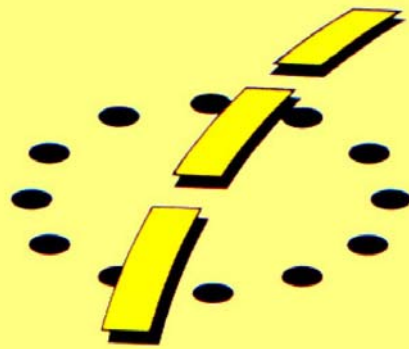


Low Temperature Asphalt



EAPA



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1. General

In the Kyoto protocol, the ratifying states agreed to lower the emission of greenhouse gases, which essentially concerns CO₂ emissions, 5% below the 1990 level in the time from 2008 to 2012. Besides other industries, the European asphalt industry also strives to contribute to this and initiate measures for emission reduction. Lower mixing temperatures and laying temperatures result in lesser emissions. As a rule of thumb, one can assume that a reduction of the temperature by 10°C results in an emission reduction by 50%. Another positive effect of the temperature reduction is a sustained improvement of the labour safety during production and paving.

In principle, there are three methods for the production of low temperature asphalt. In detail, these are based on:

1. process engineering,
2. aerogenous agents and
3. special bitumen and additives.

All methods have in common that the mixing temperature of the asphalt can be reduced by at least 20°C and up to 70°C. Here, process engineering uses different effects in order to reduce the mixing temperature of the asphalt. The method with the aerogenous agents is based on chemically bound water that is released during asphalt mixing. The additives added to the asphalt mixture during mixing or to the basic bitumen for the production of special bitumen generally concern paraffins.

2. Methods

2.1 Process Engineering

The present process engineering solutions are the KGO method (Karl-Gunnar Ohlson method), the double-coating or 2-phase mixing method and the addition of moist or moisture-retaining aggregates. The foam bitumen methods are also classified as process engineering variants.

2.1.1 2-Phase Mixing Method

The 2-phase mixing method is based on the KGO method. However, two types of bitumen with different viscosity are used here. Based on the desired viscosity level of the resulting bitumen, low-viscous bitumen is initially added to the aggregate mix. Afterwards, higher-viscous bitumen is added to this preliminary mixture. The ratio of the low-viscous bitumen to the high-viscous bitumen with reference to the total bitumen quantity is 1/3 : 2/3. Compared to conventionally produced asphalt, the asphalt mixture thus produced is supposed to be produced, laid and compacted with approximately 10°C to 30°C lower temperature levels. Reference sections are currently not available.

2.1.2 KGO Method

With the KGO method, the coarse fractions of the aggregate mix are initially coated with the bitumen. The fine aggregates, filler and sand, are added afterwards. This is supposed to result in an asphalt mix with better compacting properties so that the asphalt can be produced, laid and compacted at a lower temperature level. There are also no reference sections available here in Germany.

Aggregates in the asphalt that contain more residual moisture have a positive effect on the process-ability of the asphalt. This effect is known from using reclaimed asphalt. With hot asphalt, the residual moisture results in an effect that is similar to the foaming of bitumen. This state can be maintained throughout the entire laying phase. However, this method is not used for targeted temperature reduction.

2.1.3 Foam Bitumen

The methods with foam bitumen require largely dry aggregates as the surface tension of the bitumen is larger than that of the water. Very moist aggregates only lead to a partial wetting of the aggregates with bitumen using the foam bitumen method. Therefore, it is recommended to dry the aggregates. Asphalt mix that contains bitumen, especially with use of reclaimed asphalt, can be set by approx. 30°C lower than conventional asphalt mixes for the production temperature, laying temperature and during compacting.

The patented WAM method is a special foam bitumen method that also works with pre-dried aggregates. However, this method is a combination of the foam bitumen method and the 2-phase mixing method. With this method, the aggregates are initially coated with a low-viscous component and after with a high-viscous, foamed component. The properties of this type of asphalt remain intact over a longer period of time. With this method, laying and compacting can still take place at an asphalt temperature of 70°C to 80°C (production is at 90°C to 100°C), as countless examples in practice have shown.

2.2 Aerogenous Agents

The aerogenous agents technology is currently limited to the exclusive addition of zeolite to the asphalt during the mixing process. Zeolites are crystalline, hydrated aluminium silicates that occur in natural form and can also be produced synthetically. However, synthetic silicates are used in practice as these have stable homogenous properties. The zeolite is added pneumatically or directly conveyed mechanically to the mixer. Here the desired temperature of the asphalt mix is between 130°C and 145°C. The function of this method is based on the release of finely disperse steam by adding the zeolites to the heated aggregate mix with the simultaneous addition of the bitumen. This leads to a foaming effect that triggers a volume increase of the bitumen. The fine steam bubbles form micro-pores that increase the compaction properties of the asphalt. The steam bubbles are supposed to remain stable over time so that the low-temperature properties of the asphalt with zeolite are also preserved over a longer period of time. With this method, the asphalt temperature is lowered by approximately 30°C without changing the viscosity of the bitumen. The zeolite in a dosage of approx. 3% m/m. related to the total mix can be applied up to a mixing temperature of up to 190°C. Therefore, it is not possible to apply zeolites for temperature reduction with mastic asphalt. Practical experiences were already made with the application of zeolites with rolled asphalt.

