

LIAISON

Making transport infrastructure
climate-neutral, sustainable and circular

INFOPACK - MAY 2026

SECTOR 4 OF 5
DIGITAL TOOLS

Digitalisation, Monitoring, Predictive Maintenance

Pavement management system

AI-POWERED MONITORING TO
ENABLE SAFER, SMARTER AND MORE
SUSTAINABLE ROAD MAINTENANCE

SECTOR 4 of 5
DIGITAL TOOLS



Roads are essential to economic activity and social well-being, but their performance depends on timely and effective maintenance. When surface distresses such as cracks or potholes are not detected early, they can compromise traffic safety, increase vehicle operating costs, and shorten pavement lifespan. Traditional road condition monitoring relies heavily on manual visual inspections, which are time-consuming, costly, subjective, and potentially dangerous for inspectors.

An Intelligent Pavement Distress Detection System has been developed to support a shift toward data-driven and preventive road maintenance. The solution combines low-cost image acquisition, artificial intelligence, and a web-based management platform to automatically detect, classify, and assess pavement distresses in a fast, reliable, and scalable way.

The system uses a vehicle-mounted camera setup based on a stabilised drone camera adapted for road operation. It captures high-quality pavement images at normal traffic speeds and associates them with precise GPS locations. This enables large volumes of data to be collected efficiently without disrupting traffic or requiring specialised inspection vehicles.

Advanced deep learning models analyse the images to identify a wide range of pavement distresses, including cracks, potholes, surface defects, and drainage elements. To overcome common data limitations, the system integrates generative AI techniques, which create synthetic images of underrepresented distress types. This improves model robustness and detection accuracy across diverse pavement conditions.

A key innovation is the development of an automated Pavement Condition Index, derived from AI-based detection and pixel-level segmentation of defects. Unlike conventional indices, it provides objective, repeatable assessments of defect type, severity, and extent, supporting transparent maintenance prioritisation. All results are visualised through a user-friendly web platform, where road authorities can upload inspection videos, view detected defects on an interactive map, analyse trends, and filter results by distress type. The cloud-based, containerised architecture ensures scalability, flexibility, and secure data management.

The system is being prepared for validation in collaboration with road authorities, with the aim of integrating it into existing maintenance workflows. By enabling early detection and targeted interventions, the solution supports preventive maintenance strategies, reducing long-term costs and environmental impacts.

BENEFITS



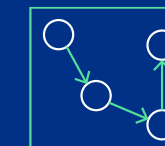
AUTOMATED DETECTION OF MULTIPLE PAVEMENT DISTRESSES USING AI



LOW-COST DATA ACQUISITION WITHOUT SPECIALISED INSPECTION VEHICLES



OBJECTIVE PAVEMENT CONDITION ASSESSMENT THROUGH AN AI-BASED INDEX



IMPROVED MAINTENANCE PLANNING AND PRIORITISATION



ENHANCED ROAD SAFETY THROUGH EARLY DEFECT DETECTION



LOWER LONG-TERM COSTS AND ENVIRONMENTAL IMPACT

ROADMAP TO IMPLEMENTATION

Definition of standard low-cost equipment (kit) for data acquisition

Enhancement of system robustness: ensure resilience against different scenarios

Pilot deployment by end user: monitoring of fully real operational conditions

Normalization, standardization of metrics for pavement condition index

Dissemination of system capabilities to potential users

Integration into the existing road-maintenance ecosystem

Digitalisation, Monitoring, Predictive Maintenance

Weigh-In-Motion System using Optical Fiber Sensor

REAL-TIME TRAFFIC LOAD MONITORING
FOR SMARTER, SAFER AND MORE
SUSTAINABLE ROAD PAVEMENTS

SECTOR 4 of 5
DIGITAL TOOLS



Heavy vehicle overloading is a major challenge for road infrastructure across Europe. Excessive axle loads accelerate pavement deterioration, increase maintenance costs, and raise safety risks, while enforcement is often limited by the disruption caused by traditional control methods. Weigh-In-Motion (WIM) systems offer a way to monitor vehicle loads in real time without stopping traffic, but conventional technologies can be costly, difficult to install, and sensitive to environmental conditions.

An innovative WIM system based on optical fiber sensors is being developed and integrated into precast concrete pavement slabs. The solution combines advanced sensing technology with modular, low-carbon construction to enable continuous, accurate monitoring of traffic loads while supporting more sustainable pavement design and maintenance. At the core of the system are Fiber Bragg Grating optical sensors that are highly sensitive to strain, immune to electromagnetic interference, lightweight, and capable of multiplexing multiple measurements along a single optical fiber. Unlike conventional electronic sensors, they are electrically passive, durable, and suitable for long-term operation in harsh road environments. To ensure reliability during concrete casting and service life, the sensors are

housed in a specially designed protective casing. This casing has been optimised through finite element modelling and validated through laboratory compression tests to amplify sensor sensitivity while protecting it during installation. A temperature decoupling mechanism further improves accuracy by separating mechanical strain from thermal effects.

The WIM-enabled slabs are manufactured using industry-friendly geopolymer concrete, significantly reducing the carbon footprint compared to conventional Portland cement concrete. The modular slab design allows rapid installation, easy replacement of damaged elements, and minimal disruption during maintenance works. A 30-metre demonstration section will validate the system under real traffic conditions.

Data collected by the sensors are transmitted to a digital platform where AI-based algorithms process the information in real time. A dedicated graphical interface allows infrastructure operators to visualise loads, track trends, and set alerts when threshold values are exceeded. This supports proactive maintenance strategies, enforcement planning, and asset management decisions. By combining low-carbon materials, optical fiber sensing, and digital monitoring, the solution enables longer pavement service life, reduced maintenance costs, and improved road safety.

BENEFITS



ACCURATE REAL-TIME VEHICLE LOAD MONITORING WITHOUT TRAFFIC DISRUPTION



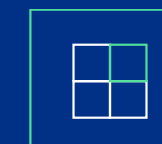
HIGH DURABILITY AND RELIABILITY THROUGH OPTICAL FIBER SENSING TECHNOLOGY



REDUCED PAVEMENT DAMAGE CAUSED BY OVERLOADED VEHICLES



LOWER MAINTENANCE COSTS AND EXTENDED SERVICE LIFE



EASY INTEGRATION INTO MODULAR PRECAST PAVEMENTS



SUPPORTS ENFORCEMENT, ASSET MANAGEMENT, AND SUSTAINABILITY GOALS

ROADMAP TO IMPLEMENTATION

WIM System Design

WIM Prototype Build

WIM Lab Validation

WIM Slab Integration

WIM Field Deployment

WIM Dashboard Setup



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