	31.8	≥ 25.0
16.0 – 22.4	2.6	100.0			

Wearing course: 3.5 cm, SMA 0/8

Bitumen: PMB PEN 45 with increased binder content + 3% Sasobit®

aggregate size [mm]	w/w [%]	res. sieving curve [%]	w/w [%] actual value	nominal value
0.0 – 0.09	12.4	12.4	filler 12.4	≥ 11.0
0.09 – 0.25	2.9	15.3		
0.25 – 0.71	3.9	19.2	sand 12.9	rest
0.71 – 2.0	6.1	25.3		
2.0 – 5.0	22.5	47.8	> 2mm 74.7	≥ 73.0
5.0 – 8.0	47.8	95.6	max. size 52.2	≥ 50.0
8.0 – 11.2	4.4	100.0		

This perpetual pavement project has to date fulfilled all expectations.

6. Outlook

We can expect that global transport will further increase and booming economies, especially China and India will push the global transport system to new frontiers. Budgets allocated to infrastructure projects have been tight over the last decade and unfortunately we will not see a turnaround soon. It is not foreseeable that budgets can keep up with the increasing trend of transport and mobility in the near future.

The lack of adequate budgets requires the application of new asphalt concepts. Reclaimed asphalt will become a very cost efficient component of asphalt layers with high quality specifications.

The concept of perpetual pavements will find its use in cities where few roads and highways must carry mass transit and where closures to traffic cause huge upsets. Transport and traffic systems are the arteries but also the bottlenecks of modern economies. Perpetual pavements last much longer than traditional asphalt concepts and will require fewer closures for repair and maintenance purposes.

The introduction of toll roads as well as privatisation of highways, airports and container terminals will further support the development of systems as described in this paper. Commercial operators of infrastructure will consider the whole life of pavements during the decision-making process. Private owners do not just look at a next legislative period; they try to minimise life cycle cost in order to maximise their income. They will conduct comprehensive cost-benefit-analysis which will show that the only way forward is to ascribe to the use of new modern asphalt systems such as perpetual design. Increasing raw material cost will further make the use of quality RAP more and more attractive.