ORGANOSILANE 'WARM COMPACTION' TECHNOLOGY FOR GREEN ROADS

Dr Ajay Ranka and Vivek Kane
Zydex Industries Pvt. Ltd
vivkane@zydexindustries.com

ABSTRACT

New Organo-Silane 'Warm Compaction' technology, apart from other green benefits, enables dropping of mixing and compaction temperatures of Hot Mixes. Although, the concept of Warm Mix Asphalt (WMA) has been around for a while, the available WMA technologies only talk of drop in mixing temperature and not the compaction temperature, which the new Organo-Silane technology does. It is therefore prudent to call this technology, a 'Warm Compaction' technology.

This paper presents the summary of laboratory studies made at Braunschweig University, Germany to assess coating efficiency of this 'Warm Compaction' technology at different mixing and compaction temperatures.

KEY WORDS

Nanotechnology, Warm Mix, Warm Compaction, Fuel saving, Low Carbon Footprint, Green, Sustainable.

1. GREEN ROADS

We have taken this earth on lease from our future generations. It is our duty to return it to them in liveable condition if not better. Striving for sustainability through prudent use of limiting natural resources and restraint in emissions is the call of the day.

As it is said, 'Nations don't build roads. Roads build a nation'. It is very important to develop road infrastructure at a brisk pace, if we want to attain / sustain high economic growth. At the same time, it is equally important to ensure that such infrastructure development is sustainable. Prudent use of limiting natural resources therefore, becomes our responsibility now, more than ever before.

There may be many ways of bringing in sustainability in building roads. Here are some of the ways in which new nanotechnology contributes to sustainability in road construction:

- Reducing the usage of limiting resources like bitumen, aggregates etc.
- Extending the life cycles of the roads, so as to defer the demand for such resources
- Reducing fuel consumption and low temperature operation leading to reduction in emission

This paper discusses the 'Low Temperature Operation' aspect of the new nanotechnology in particular.

2. CONVENTIONAL WARM MIX ASPHALT AND ITS LIMITATIONS

The concept of Warm Mix Asphalt (WMA) has been around since the 90's. It was developed in Europe in response to EEC countries signing the 1997 Kyoto Treaty to reduce greenhouse gases.

A warm asphalt mix (WAM) process has been developed in Europe and was reported by Harrison and Christodulaki at the First International Conference of Asphalt Pavements in Sydney, 2000. A more complete report was given by Koenders et al. at the Eurobitume congress in 2000. *(1)* Their paper describes an innovative warm mixture 3 process that was tested in the laboratory and evaluated in large-scale field trials (in Norway, the UK and the Netherlands) with particular reference to the production and laying of dense graded wearing courses. *(2)* Their work resulted in the development of WAM Foam, Warm Asphalt Mix with foamed bitumen. *(3)* At the Eurobitume congress in 2004, Barthel et al. introduced the use of a synthetic zeolite additive to produce warm mix asphalt. The zeolite creates a foaming effect that results in a higher workability of the mix. *(4)* Warm mixes have received some attention in Europe and Australia since around 2000. The pavement industry in North America started to give warm mixes some interest a few years later and in June 2005 the National Center for Asphalt Technology (NCAT) published two reports about the use of Sasobit, a synthetic wax, and Aspha-min, a synthetic zeolite, in warm mix asphalt. *(5, 6).*

Lower mixing temperature in case of WMA, is certainly a huge advantage, but the technology does have certain challenges as follows.

- Lower temperatures used for WMA can result in incomplete drying of the aggregates and the resulting trapped water in the coated aggregates may cause moisture damage.
- Finding the right balance between lowering the production temperatures, applying anti-stripping agents and achieving a sufficiently moisture resistant asphalt mixture might be a challenge when using WMA

This is probably the reason behind WMA technology not catching up all over the world at the pace initially anticipated.

3. ORGANOSILANE 'WARM COMPACTION' TECHNOLOGY

The available WMA technologies only talk of drop in mixing temperature and not the compaction temperature. The new Organosilane technology now allows reduction in both, mixing as well as compaction temperature.

In addition the new Organosilane technology also improves coating efficiency, leading to faster and complete coating of even the fines. This is because the Organosilane chemistry reduces the surface tension of bitumen for faster and better wetting.

The workability of the Organosilane mixes is also observed to be better and the compaction easier.

The low temperature mixing, low temperature compaction and the other benefits mentioned above are verified by laboratory studies.

