



Looking
at the future
SUREbridge



Building the future



Our generation can no longer close its eyes. More and more bridges and viaducts no longer meet the needs and requirements of our time. Stronger structures are required due to more and heavier traffic. Where highways are widened for increasing traffic, bridges and viaducts can not stay behind. Outdated constructions require costly maintenance, or have to be demolished and rebuilt. This is not a sustainable solution, not to mention the hindrance during the construction. Nowadays a bridge must be **stronger, wider, maintenance-friendly** and **sustainable**.

The **SUREbridge**-method offers the solution.



That's why: SUREbridge

Road transport is expected to double over the next twenty years (source: European Construction Technology Platform). Bridges and viaducts are among the biggest bottlenecks in the road network. Restoration and widening require innovative concepts in order to come to solutions that are socially acceptable and financially attractive.

Europe has about one million concrete bridges and viaducts. Dated structures that are at the end of their technical life require expensive maintenance, or have to be demolished and rebuilt. This is simply not sustainable, not to mention the long period of nuisance for traffic and local residents. The contemporary bridge must be stronger, wider, maintenance-friendly and sustainable.

The SUREbridge-method, which retains and strengthens the existing structure, offers the solution.

SUREbridge

SUREbridge (Sustainable Refurbishment of Existing Bridges) was initiated in 2014. It was one of the nine projects within Infravation, a joint venture between ten European countries, the United States and the European Commission. Together they stimulated innovations to improve the infrastructure. The Infravation (Infrastructure Innovation Program) participants focused on developing new materials and techniques to modernize the outdated road infrastructure on both continents. Rijkswaterstaat acted as coordinator and worked closely with sister organizations in the countries involved.

Chalmers University of Technology (Sweden), University of Pisa (Italy) and AICE Consulting S.R.L. (Italy) have teamed with FiberCore Europe to realize SUREbridge. Using the InfraCore® Inside technology from FiberCore Europe, both the capacity and functionality of existing concrete bridges are increased. The service life is therefore considerably extended, while hardly any maintenance is required.

- Possible to widen existing structures
- Hybrid constructions possible
- Lifespan up to 100 years
- Light in weight: saving on transport and foundation, among other things
- Simple, quick assembly
- Existing constructions do not have to be demolished
- Less noise pollution
- Low maintenance
- No fatigue or corrosion
- UV resistant
- Fire retardant
- Designed according to CUR96:2017

The technology is based on the fiber-reinforced polymer (composite) bridge decks FiberCore Europe has been producing for many years. By using InfraCore® Inside technology, existing concrete structures do not have to be demolished, but can be reused with small adjustments. This provides important advantages for owners of bridges:

- Shorter construction time, so less inconvenience for road users and local residents
- More strength and stiffness, so more load-carrying capacity
- Longer lifespan, virtually without maintenance
- No fatigue or corrosion
- Reduced environmental impact

Hybrid solution and saving

The concept of SUREbridge is based on a load-bearing composite InfraCore® Inside deck at the top of the bridge. If desired, the new deck can also be wider than in the existing situation. Together with the pre-stressed carbon reinforcement at the bottom of the existing bridge, this hybrid solution offers more strength and stiffness, while the weight hardly increases. According to Chalmers Technical University, this can save up to eight billion Euros in the EU alone: *'Assuming that the proposed method, in the least optimistic case, would result*

20% reduction in the refurbishment costs, it would result in a saving equivalent to € 8,000,000,000. It is worth mentioning that this figure is just the saving in the initial cost.'

FiberCore Europe has worked closely with Chalmers Technical University and the Italian engineering firm AICE to come to a definitive design. As an innovation process, SURE-bridge has been completed and tested in a full-scale test with impressive results. SUREbridge has been further developed into a technology that can be used by everyone.

Sustainable and robust renovation

SUREbridge is a total solution for the renovation of existing concrete bridges. The load-carrying capacity of damaged concrete bridges is increased by combining two techniques:

- Extra compression capacity through renovation with an InfraCore® Inside composite deck at the top
- Extra tensile capacity due to the (pre-stressed) external carbon reinforcement at the bottom

Full scale tests have shown that adapting a bridge or viaduct with the SUREbridge-method can make the construction approximately 2.5 times stronger.

