Institute for advanced architecture of Catalonia

IC2 ENERGY

STUDENT
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MATERIALS ASSIGNMENT

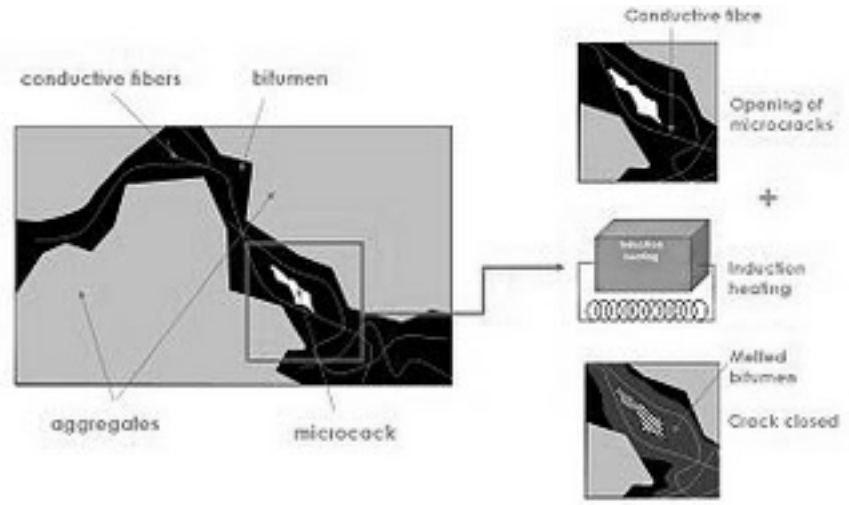
Material 1

SELF-HEALING ASPHALT

DESCRIPTION

Self-healing is receiving an increasing amount of worldwide interest as a method to autonomously address damage in materials. This asphalt is basically a special type of ZOAB (very porous asphalt concrete) containing small steel wool fibers. A known but serious problem with ZOAB is raveling: stones at the surface coming off in time due to micro cracks in the binder. The special ZOAB that is developed at Delft University can be heated with induction energy due to the fibers that are present, could close the micro cracks and with that, extends the service life of the road.

HOW THE SELF-HEALING WORKS



In the new asphalt that is developed in this project small steel wool fibers are mixed in the bitumen. After some time (probably a few years or after a strong winter like we have now) when small micro cracks occur in the bitumen and when the aggregates in the asphalt mix at the surface start to debond, the steel wool fibers are heated with induction energy. By heating up the fibers the bitumen will melt and close the cracks and repair the bond with the aggregates. It is important not to apply too much heating, because that would close all the pores in the porous asphalt.

FINANCIAL ASPECTS OF SELF-HEALING ASPHALT

Road laying and major repairs

When Rijkswaterstaat replaces an existing road surface by another type – for instance two-layer PAC instead of standard PAC – the costs consist of milling and disposal of the current road surface and the application of the new layer(s). But there is more to it then the construction costs as the road also has to be maintained. Here, only 'major repairs' are taken into account and this involves the (partly) replacement of the road surface. Compared to this, the costs for 'minor repairs' are normally negligible.

Based on experiences Rijkswaterstaat uses the following maintenance model for major repairs:

The right lane, which has been used most intensively, is replaced at the end of the life span of the road surface, after 10 years for PAC;

Four years after the previous step both lanes are replaced, so 14 years after initial construction for PAC; again 10 years after the previous step the right lane is replaced at the end of the life span of the road surface, so 24 years after initial construction for PAC.

Four years after replacement of the right lane in the previous step both lanes are replaced and the supporting layer is reinforced, so 28 years after initial construction for PAC.

Financial benefits of self-healing asphalt To make a quantitative prediction of the financial benefits that can be obtained when using self-healing materials, it would be best to compare the change (increase) in materials costs with the change (decrease) in maintenance costs. Depending on the application, other costs such as operating costs, disposal costs and environmental costs can be taken into account. It is expected that periods between road maintenance will extend when self-healing asphalt will be used, resulting in a decrease in traffic jam costs - and traffic hindrance, of course.

According to Rijkswaterstaat, the average annual costs for major repairs of 74 km2 of standard PAC in the Netherlands are amounted to 180 million euros. By extending the life span of standard PAC with 25 percent - so from 12 years on average to 15 years - the annual costs for major repairs can be reduced by 35-50 million euros. At an extension of the life span from 12 years on average to 18 years - so by 50 percent - the annual savings on major repairs will be as much as 60-80 million euro. In these amounts, the additional cost for applying self-healing asphalt are not taken into account.

