ROAD CLIMATE VARIATIONS RELATED TO WEATHER AND TOPOGRAPHY

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ABSTRACT

To increase traffic safety and minimise delays and accidents caused by slipperiness it is important to have more knowledge about processes that influence spatial variations in air and road surface temperatures. This thesis focuses on influences from: Shading and its duration, sky-view factor (SVF), cloud cover and wind speed and changes in weather. These parameters affect the risk of slipperiness both in time and space. Data from stations in the Swedish Road Weather Information System (RWIS), synoptic stations and mobile measurements along selected roads in the south-western part of Sweden were used to analyse air and road surface temperature (RST) variations. Two new methods to calculate SVF were developed. In the first method, the software IDRISI was used to calculate SVF in forest from scanned fish-eye photographs. In the second method, an arrangement with a polished hemisphere of stainless steel together with an IR-sensor was used to measure SVF continuously along the road.

The results showed that daytime differences in RST between shaded and sun-exposed stations are determined by maximum solar elevation. The magnitude of these differences was large enough to prevail after sunset in October and from February to April. SVF had a significant influence on night-time RST but was less important for air temperature. A second order relationship between RST and SVF was received during late spring, where low SVF resulted in low temperatures. During autumn, on the contrary, a linear relationship was obtained where low SVF resulted in high temperatures.

The presence of clouds generally reduced the RST differences during the day but situations with no more than 1-3 oktas are similar to clear conditions considering RST differences. The differences were, however, significantly reduced for situations with cloud cover between 4-6 oktas, but shading from topography and vegetation was still important. Air temperature decreased with increasing altitude during overcast conditions and had a higher correlation with altitude than RST. Thermal inertia of the road and placement of the sensors could explain the lower correlation for the surface temperatures. Changes from clear to overcast conditions could result in a large reaction time for RST compared to air temperatures. The adjustment time to the new conditions after front arrival depended on preceding weather, magnitude of existing temperature differences when the front arrived, time of front arrival, wind speed and precipitation.

The obtained results can be used in stretchwise local climate modelling to increase the accuracy of RST interpolations for stretches between the RWIS stations. More reliable temperature patterns can increase the possibility to forecast road surface status and maintenance actions can be taken in advance to prevent road slipperiness. The method to calculate SVF continuously can be a useful tool in addition to thermal mapping to detect areas prone to night-time slipperiness.

Key words: local climate; Road Weather Information System; air temperature; road surface temperature; screening effects; temperature decrease with altitude; sky-view factor; road slipperiness