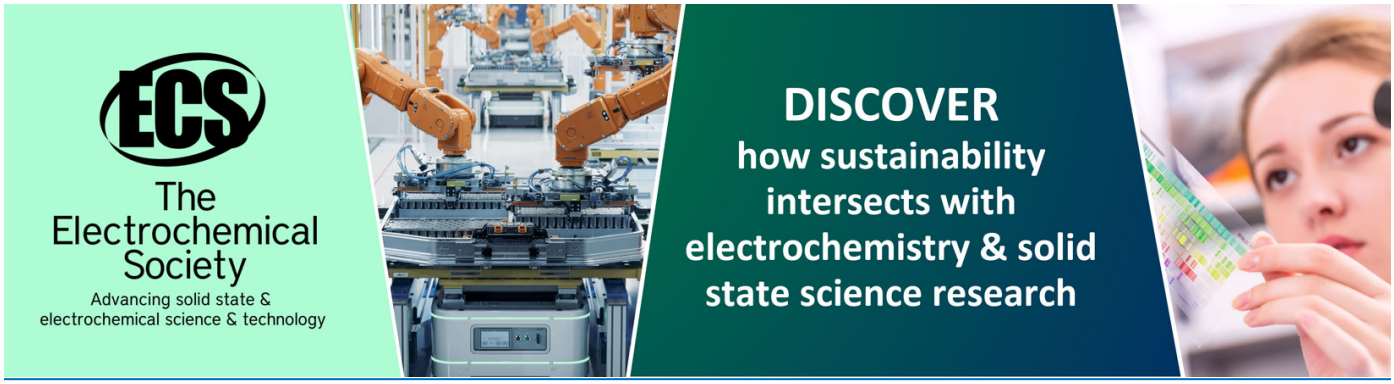
Motivational Bonus-System Based On Pavement Installation Temperatures Measurement By Thermographic System (TGS Pavement) In Estonia



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MOTIVATIONAL BONUS-SYSTEM BASED ON PAVEMENT INSTALLATION TEMPERATURES MEASUREMENT BY THERMOGRAPHIC SYSTEM (TGS PAVEMENT) IN ESTONIA

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Abstract. Paving is one of the most crucial stage in the matter of road lifespan, since it is the surface layer that has stand up to all the external factors (weather, traffic etc.). Insufficient pavement density caused by thermal segregation during paving works can reduce the lifespan significantly, especially in Estonian climate (freeze-thaw cycles). Modern technology offers different solutions to reduce the risk of low quality in asphalt production and road paving works. Mobile asphalt plant, feeder and thermo-isolated trailers are some piece of equipment, that contractor can use to level up the minimal required quality requirements. The question is, when to use those and which to use? Moreover, is there any possibility to motivate the contractors to put in some extra effort? In Estonia, motivational bonus-system has been established to encourage innovation and reward the extra effort that has been made for quality improvements. The methodology is based on years of experience gained in different researches and pilot-projects. There are no strict rules for the road paving equipment in the methodology – for example contractor can choose himself either the feeder or/and thermo-insulated trailers are used on not. The main requirement is that the temperatures of entire paving process (surface layer) has been measured and analyzed by special thermographic system. Current presentation discusses the symbiosis of bonus-malus system and development of special thermographic system (TGS Pavement) as a multifunctional tool in asphalt paving in Estonia.

Keywords: road, pavement, paving, segregation, homogeneity, thermography, bonus-malus system

Introduction

Paving is one of the most crucial stage in the matter of road lifespan, since it is the surface layer that has to stand up all the external factors (weather, traffic etc.). Insufficient pavement density caused by thermal segregation during paving works can reduce the lifespan significantly, especially in Estonian climate (freeze-thaw cycles). Current presentation discusses the symbiosis of bonus-malus system and development of special thermographic system (TGS Pavement) as a multifunctional tool in asphalt paving in Estonia.

1. Traditional pavement installation measuring method

Asphalt paving temperature measuring is a standard procedure in paving process. The idea and need for this kind of measurement is to assess the quality of pavement homogeneity, segregation and density. In most countries the current practice is that the measurement is done by supervisor using an ordinary spot temperature thermometer. Although nowadays many hand-held systems have been developed and even portable IR cameras are affordable and widely used, this method is really superficial and actually does not give us any valuable information about the pavement quality at all. Why? Measurement made by traditional spot method represents only one single point temperature and is not giving any information about pavement homogeneity in transverse and longitudinal direction. Even more, spot measurements are strongly influenced by measurement distance and angle (different at each measurement), non-systematically stored and not geo-reference, which makes it impossible to link any future defect with the paving temperature of investigated pavement area.

