

A brief introduction to polymer modified bitumen (PMB)

Two types of polymer are generally used to modify bitumen for road construction: plastomers and elastomers. EVA (Ethene-Vinyl-Acetate) and PE (Polyethylene) are examples of commonly used plastomers. SBS (Styrene-Butadien-Styrene) is the most used elastomer. Basically, plastomers increase the viscosity and stiffness of the bitumen. Elastomers also improve the elastic behavior of the bitumen.

Applying a stiffer bitumen in asphalt mixtures generally results in improved performance with respect to rutting resistance. Both SBS, EVA and PE modified bitumen have been applied successfully in situations where rutting was a problem with penetration grade bitumen (up to a limit). However, the bitumen should not be too stiff, because that may result in brittle asphalt mixtures, which has caused severe cracking failures with some types of plastomer modified bitumen in practice, even at (air) temperatures of 40 °C and higher.

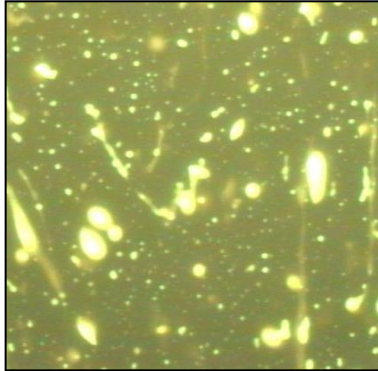
Fatigue cracking is controlled by the fatigue life of the mixture and the strains in the asphalt pavement structure. For penetration grade bitumen, the use of a stiffer bitumen (lower penetration grade) generally results in an asphalt mixture with a lower fatigue life. At the same time, however, the strains at the bottom of the pavement are also reduced. Plastomer modified bitumen perform in this case similar to penetration grade bitumens. To the contrary, elastomer modified bitumen generally show, due to the improved elastic behavior, a better resistance against fatigue cracking. The net effect can be analyzed with modern pavement design methods.



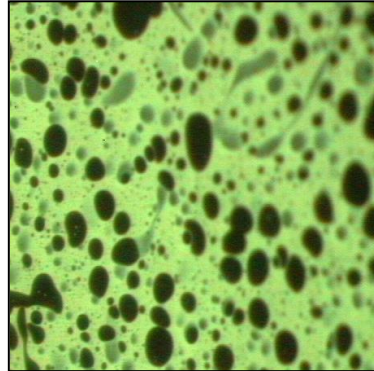
Surface cracking may be temperature or load induced. In both cases the best performance can be expected with a bitumen that is optimized with respect to stiffness and tenacity (strength and toughness); this after aging. In this respect elastomer modified bitumen have more potential than plastomer modified bitumen.

The performance of asphalt layers depend not only on the properties of the materials, but also on the variation in properties (the weakest link determines the strength of the chain). In this respect there is a significant difference between (proper) elastomer modified bitumen and plastomer modified bitumen. Plastomer modified bitumen are usually unstable two phase systems, while elastomer modified bitumen can be stable two phase or even one phase (chemically bound) systems. When unstable systems are not sufficiently stirred, the polymer separates from the bitumen. This will result in an inhomogeneous bitumen with areas with high and low polymer content.

When added to bitumen a compatible elastomer (for example SBS) will absorb the oily fraction from the bitumen, which causes the polymer to swell (up to eight times its original volume). After some time, the swelled polymer starts to dissolve in the bitumen. This physical process takes time (at least several hours) and can be influenced by the production process and the use of additives. Plastomers (for example EVA) melt at high temperature. When added to bitumen they appear as small droplets that are dispersed in the bitumen. The bigger the volume of the polymer in the bitumen, the more it will (positively) affect the properties of the bitumen.



*Low polymer content (EVA)
(continuous bitumen phase)*



*High polymer content (EVA)
(continuous polymer phase)*



*Sealoflex® PMB
(fully integrated continuous polymer phase)*

Sometimes the polymer is added directly to the asphalt mixture in an asphalt plant. In this case the polymer has almost no time to interact with the bitumen and therefore will not show a significant increase in volume. Besides, it is unlikely that a homogeneous end product is obtained. All together the improvement of the asphalt properties will be significantly less than with a proper polymer modified bitumen with the same polymer content.

For more information regarding use and performance of polymer modified bitumen in asphalt mixtures, you can contact one of the authors below or surf to www.ooms.nl/research to download one or more of the related publications.

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