SMART-DECK

The durability of road bridges made of strengthened concrete is endangered in particular by chlorides seeping into the concrete due to damaged waterproofing, joints and transition profiles. Corrosive damage to the reinforcement steel usually only becomes visible on the upper side of a bridge once a substantial amount of damage has already been done. Furthermore, the higher volume of traffic on some bridges is leading to deficits in terms of their shear force and flexural load-bearing capacity in transverse direction.

SMART-DECK – a multifunctional, intelligent strengthening and protective system – is aimed at preventing the described defects by means of modular functionalities. The system is intended to permit for the first time full-area real time moisture monitoring, section-by-section controllable preventive cathodic corrosion protection (pccp) as well as an increase in the load-bearing capacity in transverse direction in existing bridges.

Monitoring permits damage at the waterproofing level to be recognised at an early date and – in combination with the pccp – impediments to traffic to be avoided. A renewal of the road surface of the bridge is not immediately necessary but can be postponed for years to time periods with favourable traffic levels.

Monitoring, pccp and the strengthening effect are achieved using two textile carbon layers combined with a special mortar. The strengthening layer is intended to enlarge both the shear force and the flexural load-bearing capacity of the carriageway slab in transverse direction without significantly increasing the dead weight of the load-bearing structure.

The textile concrete intermediate layer is installed on the upper side of the carriageway slab of the bridge between the existing load-bearing structure and bridge flooring. The condition of the carriageway waterproofing can be monitored section by section due to the division into fields in the longitudinal direction of the bridge.

SMART-DECK is aimed at unifying the functionalities described in a modular manner. If, for example, there is no load-bearing deficit, the load-bearing capacity need not be enlarged in order to economise on a part of the carbon strengthening and increase economic efficiency.

Mode of function

SMART-DECK consists of a thin layer of moisture-sensitive mortar, PCC (polymer cement concrete) with a maximum aggregate size of four millimetres. The mortar layer is strengthened with two carbon layers seeped in epoxy resin, the position of which to each other is secured by spacers. The sections of textile strengthening can be up to 20 square metres in size and each represent a sensor which is separately controlled.

Overview of the functionality of the SMART-DECK monitoring system and the condition of the waterproofing; green: intact, yellow: significant drop in resistance; red: limit resistance value undercut, leaks exist, and pccp necessary (source: ibac)
via a bus system. Using calibration curves, the moisture content of the mortar is determined by measuring the electrical resistance between the two carbon layers. A drop in resistance indicates a leak in the waterproofing because lower resistances are associated with a high water saturation content of the mortar.

Using a status display, the operator is able to monitor the electrical resistance via mobile radio or internet in real time, thereby drawing conclusions as to the condition of the waterproofing.

If it is not possible to repair a damaged bridge promptly, the necessary construction work can be postponed to more favourable periods by activating the pccp, which builds up an electric field between one textile layer and the reinforcement steel to cathodically polarise the reinforcement steel. This counteracts the corrosion of the reinforcement steel and therefore prevents its depassivation.

**Small demonstrator**

After the creation of a catalogue of requirements and the development of a mortar system, a textile reinforcement and a measurement system, a demonstrator was built in April 2016 on the site of BASf for evaluation and optimisation the overall system outside the laboratory scale.

The functionality of the monitoring system was successfully verified by temperature and moisture (multi-ring electrode) measurements. The monitoring data can be retrieved at any time via the Internet via a remote desktop connection. The pccp functionality was also successfully tested. In addition, component tests were carried out on larger sawn segments to investigate the load-bearing behaviour in the laboratory.

It could be shown that the SMART-DECK layer can significantly increase the bending and transverse load bearing capacity of the bridge deck slab.

**Large-scale demonstrator**

After a final optimisation of the individual components, the SMART-DECK system was applied for the first time in summer 2019 on a bridge structure to validate the concept under real construction site conditions and to evaluate it under traffic conditions.

SMART-DECK is applied on a new bridge building in Mönchengladbach which carries over the Niers. The road administration of Mönchengladbach will continuously receive information about the condition of the sealing system and thus an important operating parameter for maintenance planning.

**Project partners**

The SMART-DECK project is supported by the Federal Ministry of Education and Research (BMBF) as part of the “HighTechMatBau” funding programme.

- Eurovia as network coordinator
- BASf
- instakorr
- Massenberg
- RWTH Aachen (ibac, IMB)
- StoCretec
- solidian GmbH

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**Published by**
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July 2019