2. Innovative solutions for pavement temperature quality measurement

What roadowner actually needs for pavement quality assessment, is a continuous pavement installation temperature measurement across the entire pavement freshly laid (length and width). Nowadays there are only few technical IR solutions in the world that can provide a data collection, which would be really useful for pavement installation quality monitoring. All these systems are slightly different from the technical parameters and data analyzing software possibilities, but the purpose is the same – irreplaceable tool for pavement quality monitoring and assessment.

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One of the devices on the market is TGS Pavement - innovation by Teede Tehnokeskus, Estonia (see figure below). TGS Pavement's main specifications are:

- Real-video and data monitoring (both on jobsite and in the office)
- Temperature measurement across the entire pavement laid (length and width)
- Temperature measurement for each 10x10 cm
- Geo-referenced data (high precision GNSS)
- 100% pavement quality reporting
- Easy to install and use
- Works with any paver type

Figure 1. TGS Pavement thermographic system attached to paver.

As in most countries, the use of thermographic system while paving asphalt is not required by roadowners, the systems are mostly used by innovative asphalt paving contractors only, to monitor their own quality. Now as we see the benefit for both parties (roadowner and contractor) of the system, how can we popularize the usage of it?

3. Motivational bonus-system in Estonia

Modern technology offers different solutions to reduce the risk of low quality in asphalt production and road paving works. Mobile asphalt plant, feeder and thermo-isolated trailers are some pieces of equipment, that contractor can use to level up the minimal required quality requirements. The question is, when to use those and which to use? Moreover, is there any possibility to motivate the contractors to put in some extra effort?

In Estonia, motivational bonus-system has been established to encourage innovation and reward the extra effort that has been made for quality improvements. The idea of the methodology is that if the pavement installation quality is higher than the minimum requirements, then the contractor is able to earn bonus (up to 5% of the contract fee). The bonus calculation has two components:

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- Bonus for avoiding paver full-stops while paving
- Bonus for avoiding risk-areas

Paver stop is counted when the paver stays in the same location for at least 2 minutes (to earn bonus it is allowed to make 5 stops in the length of 1000 meters of paving). Risk-area is an area with installation temperature lower than the average temperature of the last 100m of pavement installation temperature (the percentage of risk-area has to be lower than 5% to earn bonus).

The methodology is based on years of co-operation between Estonian Transport Administration, Teede Tehnokeskus and multiple asphalt paving contractors in Estonia. The basic criteria was, that there should be no strict rules for the road paving equipment in the methodology – for example contractor can choose wheather the feeder or/and thermo-insulated trailers are used on not. The main requirement is that the temperatures of entire paving process (surface layer) has been measured and analyzed by special thermographic system.

