

Exposure Reduction in the laying of asphalt products

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Introduction

The possible health hazards of fumes and aerosols from bitumen have been a subject of discussion for several years, not least because there is often no clear distinction made between the use of the terms “tar” and “bitumen”. In addition, the German occupational exposure limit for fumes and aerosols emitted from hot bitumen, is a technical guidance value, which reflects technical state-of-the-art and is not primarily based on toxicological findings.

A concerted effort by all the participating associations and institutions of the BITUMEN Forum has resulted in a rationalisation of the debate on classification and in the establishment of a threshold limit for bitumen exposure. The Forum is working on an extensive research programme in order to assess possible health hazards arising from handling bitumen and to establish exposure reduction measures. This paper describes some significant innovations arising from that research.

The BITUMEN Forum

Following encouragement from the Ministry for Labour and Social Affairs, the German BITUMEN Forum was formed at the beginning of 1997. All institutions whose members have interest in or are responsible for applications of bitumen or bituminous products are represented in the Forum. These include: The producers of bitumen, the many producers of bituminous products and users of those products such as roofers, road construction and other construction companies. In addition, the relevant institutions for occupational safety and health, and of course, trade unions are also represented in the BITUMEN Forum. Even companies and associations from other European countries also work within the Forum.



The Forum coordinates an extensive programme in order to establish the best possible basis for assessing possible health hazards arising from handling bitumen. To a large extent the work is already successfully completed, those work activities being:

- determination of the constituents of the different bitumen (Knecht et al., 1999);
- measurement of fumes and aerosols arising from work with hot bitumen (Rühl and Kluger, 2001);
- the search for suitable protective gloves for use in handling bituminous emulsions and solvent based bituminous products (Deutsche Bauchemie);
- supporting the German part of a European epidemiological study of the incidence of cancer in “bitumen workers”;
- possible absorption through the skin of bituminous constituents when dealing with cold bituminous products, (Drexler und Angerer, 2002);
- investigation into dermal absorption of certain constituents from fumes and aerosols released from hot bitumen (Knecht et al., 2001).

The following studies are still going on:

- effects of exposure on the respiratory system when laying mastic asphalt (Rumler and Raulf-Heimsoth, 2001) and in particular:
- animal experiments on inhalation of fumes and aerosols from bitumen in order to determine any possible carcinogenic effects (Fuhst et al., 2001).

The work mentioned above is financed almost 90% by the bitumen producers. The remaining funding is provided by other members of the Forum who, by their contribution, are also actively involved in the studies (Rühl and Musanke, 2001).

The BITUMEN Forum published a status report in 2000 in which origin, aims and work of the Forum are described in detail. (www.GISBAU.de).



Evolution of Low Temperature Products

The primary conclusion of the Forum is the promotion of 'reduced temperature asphalt laying', which technology was developed in the last few years. Reduced temperature asphalt laying primarily reduces exposure of the employees, but also saves energy, reduces CO₂ production and improves quality of the asphalt products.

Thus, reduced temperature asphalt laying is not only the ideal way for safety at work, but it is also the key innovation for the laying of rolled asphalt and mastic asphalt.

Reduced temperature asphalt may be produced in different ways. Thus not only one technology will be promoted, but there will be a market-driven competition of several successful competing technologies.

Laying of rolled asphalt and mastic asphalt

Rolled asphalt is primarily used in road construction. Rolled asphalt is transported by open or tarpaulin-covered trucks from the mixing plant to the construction site where it is processed by a paving machine. The paver distributes the asphalt even on the road and compresses the asphalt, which is brought into the final form by rollers. Laying temperature of rolled asphalt is approx. 160°C.

Mastic asphalt is used as floor cover in house building and for special purposes in road building. It is transported in heated mixer-vehicles from the mixing plant to the construction site and may be processed manually or by screed machines. Mastic asphalt, with a laying temperature of approx. 250°C, because of its greater fluidity, does not have to be compressed and may be stressed almost immediately after it has cooled.

