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An Infrared Survey on a Concrete Bridge Deck

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SUMMARY

An infrared survey was carried out on a concrete bridge deck using a mobile IR-acquisition unit. The survey covered one lane of the bridge and was repeated once per hour during 20 hours. Results show only minor temperature differences between on bridge and off bridge and no influence of structural elements such as girders.

Introduction

Porous asphalt pavement is becoming more and more popular because of its noise reduction capabilities. The use of porous asphalt can eliminate the need for sound-insulating walls in many locations. In addition, under rainy conditions aquaplaning and spray are prevented. On porous asphalt the water is not running off the surface but infiltrating into the pores and draining away sideways. Porous asphalt has typically 22% air voids with 15% of the air voids being interconnected resulting in a large internal contact surface. These interconnected voids create micro conduits that lead the water away from the surface. One disadvantage of porous asphalt is that it has to be replaced every 5-10 years because it is losing its advantageous properties.

Doubts on the safety of porous asphalts on bridge decks, particularly in winter, have reduced the use of these innovative pavements. In order to investigate the behaviour of porous asphalt on bridge decks, a research project was carried out (FEDRO, 2008). Thermography data were recorded once per hour on one lane of the bridge "Pont sur l'Arnon" (length 83m) on the motorway A5 near Yverdon, Switzerland during a period of 20 hours. The aim of this campaign was to verify if the temperature measured by stationary probes in the middle of the bridge were representative for the whole surface, the extrapolation of the temperatures measured by the probes onto the whole surface and a comparison between surface temperatures on the bridge and off the bridge. As problems were mainly expected during temperature drops, the survey was carried out during a drop of the air temperature from 10C to 1C (*Figure 1*).

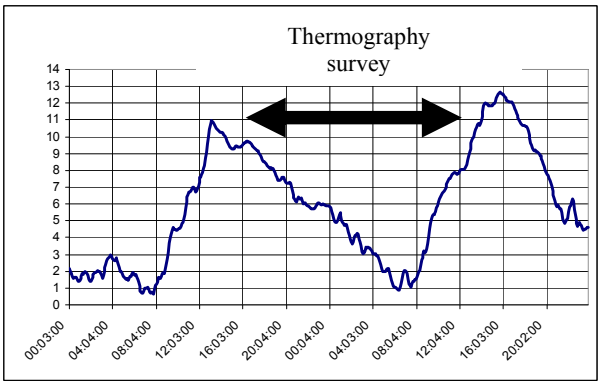

Figure 1 *Temperature drop during thermography survey.*

Mobile IR-acquisition system

Thermography is a method working in the infrared range of the electromagnetic spectrum. Usually cameras recording in this range are used to take either single pictures or movies. Thermography is used for mapping the surface temperature of objects and, using this information, for detecting defects that influence this temperature such as delaminations or blisters. Empa's mobile system for thermography inspections on large surfaces such as bridge decks is shown in *Figure 2*. The IR-camera (Agema THV 900LW, black arrow) is mounted in a height of 3.11 m (*Figure 3*). This leads to an image size of 1.21 m x 2.40 m. A GPS antenna (white arrow) is mounted on top of the camera. GPS and thermography data were recorded simultaneously and merged later via a time stamp. One lane of the bridge was measured once per hour during 24 hours in February 2007. Two passes were required to cover the whole lane. An example of GPS positions recorded during two passes is shown in *Figure 4* together with he two joints at both ends of the bridge.