4. CASE STUDY - TRANSFER CENTRE FOR THE ROAD SECTOR (TSW), BRAUNSCHWEIG UNIVERSITY, GERMANY

TABLE 1 Compositions of the type of asphalt applied

Asphalt		AC 16 B S	AC 11 D S
Bitumen		50/70	25/55-55 A
Bindemittelgehalt	M.-%	4,3	6,0
Anteil ZycoTherm®, bezogen auf den Bindemittelgehalt	M.-%	0,10	0,15
Gesteine		Gabbro	Gabbro
> 16,0 mm	M.-%	2,8	-
11,2 - 16,0 mm	M.-%	28,5	0,5
8,0 - 11,2 mm	M.-%	12,1	20,2
5,6 - 8,0 mm	M.-%	12,8	10,8
2,0 - 5,6 mm	M.-%	15,2	23,3
0,063 - 2,0 mm	M.-%	22,0	37,6
< 0,063 mm	M.-%	6,6	7,6

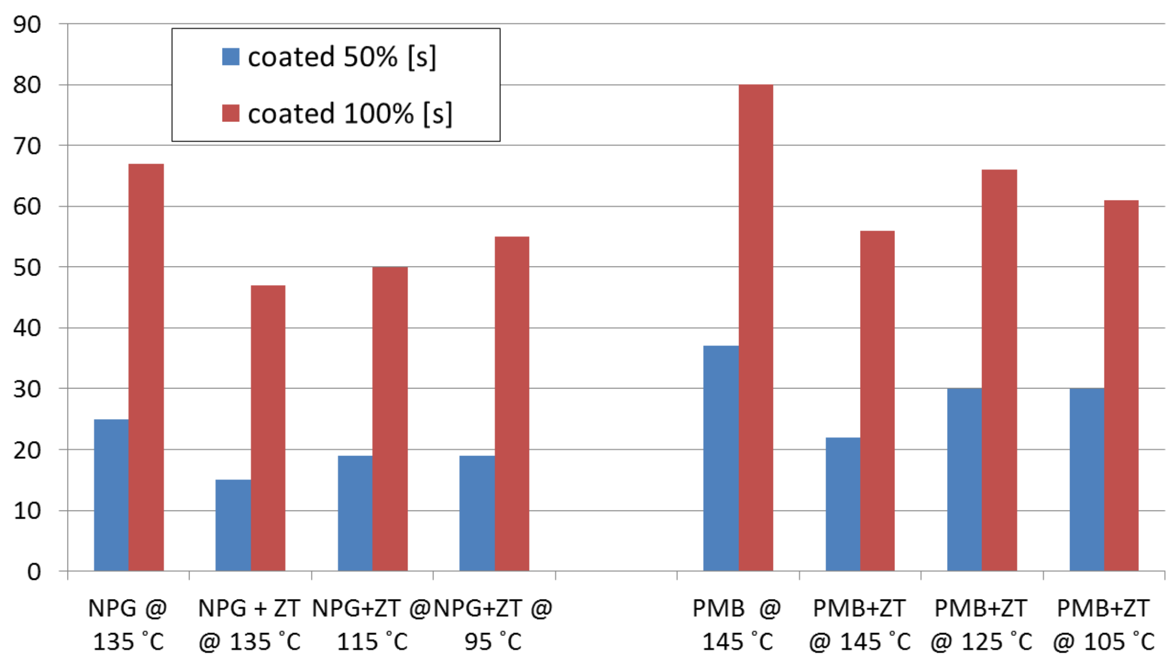

FIGURE 1 Coating Efficiency of ZycoTherm at different mixing temperatures

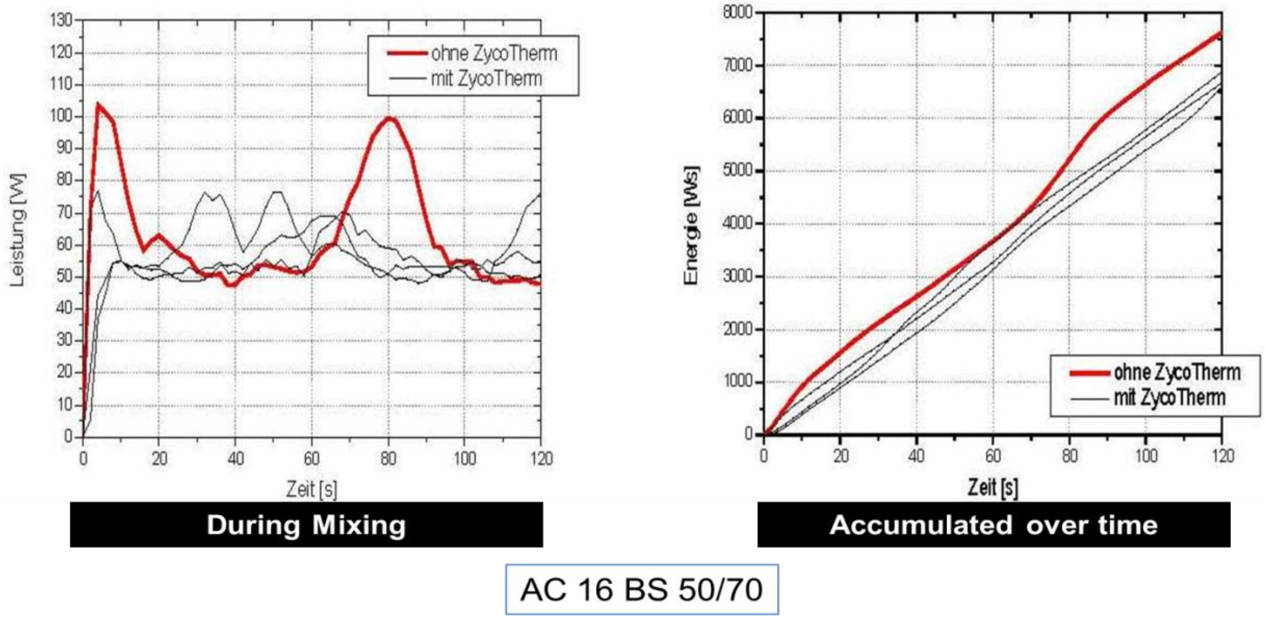

FIGURE 2 Effect of ZycoTherm on Power / Energy Consumption while mixing

Summary

- Goal of the examinations carried out here was to document the influence of the binding agent ZycoTherm® on the mixing process and to document the compression properties of asphalt.
- For this purpose, two types of asphalt that are common in Germany, an asphalt binding agent AC 16 B S with 50/70 and an asphalt concrete for asphalt surface layers AC 11 D S with 25/55-55 A, were mixed with and without ZycoTherm® and compressed at different temperatures. An overview of the variants produced is specified in table 1.
- During the mixing processes, the power consumption of the laboratory mixer was recorded and the time that the degrees of coating of 50 %, 75 %, 90 % and 100 % were reached was noted. The times for reaching the degree of coating of 50 % are specified in table 2. The mixed material is coated quicker when ZycoTherm® is added. On average, 20 % less time is required. With regard to the mixing performance, for AC 16 B S a tendency was recognised that less performance was required when adding ZycoTherm®.
- The compression resistance does not show any difference for both asphalt types when adding ZycoTherm®, as documented in table 2.
- The raw density of the asphalt mixture produced can be considered as equal for both types of asphalt.
- The densities by volume of the roller compressed asphalt test plates only indicate small differences. The void content is specified as out coming result in table 2.

TABLE 2 Overview for producing the asphalt variants

Variant	Mix type	Binder type	Addition of ZycoTherm®	Compaction Temp.	50% Coating achieved	Compaction resistance	Void content
-	-	-	-	^{O}C	s	21 Nm	Vol.-%
1a	AC 16 B S	50/70	No	135	25 s	41.6	7.0
