D3.1
Conceptual design of the GFRP deck elements and its connections

SURE BRIDGE
Sustainable Refurbishment of Existing Bridges

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Conceptual design of the GFRP deck elements and its connections

Colophon

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The information in this publication does not necessarily represent the view of the Infravation.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement No. 31109806.0009.

SUREBRIDGE project is co-funded by Funding Partners of The ERA-NET Plus Infravation and the European Commission. The Funding Partners of the Infravation 2014 Call are:
MINISTERIE VAN INFRASTRUCTUUR EN MILIEU, RIJKSWATERSTAAT
BUNDESMINISTERIUM FÜR VERKEHR, BAU UND STADTENTWICKLUNG,
DANISH ROAD DIRECTORATE,
STATENS VEGVESEN VEGDIREKTORATET,
TRAFIKVERKET – TRV,
VEGAGERÐIN,
MINISTERE DE L'ECOLOGIE, DU DEVELOPPEMENT DURABLE ET DE L'ENERGIE,
CENTRO PARA EL DESARROLLO TECNOLOGICO INDUSTRIAL,
ANAS S.p.A.,
NETIVEI, ISRAEL - NATIONAL TRANSPORT INFRASTRUCTURE COMPANY LTD,
FEDERAL HIGHWAY ADMINISTRATION USDOT

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1 Executive summary

The SUREBridge solution aims to be a full refurbishment solution for existing concrete bridges, offering both an increase in load bearing capacity and the possibility to change the functionality of the bridge.

The SUREBridge solution does this by offering a flexible strengthening solution that is a combination of externally bonded prestressed CFRP strengthening strips (at the bottom and sides) and a GFRP deck at the top of the bridge. The FRP deck is constructed from modular, easily transportable and installable deck elements and is connected to the substructure in such a way that there is composite action between the existing concrete structure and the FRP deck.

This deliverable outlines the rationale behind the concept development of the GFRP deck elements and its connections to the existing concrete substructure and neighbouring deck elements. As this deliverable focuses on the concept design, a simplified deck is assumed, with perfect connections with its surroundings. This assumption will be tested at a later stage using experimental testing and more elaborate modelling in the detailed design phase.

Based on a number of top-level requirements regarding the offered increase in load bearing capacity, lifespan increase and acceptability – both financially and technically – a structural concept for the deck itself is selected out of a number of candidates. The proposed solution, InfraCore provides a high level of structural integrity (robustness, damage tolerance), has a proven track-record for heavy traffic applications and is proven economical. A first design is proposed, based on the experience of the manufacturer. As the structure is ‘sandwich-like’, it provides a bending stiffness of itself and is effective in spreading highly localized loads to the supporting structure. As such, it relieves the (possible damaged) substructure.

Based on the geometry of the proposed InfraCore deck, a number of options for the FRP-FRP and FRP-concrete connections was investigated. The selected FRP-FRP connection is capable of transferring most internal forces between deck elements. As such, the connection allows assembling a complete deck out of smaller elements, without reducing the load bearing capacity. A practical geometry for the connection is proposed, the capacity is estimated. Test specimens are produced to be tested.

To complete the SUREBridge solution, a number of possible concepts for the FRP-concrete connections have been developed from experience and literature study. As all concepts promise a similar performance level, a test is setup to determine the capacity and practicality of all concepts.

All elements combined form the SUREBridge solution. To assess the effectiveness of the solution and determine first order geometry and mechanical requirements for the design, a finite element analysis on a simplified plate bridge has been performed.

Strengthening the concrete deck using CFRP prestressed strengthening and GFRP InfraCore decking, increases live load capacity with a factor > 2,5. Shear stress on the bonded joint between concrete and deck is < 0,5MPa, which is expected to be well-achievable by all proposed FRP-deck connection options.

The expected live load increase shows a possible upgrade of the San Miniato bridge to modern Eurocode standards if no widening option is selected. For the San Miniato bridge, option A1 was determined to be achievable as a limited widening is required to provide more comfort to passing traffic.