2.3 Special Bitumen and Additives

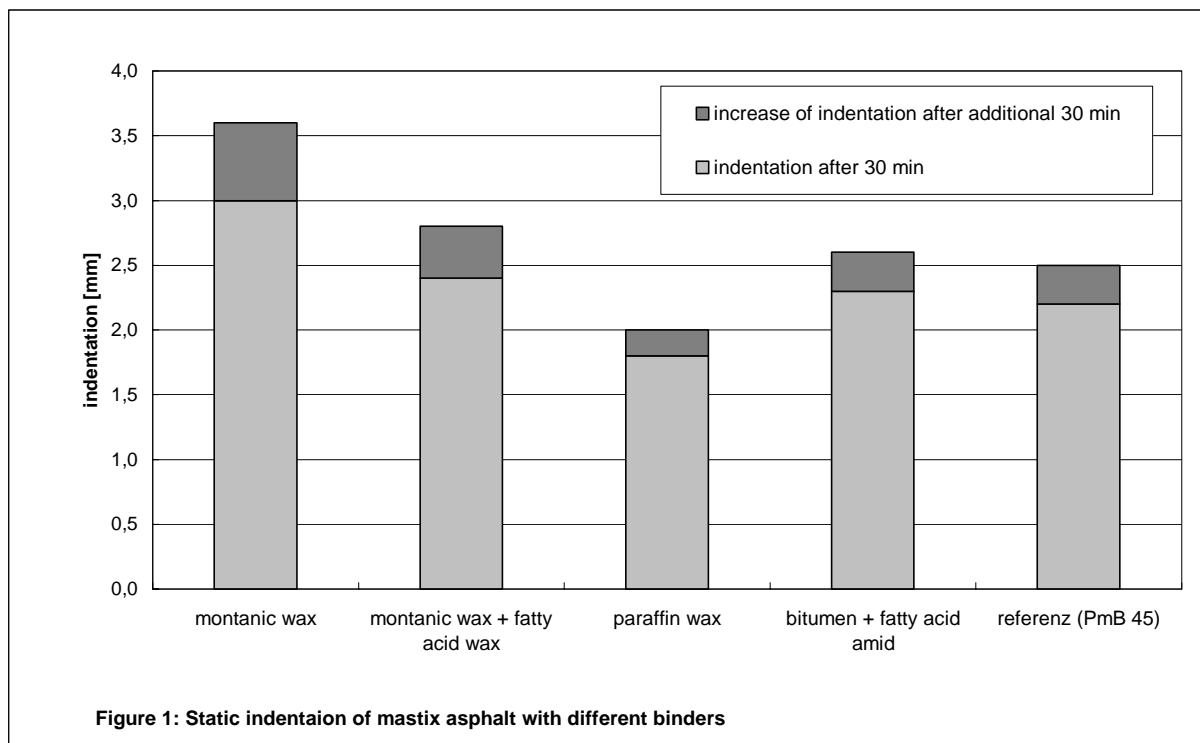
Normally paraffins are used for special bitumen's and for additives. Compared to bitumen-inherent paraffins, the added paraffins are long-chained hydrocarbons so that the properties of the basic bitumen are not adversely affected. The paraffins crystallise between 80°C and 120°C and change the behaviour of the basic bitumen in this temperature range. This leads to a stiffening of the bitumen below the limit temperature of approximately 80°C, it becomes more viscous. Starting at around 80°C, the viscosity of the bitumen becomes lower than that of the basic bitumen. Due to these properties, one can determine temperature reductions of between 30°C and 40°C with mastic asphalt and rolled asphalt compared to conventional asphalt. In practice, these methods with special bitumen have been tested since 1996.

