Rannsóknaráðstefna Vegagerðarinnar
Hörpu, 8. nóvember 2013

Vetrarblæðingar
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FORENSIC INVESTIGATION OF SURFACE DRESSINGS FAILURE IN ICELAND

Executive Summary

During the winter 2012-2013, several road sections in Iceland have been reported and confirmed as having extensive damage in their surface dressings. The damage was described as the bitumen on the bottom side of the surface dressing coming loose like an emulation and was pumped up by traffic load through small “eyes” in the surface layer, sticking to tires and all over cars passing over this area, but no damage could be seen on the surface. This was a huge and very annoying problem to the drivers, especially on roads with heavy traffic of larger vehicles; many cars were damaged and the ICERA´s insurance company had to pay an expensive car cleaning cost. Preliminary studies indicated that the worst bleeding was on pavement sections with old rape seed oil mixed in with the bitumen but sections with ethyl ester from fish oil were also affected.

As part of a detailed forensic investigation to determine the causes of the severe pavement failure in several locations, the Icelandic Road Administration took pavement samples from six road sections; those samples were then sent to the Royal Institute of Technology KTH Highway and Railway laboratory (Sweden) for a comprehensive laboratory evaluation.

Three binders including N (bitumen pen 160/220), binder K8 (bitumen pen 160/220 + Ethyl ester from fishoil 7,5 %) and binder K9 (bitumen pen 160/220 + Fatty Acid Methyl Esters FAME from Rape seed oil 7,5 %) were subjected to an extensive rheological and chemical characterization. Surface dressing samples were scanned using the X-ray Computed Tomography System in order to evaluate their internal structure parameters such as aggregate gradation, aggregate shape, binder distribution, air voids size and connectivity.

Strictly speaking, the N binder does not meet the penetration grades requirements to be classified as 160/220; however, it could also be a 160/220 originally, which due to several causes has become slightly stiffer. Binders are a lot stiffer after recovery (mixing, laying, field aging, laboratory recovery); probably fairly close to the unaged original bitumen (Binder N).
The binder N was classified as Superpave PG 52-28; conversely, the modified binders, K8 and K9, did not meet the Superpave binder specifications. Binders that do not comply with Superpave requirements may have negative effects on the road performance such as reduced binder-aggregate adhesive strength, bleeding and/or reduced lifetime of the surface layer.

The chemical characterization of the binders revealed enhanced surface polarity due to the solubility issues of ethyl ester from fishoil with the original bitumen (binder N).
The density difference between ethyl ester and bitumen popped the polar oil phase at the surface as cream. Furthermore, universal sorption studies confirmed the polar surface of stones because of their high affinity toward polar liquid such as water as compared to dispersive liquid such as diiodo-methane. Hence, stone surface was covered with polar oil phase rather than bitumen; which led to debonding of asphalt binder from aggregate surface. This problem can be substantially aggravated when the surface dressings are exposed to moisture or water.

X-ray tomography analysis performed on samples taken from every pavement section included in this study; two major problems: debonding between aggregates and binder, as well as significant binder bleeding were clearly identified and appear to play a key role diminish the structural capacity of the surface dressings. Other concerns are related with the use of rounded and/or relatively light/weak aggregate particles in the surface dressings.