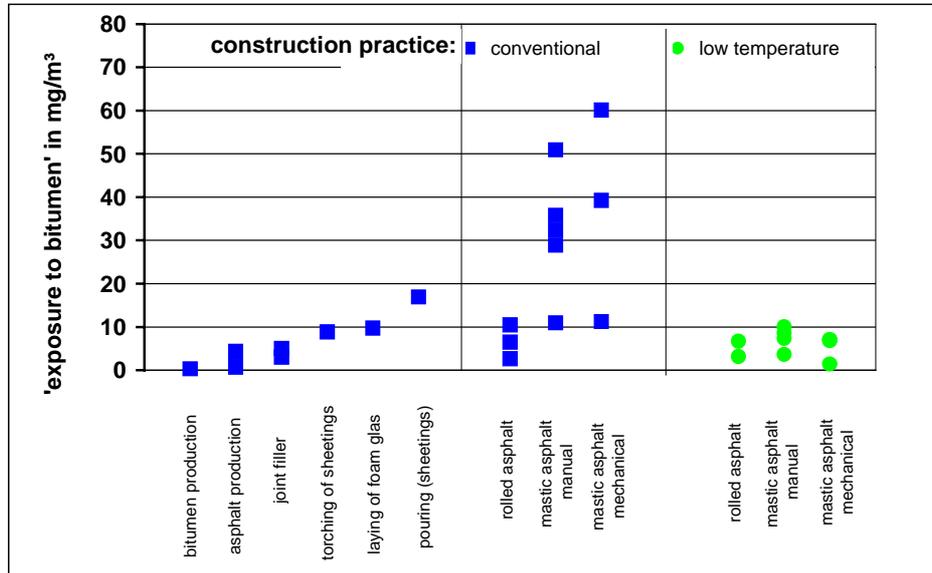
However, the higher laying temperature of mastic asphalt causes a high exposure of the employees. Therefore, in Germany all mastic asphalt workers are being medically assessed (from an occupational medicine perspective). A large cohort of these workers is also going to be examined during a whole shift to assess the possible chemical irritative effects on the respiratory system. This work is done by the Berufsgenossenschaftliches Forschungsinstitut für Arbeitsmedizin (BGFA, BG Research Institute for Occupational Medicine) (Rumler und Raulf-Heimsoth, 2001).

Exposure of the employees

For nearly all uses of bitumen, the BITUMEN Forum has determined typical exposure data for the employees. (Graph 1). In the predominant number of the cases, the threshold limit value of 10 mg/m³ is not exceeded. But for conventional mastic asphalt frequent transgression of the limit is to be expected.

Even if as yet this limit value is only empirically founded - there being no statement about the associated health hazard - it is very significant that with the use of low temperature asphalt laying, the exposure of the mastic asphalt workers is then reduced to the same order of magnitude as for all other bitumen workers.

When using low temperature asphalt for rolled asphalt laying, exposure may be reduced to approximately half of the typical value.



Graphic 1: Exposure to fumes and aerosols of bitumen for production and for different uses of bitumen. Normally, 95-percentile-values for different activities are presented.

Development of reduced temperature asphalt

There are several ways to produce asphalt mixes which may be processed at considerably lower temperatures than hitherto.

One technique is based on the addition of zeolites to asphalt in the mixing plant. The zeolites are the same as used in large quantities as substitutes for phosphate in washing powder. Zeolites release steam at temperatures between 100°C to 200°C. This leads to a foaming effect, which improves asphalt's pliability. By this way, rolled asphalt may be laid at considerably lower temperatures (about 30°C) as usual.

The other ways to lower the laying temperature are based on admitting organic substances like amid-waxes or paraffins. These methods may be used for rolled asphalt as well as for mastic asphalt. With that, mastic asphalt may be processed at temperatures below 210°C.

On construction sites with low temperature asphalt laying there is no 'blue smoke' any longer, nevertheless the asphalt product achieves the same finished quality.

Experiences with low temperature asphalt laying

Rolled asphalt may be processed at approx. 130°C (instead of approx. 160°C) and mastic asphalt at below 210°C (instead of approx. 250°C). These temperatures lead to a very significant exposure reduction for the employees, especially for mastic asphalt (see table 1), to an extent which seemed to be impossible a few years ago.