Figure 2 *Empa's mobile IR-unit.*

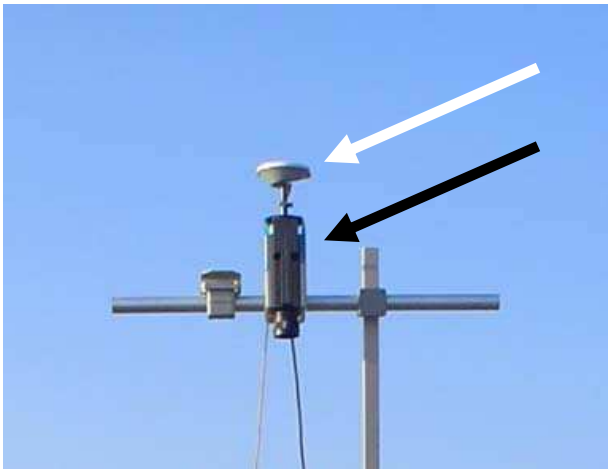

Figure 3 *Empa's mobile IR-unit(detail).*

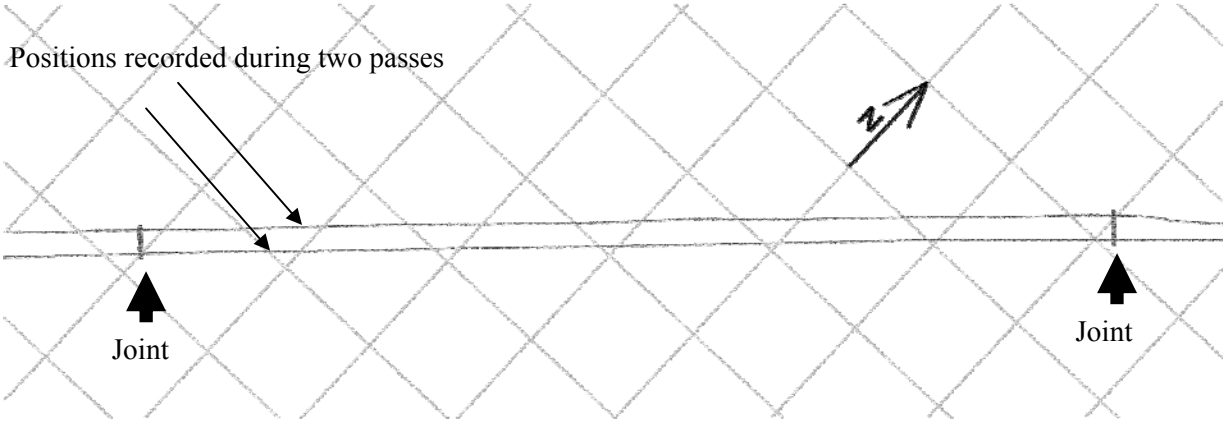

Figure 4 *GPS positions of two passes.*

Results

In ***Figure 5*** the infrared emissions during 20 hours are displayed. This is closely related to surface temperatures but not necessarily identical as the infrared emission depends also on the emissivity of the surface. The infrared survey proofed that there are only minor temperature variations on the bridge which means that the stationary probes are representative and that there is no relevant temperature difference between on bridge and off bridge. This is confirmed by the temperature values provided in ?. Minimum and maximum temperatures on bridge and off bridge differ less than 0.5 degrees C. The corresponding longitudinal temperature profiles are presented in *Figure 6* and *Figure 7*. At 4 p.m. the temperature on the bridge is about 0.5 degrees lower than off the bridge. On the bridge, there is a temperature gradient from North to South, the reason for this is unknown. At 5 p.m., the temperatures on and off the bridge are almost identical.

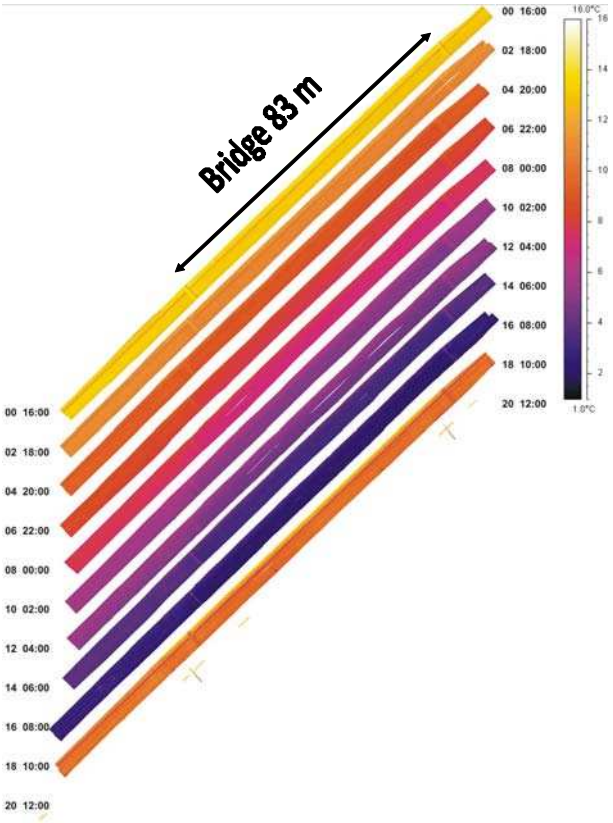

Figure 5 *Surface temperatures during 20 hours.*

Table 1 *Summary of surface temperatures.*		
	Off bridge	**On bridge**
Time 4 a.m.		
Min. temperature C	4.71	4.34
Max. temperature C	5.18	4.61
Mean temperature C	4.96	4.48
Time 5 p.m.		
Min. temperature C	12.07	11.92
Max. temperature C	12.27	12.21
Mean temperature C	12.16	12.04

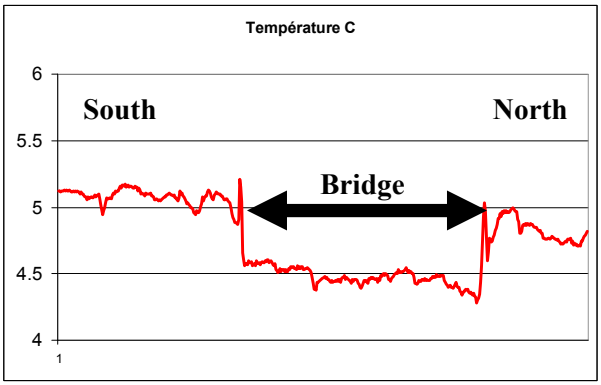

Figure 6 *Temperature profile at 4 a.m.*

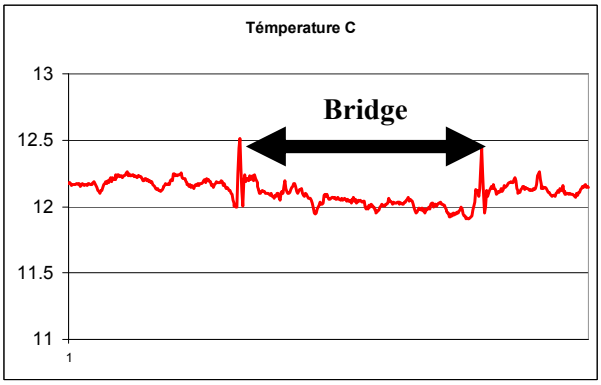

Figure 7 *Temperature profile at 5 p.m.*

Conclusions

An infrared survey was carried out on one lane of a motorway bridge during 20 hours with a mobile IR acquisition unit.
It was shown that the temperatures measured by stationary temperature probes are representative for the whole bridge deck. There are no relevant temperature differences on the bridge. Girders or other structures show no influence on the temperature on the bridge deck.
The temperature difference between on bridge and off bridge was less than 0.5 degrees C.

Acknowledgements

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References

FEDRO, Swiss Federal Roads Office, 2008, Report Nr. 653, Applicabilité de l'enrobe drainant sur les ouvrages d'art sur le réseau des routes nationals