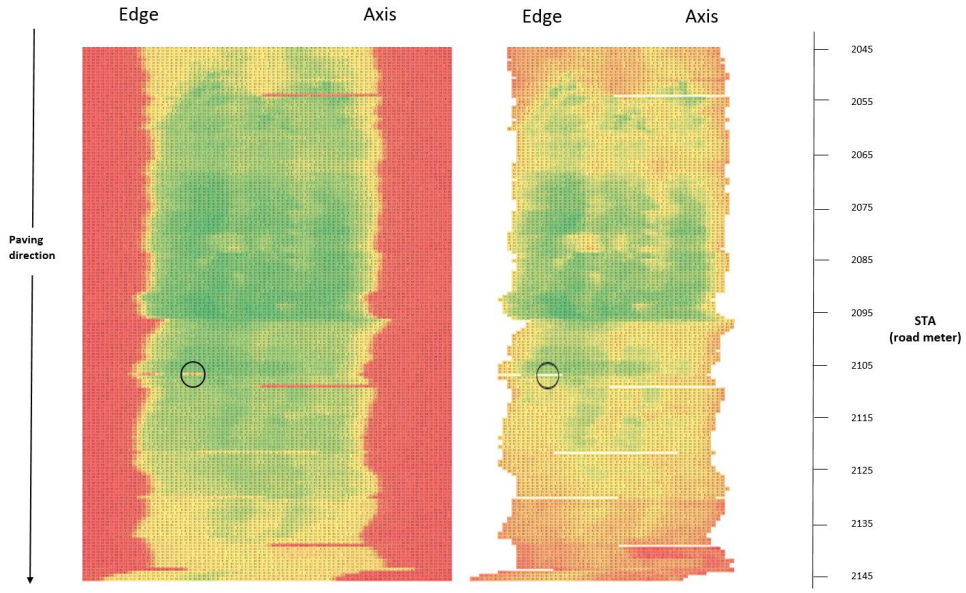

Figure 2. Data analyzing process (raw data on the left side and cleared data on the right side).

The first pilot projects took place in 2016 – three test sites in total length of ca 18 kilometers. In 2020 the numbers had increased to more than 40 jobsites in total length more than 230 kilometers. On that basis it can be stated that the methodology fulfills the purpose.

4. Additional benefits of TGS Pavement

Most clients have seen the benefit of the thermographic system and it has become more and more popular to use the system all the time – even on the sites where it is not able to earn bonus. Why? The system offers feedback and confidence for the contractor, that their quality meets the requirements. If there is any issue with machines (paver, feeder, non-insulated trucks) or really un-homogeneity pavement or the weather (wind, low temperatures) affect to the pavement temperature, then the information is immediately available and contractor can make decisions in the blink of an eye. That saves great amount of money every year for system users.

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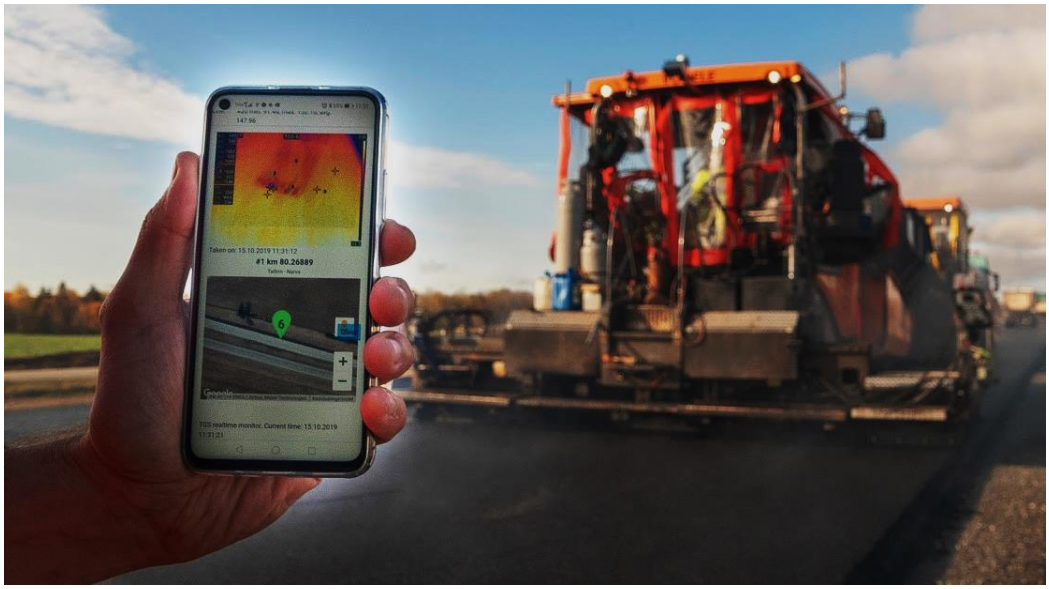

Figure 3. Pavement installation real-time monitoring on jobsite (using Wi-Fi or 4G)

The system is user-friendly, as it transforms the results into dynamic images and graphs that are easy to follow. The data is saved and uploaded to cloud, so that it can be monitored on-site or even across the world both in real-time or historically. Some of the most crucial information that can be captured for efficient planning and paving process:

- Weather information (possibility to use data from on-site weather station with forecast)
- Thermal map of full day (immediate feedback of thermal homogeneity)
- Whole cross-section temperature values
- Thermal images for decision making supporting