Lower mixing temperatures mean less stress for the mixing plant and lead to less ageing of the bitumen. Energy requirement reduces about 30% when the mixing temperature is decreased by about 30°C or 35°C. For a mixing plant normally needing 8 litres fuel oil per tonne asphalt it achieves a reduction of 2.4 litres per tonne. In view of an asphalt production of 63 million tonnes in Germany, there results an overall reduction potential of 150 million litres fuel oil yearly.

With that there is an enormous potential to reduce CO₂-emissions. The production of 63 million tonnes of asphalt in Germany leads a formation of 1.6 million tonnes of CO₂. Low temperature asphalt would lead to 400,000 tonnes less CO₂. (Barthel, 2001).

Low temperature asphalt has better utilisation characteristics (Damm, 2003), and for mastic asphalt, durability is increased up to 60% (Schellenberg, 2003).

Rolled Asphalt	conventional asphalt	low temperature asphalt
	160 - 180°C	approx. 130°C
	95 percentile of many measures	results until now
Paver operator	6,5 mg/m³	0,4 - 3,1 mg/m³
Screed operator	10,4 mg/m³	0,6 - 6,9 mg/m³
Mastic asphalt	conventional mastic asphalt	low temperature mastic asphalt
	240 - 250°C	approx. 205-230°C
	95 percentile of many measures	results until now
Charger, manual work	28,9 mg/m³	0,5 - 8,6 mg/m³
Smoother, manual work	35,8 mg/m³	0,6 - 10,8 mg/m³
Charger, mechanical work	61,4 mg/m³	1,3 - 7,8 mg/m³
Screed operator	40,6 mg/m³	1,7 - 11,1 mg/m³
Smoother, mechanical work	12,3 mg/m³	0,5 - 1,5 mg/m³
Table 1: exposure of the employees when working with conventional or with low temperature asphalt		

Moreover, there are additional applications for low temperature asphalt laying:

- Low temperature asphalt has been used on a motorway bridge, because the temperature sensitive coating of the steel bridge did not allow higher working temperatures.
- The landing runway of Frankfurt (am Main) airport is being replaced. In 300 nights between 22:00 and 6:00 short sectors of the landing strip will be broken off and replaced by new asphalt in 60 cm thickness. Since aeroplanes must be able to take off and land from 6:00 again, the asphalt must not exceed a temperature of 80°C at that time. This can only be achieved using low temperature asphalt.



laying of low temperature asphalt at Orly (France)

Outlook

Low temperature asphalt is the ideal way to protect the employees working with hot asphalt from the point of view of health and safety at work. Through developing low temperature asphalt, the asphalt industry expects to achieve

- less fumes and aerosols at the laying process;
- less emissions on the mixing plant;
- reduced energy consumption;
- reduction of CO₂ formation;
- less wear of the plant;

- hardly any ageing of the binder;
- improved product utilisation characteristics.

It is up to the customers now, especially the road construction authorities, to make the necessary practical applications possible for the new technologies. The industry has developed the technology, now the customers have to enable its implementation, even if low temperature asphalt has yet not become definitive part of the road specification. In Austria, the local government of Tyrol already lists low temperature asphalt in their tender documents.

The BITUMEN Forum promotes utilisation of low temperature asphalt mainly by disseminating corresponding information and by performing air monitoring on the construction sites. For example the level of exposure has now been measured for employees laying low temperature asphalt in France.

In August 2002 there was a visit of a delegation of the American National Asphalt Paving Association (NAPA) and the American National Institute of Occupational Safety and Health (NIOSH) to Germany. They wanted to get information about low temperature asphalt laying from members of the German asphalt association (Deutscher Asphalt Verband, DAV) and the BITUMEN Forum. On a return invitation of NAPA, members of the BITUMEN Forum reported about the state of the art concerning low temperature asphalt at the 48th general meeting of NAPA in San Diego in January 2003 (Cervarich, 2003).

When low temperature asphalt laying becomes standard construction practice, this will mean the end for the high bitumen-exposure for mastic asphalt workers. And in addition, as the far predominant part of bitumen is used in rolled asphalt applications, the exposure of the many rolled asphalt workers will be reduced considerably.

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