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RFID sensors to measure the energy consumption of warm mix and recycled asphalt

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Abstract

Governments, regulatory bodies and road authorities all push for and promote sustainability. Contractors respond with strategies to reduce their carbon footprints. Besides optimising their asphalt production and logistics processes, companies are investing in the development of low energy asphalt mixes.

Warm Mix Asphalt (WMA) is such an asphalt mixture produced at lower temperatures, thereby requiring less energy. It has recently become very popular in the Netherlands with various types of WMA products being developed by construction companies. In essence, the asphalt mix is modified to reduce the viscosity and the mixture is therefore more flexible at lower temperatures enabling more time available for a very important part of the construction process viz. COMPACTION.

While essential research effort has been put into developing techniques for adjudicating WMA, optimising their composition and rationalising the design; less effort has been put into the operational handling and consequences regarding energy consumption and durability. In short, little is known about actual energy consumption during the asphalt compaction process.

By placing RFID sensors into the asphalt mixture, temperatures and pressures can be measured during laboratory testing and construction, but also during usage and maintenance of the road where additional RFID sensors can be added to measure weather conditions and other long-term parameters.

Keywords

RFID; asphalt; energy consumption; compaction temperature; vehicle load pressure; durability; energy

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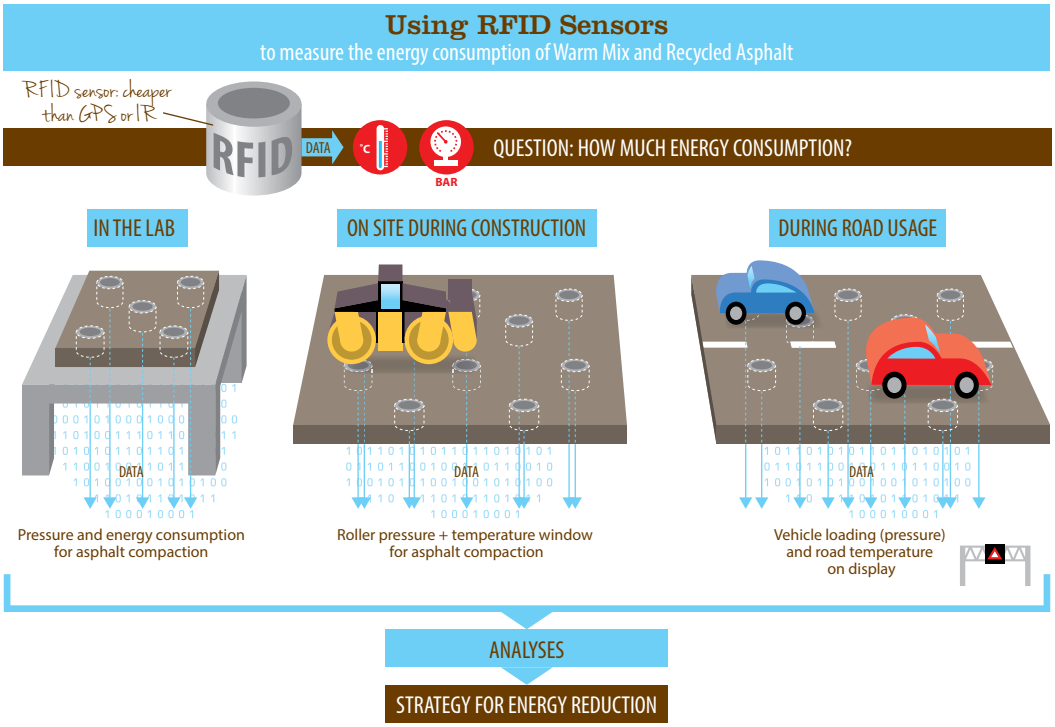

FIGURE 1 Graphical abstract

Concept

Simply put, we will determine energy consumption using Radio Frequency Identification (RFID) sensors. These rather clever sensors are currently experiencing a developmental boom given their potential. Over the last decade or so, RFID tags have been used by the retail and consumer goods to identify and track objects on a very large scale. Also, the last few years has seen much progress in making RFID a reliable, standardised wireless communication medium with the ability to mass produce low-cost RFID tags. RFID uses wireless electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects. Whilst many of today's wireless sensor technologies are still very expensive, RFID offers good potential for the development of pervasive sensors. In other words, we can use it to track certain process parameters in the testing and construction of asphalt. By placing RFID sensors into the asphalt mixture, temperatures and pressures can be measured during laboratory testing and construction, but also during usage and maintenance of the road where additional RFID sensors can be added to measure weather conditions and other long-term parameters. RFID sensors will be used to monitor:

- (1) compaction temperature and pressure during the laboratory testing process;
- (2) compaction temperature and pressure during the asphalt construction process;
- (3) vehicle load pressure and road surface temperature on the constructed asphalt layer over the long-term in terms of energy and durability.

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The main aim of the project is "To measure the energy consumption during asphalt construction using RFID-sensors and to determine the relationship with the asphalt quality (durability) of WMA using laboratory experimentation."

Method

The project activities include:

- Monitoring the energy consumption for different operational compaction strategies in the laboratory and during three field projects;
- Measuring the roller pressure, the number of roller passes and the temperature window for compaction using RFID-sensors;
- Drilling asphalt cores from the constructed road and determining the asphalt quality characteristics, such as resistance to rutting and cracking, in the laboratory; and
- Monitoring and displaying vehicle load pressure and road surface temperature on dynamic display boards.

The energy consumption during construction is focussed on: the roller type and pressure; the number of roller passes and temperature of the asphalt mixture during compaction.

This research starts with monitoring the asphalt temperature and roller pressure during laboratory testing and construction. If successful, the ambition is to use RFID sensors to monitor additional parameters such as ambient temperature, moisture and precipitation during the usage and maintenance of the asphalt road. This may also provide much-needed data for the planning of maintenance strategies and other necessary interventions. Furthermore, the RFID-sensors can be included as measuring instruments in the existing Process Quality improvement (PQi) monitoring framework developed in the ASPARi-network to monitor the on-site construction process of asphalt roads.

Results

The tangible results of this research project will be:

- Demonstrate the suitability of RFID-sensors in monitoring asphalt temperatures and compaction pressures during asphalt construction projects and laboratory testing;
- Demonstrate the usefulness of RFID technology in the dual role of dynamic data display and long-term data collection instrument
- Better understanding of the influence of different compaction strategies on asphalt quality characteristics for WMA.

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