3. Application

3.1 Mastic asphalt

Customary asphalt paving is done at temperatures between 240°C and 270°C for mastic asphalt. The upper paving temperature is used when paving mastic asphalt screed in building construction as a rule. Due to its composition, production and paving of the mastic asphalt have to be done at higher temperatures than is the case with rolled asphalt. That particularly applies to mastic asphalt screed with its highly viscous binder, which is used in building construction. Mastic asphalt screed paving is very frequently done in closed rooms with hand paving, so the worker comes into direct contact with the vapors and aerosols. Temperature reduction in the case of mastic asphalt is only possible at present with the aid of additives to the bitumen or with bitumen that these additives already contain. Montanic waxes, fatty acid amides, paraffin waxes or polyethylene waxes are possibilities here. All of the other methods for temperature reduction are not suitable due to the high temperatures. The production temperature and even the paving temperature can be very effectively reduced by around 30°C with the aid of the additives to the binder or ready-to-use special binders, so a substantial reduction in the vapors and aerosols can be noted for mastic asphalt screed and for mastic asphalt for road construction.

All of the additives change the binder performance, so the usage characteristics of mastic asphalt are also changed. The static indentations for mastic road asphalt are shown with a paving temperature of 220°C as an example in Figure 1.



The reference mastic asphalt was produced with a temperature of 250°C. Only a combination with paraffin wax provides a substantial improvement in the resistance against permanent deformation vis-à-vis the reference mastic asphalt. A slight or substantial deterioration can be noted in all of the other cases.

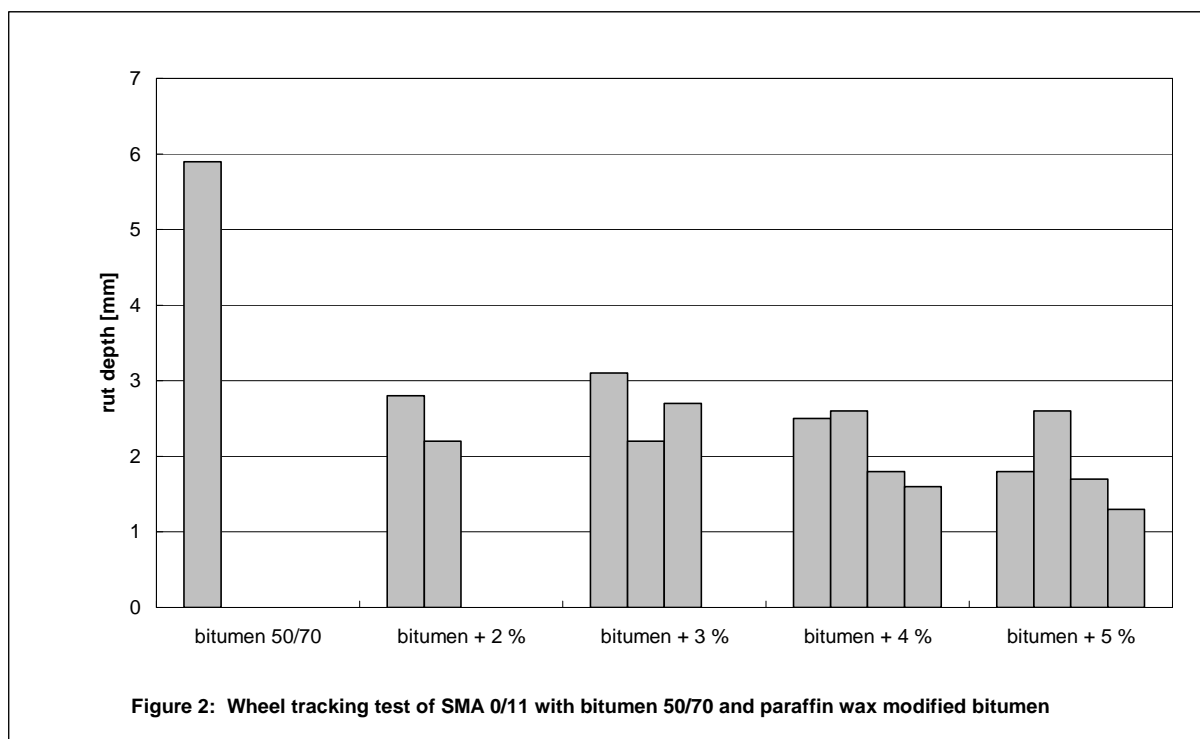
3.2 Rolled asphalt

Rolled asphalt paving is done, depending on the binder viscosity and the asphalt type, at temperatures between 150°C and 180°C in most cases. Aside from the environmental-protection aspects, economic and industrial-safety aspects also play a role in the case of low-temperature asphalt when the familiar discussion involving vapors and aerosols from bitumen alone is considered. Although the latter point specifically, is more likely to involve the producers and users of mastic asphalt, there are nevertheless also fundamental arguments for still giving consideration to the topic of temperature reduction even in the case of rolled asphalt, which is not a problem in this respect:

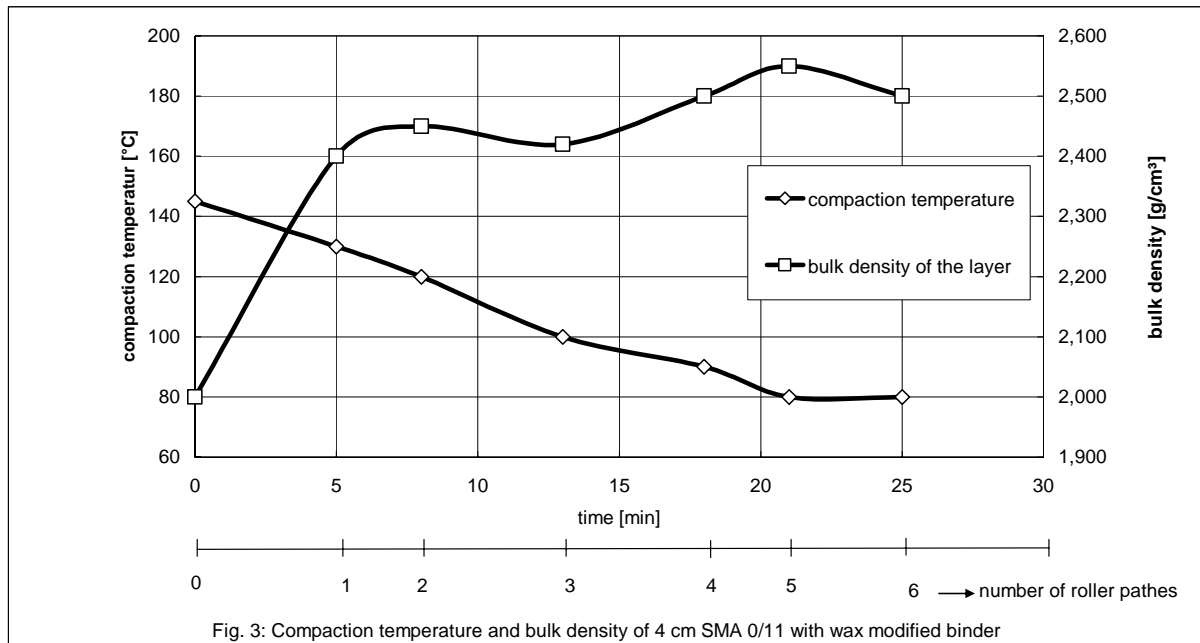
- Temperature reduction means possible savings in energy, as well as a reduction in the CO₂ emissions, because not only is the temperature reduced by 20 to 30% during the mixing and paving phase of the hot asphalt, the use of energy is also reduced in general when heating the asphalt mixture.
- Greater compacting readiness of the asphalt and therefore better durability are also achieved with temperature reduction.

Temperature reduction in the case of rolled asphalt can be done with all of the methods mentioned above. The foam bitumen method and the method with aerogenous agents don't change the binder and therefore don't change the asphalt characteristics. Whereas the water first has to be discharged in the foam bitumen method in order to achieve the appropriate strength in the asphalt, the gas creator zeolite can no longer be detected after the paving. The zeolite is allocated to the filler within the framework of the mix design. There is only a maximum of up to 4 hours of time between the production and the paving of the asphalt when zeolite is used, because the water vapor effect no longer exists at that point according to the specifications.

The methods with special binders and additives lead to an increase in viscosity of the binder at the usage temperature of the asphalt, so an improvement in the resistance behavior against permanent deformation can be observed, as is shown in the example in Figure 2 using the additive based on paraffin wax.



The highly viscous binders with the additive based on paraffin don't lead to any deterioration of the low-temperature behavior compared with basic bitumen. The bulk density and the compaction temperature progression vis-à-vis the compaction are shown in Figure 3 with the example of stone mastic asphalt with a binder with an additive based on paraffin. The possible compaction time is indicated by the curve progressions.



4. Outlook

The asphalt industry has a large number of possibilities for temperature reduction in asphalt mixing and laying. The methods proven in practice enable a reduction of the asphalt temperatures of between 30°C and 70°C compared to common asphalt mixing. The bitumen properties and thus also the asphalt properties do not change with the exception of the special bitumen and the additives. Compared to basic bitumen, the special bitumen has changed viscosity properties. The same also applies for the additives versus their original bitumen. These viscosity changes improve the thermal stability of the asphalt. The stiffer bitumen behaviour does not have an adverse effect on the low temperature behaviour, at least with the selected additives.

Additional extensions of the mixing facility are required for the mixing of low temperature asphalt on the basis of process engineering and aerogenous agents. The application of special bitumen or additives does normally not require additional constructional measures on the mixing facility. As a rule, the necessary investment costs cannot be amortised in the short run when offset against the energy savings. Environmental and labour safety aspects should be in the foreground with this counter-account.

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