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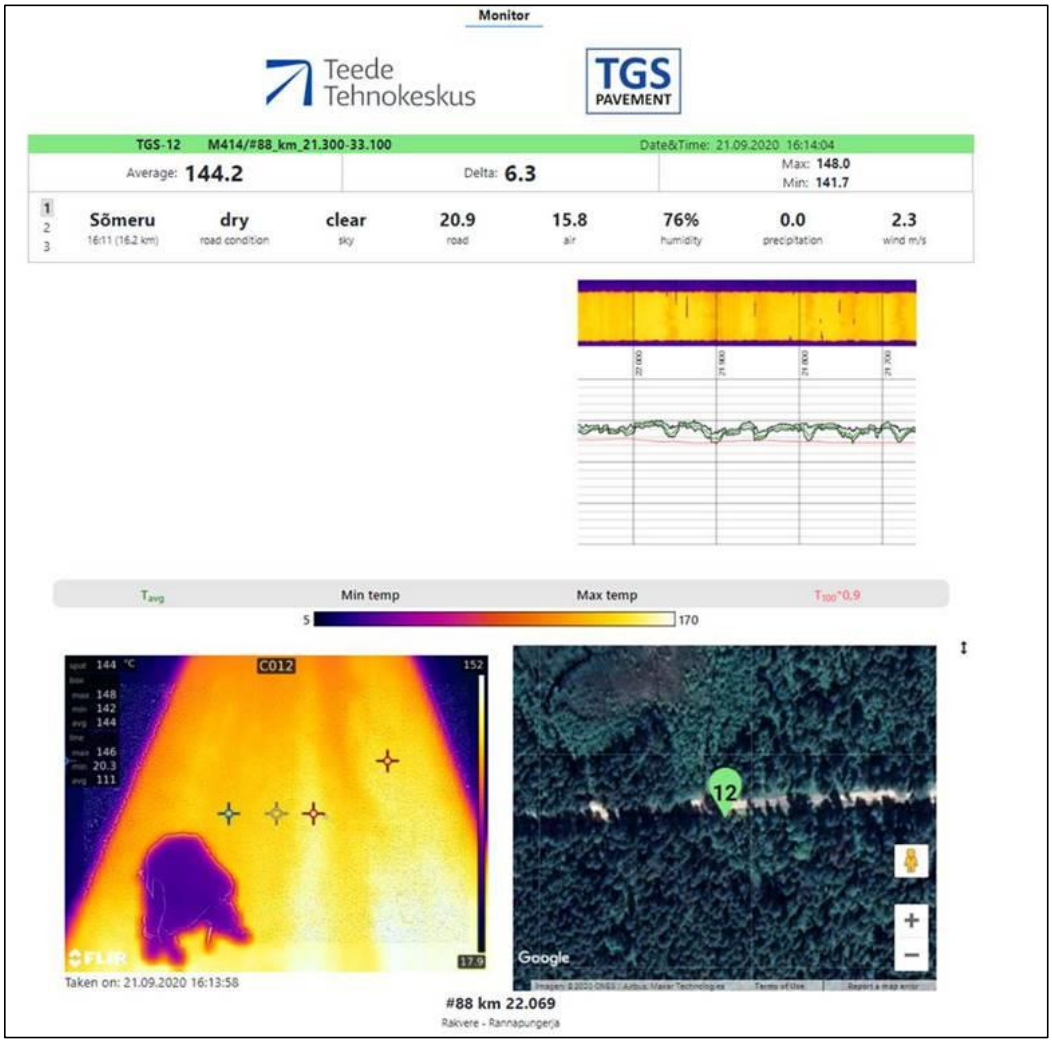

Figure 4. Pavement installation real-time monitoring in backoffice.

5. Conclusions

The most common reason for pavement failure is high-temperature segregation that causes uneven compaction that makes pavement susceptible to damage from moisture and freeze-thaw cycles. TGS Pavement is a thermographic system for pavement quality monitoring that is one of the few solutions in the world that provides real-time pavement quality reporting. Adding a motivational bonus-system to the paving process creates a solid foundation for maximizing the effort from each party.

In period 2019-2020, around 300 kilometers of state roads were measured and analyzed with TGS Pavement system. The pavement quality has become more stable and long-term users have polished their paving process to optimum. Most clients use the system in their everyday job, even if there is no opportunity for bonus.