Besides these 'direct' savings, self-healing asphalt yields indirect advantages, for instance less traffic jams due to road maintenance and hence less social traffic jam costs. Traffic jam costs, expressed as capitalized hours of time loss of waiting people and their alternative routes, amounted in 2008 in the Netherlands to 2.8 billion euros, of which 'only' 4 percent or about 110 million euros were caused by road maintenance. It would be reasonable to assume that the number of traffic jams decreases proportionally with the length of the maintenance period. Therefore, a life span extension for self-healing asphalt with 25 percent from 12 years on average to15 years would render 22 million euros less traffic jam costs. At a life span extension of 50 percent - from 12 years on average to 18 years - the social traffic jam costs would be 37 million euros less. Again, here the additional cost for applying self-healing asphalt is not taken into account.

The combined annual savings related to major repairs and social traffic jam costs are approximately 65 million euros at a life span extension of 25 percent and over100 million euros at a life span extension of 50 percent, for the entire PAC area in The Netherlands. To determine the net savings, the additional costs for self-healing asphalt have to be subtracted. A 100 percent (or 200 percent) higher bitumen price results in approximately 8 million (or 16 million) euros additional annual costs.

So even if the price of self-healing bitumen will be twice as high as for standard bitumen, The Netherlands can save approximately 90 million euros annually by investing in self-healing asphalt with a 50 percent extended life span compared to traditional PAC. Only when the cost price of self-healing bitumen will be more than 13 times the price of standard bitumen, self-healing asphalt will be less attractive from a financial point of view.

Not only 'society' would prefer to have this new type of asphalt. Also the road maintenance authority – Rijkswaterstaat and road contractors with maintenance agreements – will be able to plan much better using this new material.

APLICATION

Self-Healing Asphalt on A58

Saturday December 11 was an important day for the self-healing asphalt. The concept, which is the outcome of the IOP project SHM0617 “Unraveling of Porous Asphalt” is used in a full-scale application. On the Dutch highway A58 near Vlissingen a section of 400 meter had to be renewed. Rijkswaterstaat, always willing to try new inventions, offered the road to science. The self-healing porous asphalt developed by the Microlab and the Road Engineering lab of the Civil Engineering faculty of Delft University was used. Contractor Heijmans, also partner in the IOP project, took care of making the asphalt and placing it on the road. Partner INTRON will take care of the healing process by using an induction machine to heat up the steel wool fibers that are placed inside the material.

SOURCE

www.selfhealingasphalt.blogspot.com

Material 2

NATURAL INSULATION

DESCRIPTION

HOMATHERM flexCL 040 is a very practical insulation material in flexible batt form, made from recycled newspaper and recycled jute sacking. The material is treated with borax to resist insects and to make the insulation fire-resistant. The material is very comfortable to work with, and can be readily cut to fit where necessary. Installation is safe and easy, protecting the health of both installers and building occupants.

Homatherm improves the climate in the building because of its thermal and vapor diffusion capacity - the ability both to regulate temperature and to absorb moisture and gently give it off again. It protects the structure and keeps it dry, prolonging the lifetime of the building fabric.

Homatherm can be used between rafters, joists and timber studs in breathing constructions. It can also be installed as a partial fill insulation for cavity wall construction with a ventilated air gap.

ADVANTAGES

COMPOSITION & MANUFACTURE

- Contains over 90% re-cycled material
- No toxins or toxic emissions during manufacture

INSTALLATION & DISPOSAL

- No health risks for workforce or installers
- Easily cut to shape
- Flexible in all directions
- No VOC emissions
- Helps to avoid the use of treated timber
- Durable / Low maintenance
- Reusable / actively recycled

PERFORMANCE

- Excellent thermal performance in winter

- Excellent thermal performance in summer
- Excellent low-frequency acoustic performance
- High vapor permeability
- Hygroscopic (absorbs & releases moisture)
- Absorbs harmful VOC's and toxins
- Vermin and fungus resistant
- Electrically neutral
- Non-radioactive
- Free from toxins and allergens
- Dimensionally stable (low thermal movement)

GENERAL INFORMATION

HOMATHERM flexCL 040 batts are high-density semi-rigid insulation slabs made from recycled newsprint and 7 - 10% polyolefin fibers.

The cellulose fibers enable the insulation to absorb up to 17% moisture without losing on thermal performance. And since moisture is absorbed by the insulation, not the timbers, structural timbers without preservative treatment can be used.

The polyolefin fibers enable the slabs to be flexible in all directions (their inclusion also resulting in a significant reduction in the embodied energy of the product).

The density of the batts (typically 60-90 kg/m^3) ensures superior acoustic performance relative to mineral wool insulation materials whilst the excellent specific heat capacity of the batts ensures that FlexCL batts not only insulate during the winter, but also prevent summer overheating (2.4 times better than a mineral wool of equivalent density).

APPLICATIONS

Suitable for floors, walls, and roof constructions

Suitable for partial fill cavity wall construction

SOURCE

www.constructionresources.com