1b			Yes	135	15 s	43.5	7.1
1c			Yes	115	19 s	42.8	7.2
1d			Yes	95	19 s	41.3	6.9
2a	AC 11 D S	25/55-55 A	No	145	37 s	37.3	4.3
2b			Yes	145	22 s	34.2	4.6
2c			Yes	125	30 s	36.5	5.0
2d			Yes	105	30 s	36.5	5.3

- For AC 16 B S, no tendency could be specified with regard to the void content. The void contents are within a narrow range so that this can be considered as equal.
- The void contents for AC 11 D S increase with reducing compression temperature. This increase however, is not within the testing accuracy so that here, only one tendency can be specified, there is no statistical security. Deviations within these ranges can still be considered as close to practice.
- As a summary, it can be stated that when adding ZycoTherm® you can reduce the time for coating the stones and with a significantly reduced compression temperature, you can achieve an almost consistent void content.

5. CONCLUSION

In summary, addition of ZycoTherm, the Organosilane additive to bitumen

1. Allows the mixing temperature to be lower
2. Gives equivalent or better compaction at lower compaction temperatures.
3. Improves coating efficiency, leading to faster and complete coating.
4. Reduces mixing effort and saves energy.

Overall, the Organosilane technology, in addition to lower mixing temperatures, allows lower compaction temperature and gives all the benefits stated above.

REFERENCES

1. Advisory note 17 – Warm Mix Asphalt – a-state-of-the-art review. Australian Asphalt Pavement Association (AAPA). http://www.aapa.asn.au/docs/no17.pdf
2. Koenders, B.G., D.A. Stoker, C. Bowen, P. de Groot, O. Larsen, D. Hardy & K.P. Wilms. Innovative processes in asphalt production and application to obtain lower operating temperatures. 2nd Eurasphalt & Eurobitume Congress, Barcelona, Spain September 2000.
3. Webpage of Shell Global Solutions. http://www.shell.com. Accessed November 2005.
4. Barthel, W., J.P. Marchand, M. Von Devivere. Warm asphalt mixes by adding a synthetic zeolite. Eurovia. www.asphamin.com. Accessed November 2005.
5. Hurley, G.C. and B.D. Prowell. Evaluation of Aspha-min® zeolite for use in warm mix asphalt. NCAT Report 05-04. National Center for Asphalt Technology, Auburn

   University, USA, June 2005.
6. Hurley, G.C. and B.D. Prowell. Evaluation of Sasobit® for use in warm mix asphalt. NCAT Report 05-06. National Center for Asphalt Technology, Auburn University, USA, June 2005.