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Winter risk estimations through infrared cameras an principal component analysis

M. Marchetti (1), J. Dumoulin (2), and L. Ibos (3)

(1) CETE Est - ERA 31, France (mario.marchetti@developpement-durable.gouv.fr), (2) IFSTTAR, MACS, France (jean.dumoulin@ifsttar.fr), (3) Université Paris Est - Créteil, CERTES, (laurent.ibos@u-pec.fr)

Thermal mapping has been implemented since the late eighties to measure road pavement temperature along with some other atmospheric parameters to establish a winter risk describing the susceptibility of road network to ice occurrence. Measurements are done using a vehicle circulating on the road network in various road weather conditions. When the dew point temperature drops below road surface temperature a risk of ice occurs and therefore a loss of grip risk for circulating vehicles.

To avoid too much influence of the sun, and to see the thermal behavior of the pavement enhanced, thermal mapping is usually done before dawn during winter time. That is when the energy accumulated by the road during daytime is mainly dissipated (by radiation, by conduction and by convection) and before the road structure starts a new cycle. This analysis is mainly done when a new road network is built, or when some major pavement changes are made, or when modifications in the road surroundings took place that might affect the thermal heat balance. This helps road managers to install sensors to monitor road status on specific locations identified as dangerous, or simply to install specific road signs. Measurements are anyhow time-consuming. Indeed, a whole road network can hardly be analysed at once, and has to be partitioned in stretches that could be done in the open time window to avoid temperature artefacts due to a rising sun.

The LRPC Nancy has been using a thermal mapping vehicle with now two infrared cameras. Road events were collected by the operator to help the analysis of the network thermal response. A conventional radiometer with appropriate performances was used as a reference.

The objective of the work was to compare results from the radiometer and the cameras. All the atmospheric parameters measured by the different sensors such as air temperature and relative humidity were used as input parameters for the infrared camera when recording thermal images.

Road thermal heterogeneities were clearly identified, while usually missed by a conventional radiometer. In the case presented here, the two lanes of the road could be properly observed. Promising perspectives appeared to increase the measurement rate.

Furthermore, to cope with the climatic constraints of the winter measurements as to build a dynamic winter risk, a multivariate data analysis approach was implemented. Principal component analysis was performed and enabled to set up of dynamic thermal signature with a great agreement between statistical results and field measurements.