Longer lifespan lower maintenance

This is how it works



Strengthening with the SUREbridge-method is achieved by increasing the cross-section of the bridge with an additional FRP compression zone at the top and extra carbon tensile reinforcement (pre-stressed or not) at the bottom. This reinforcement only works if all components work together. This is achieved by applying the FRP panel to the bridge in a shear-resistant manner. The panel is first mounted on levelling bolts, after which the gap is filled with low-shrink concrete mortar. Due to the applied roughness on the underside of the composite panel and the roughness of the top of the concrete, the intermediate layer transfers the shear stresses. With the levelling possibility, dimensional deviations from the substructure can be compensated and the bridge deck can be given a crowned or sloping cross fall.

INFRACORE® INSIDE

InfraCore® Inside technology has been specifically developed for heavy-duty composite (fiber-reinforced polymer) load bearing structures. The InfraCore® Inside technology is based on the principle that there is a continuous structural connection of glass (or carbon) fibers between the top and bottom of the structure, which prevents delamination. InfraCore® Inside technology does not have resin-dominated fracture surfaces.

The technique has been tested for a combination of load, fatigue and damage due to impact load. As a result, it has been proven that InfraCore® Inside technology does not result in delamination as a result of fatigue on a damaged panel (due to a shock load, accident or a construction fault). Cracks in pultrusion systems (fibers in one direction) or delamination in sandwich constructions (unconnected upper and lower skin of the structure) can lead to problems in FRP applications due to the risk of an initially small crack or damage growing to unacceptable damage and eventually fatal collapse. That is impossible with InfraCore® Inside technology.

InfraCoreinside

INFRAVATION

Rijkswaterstaat – the national road and waterways authority of The Netherlands – coordinated Infracore, an international program for smart innovations in the construction and maintenance of roads and bridges. Infracore (a combination of Infrastructure Innovation) was a joint venture between road authorities from Germany, France, Spain, Italy, Denmark, Norway, Sweden, Iceland, Israel, the Netherlands and the United States. Including co-financing from the EU, Infracore had a budget of nearly ten million Euros.

Goals and challenges

Infracore was initiated to accelerate the application of promising innovations in the construction and maintenance of roads and bridges in order to achieve lower costs, less traffic and less environmental impact.

The most important challenges

- Advanced predictive infrastructure performance processes
- Enhanced durability and life-time extension
- Rapid and non-destructive methods for routine quality and performance checks of materials and construction
- Keeping freight routes open through zero-intrusive maintenance
- Ensuring infrastructure performance under all weather conditions
- Resource and energy efficiency in road construction and maintenance (eco-design)
- Virgin material reduction by substitution or recycling

Projects

An international call yielded more than a hundred project proposals. After a first evaluation round, the 25 most promising ideas remained. These were subsequently selected by priority by an international panel of independent experts. Nine projects were financed with the available budget, including SUREbridge.

Collaboration

Communication about Infracore was provided by partner FEHRL, an international collaboration of research institutes in the field of road infrastructure. For the Dutch market, there is cooperation with the Infra-innovation network, facilitated by knowledge platform CROW. This platform serves as a source of information to facilitate the use of and knowledge about the future Infracore innovations. Municipalities and provinces are informed via this channel. Each of the participating countries is making efforts to make the results reach the asset managers of that country.

AICE
CONSULTING



CHALMERS
UNIVERSITY OF TECHNOLOGY



UNIVERSITÀ DI PISA

FIBERCORE EUROPE

FiberCore Europe is the specialist and market leader in load-bearing FRP structures (fiber-reinforced plastic) for the infrastructure sector. The company's InfraCore® Inside technology is patented worldwide and already applied in twenty countries. The technology is used in bridges, bridge decks and lock gates. FiberCore Europe has realized a trend change in a short time with building more than seven hundred structures. From bicycle/pedestrian bridges to road bridges and lock gates. FiberCore Europe supplied, among other things, the largest lock gates ever made in FRP of more than 13 x 6.2 meters (h x w) for a lock of Rijkswaterstaat in the Wilhelminakanaal in Tilburg (The Netherlands).

In addition to concrete and steel, FiberCore Europe has put FRP on the map as a serious and mature construction material. The composites constructions of the fast growing company have proven themselves as light weight, load bearing and heavy duty. In use they are strong, low-maintenance and durable.

Application of SUREbridge in projects

Each bridge is different and therefore it must be decided per project what the possibilities are with the SUREbridge-method, what the costs are, and whether this approach is realistic. Because SUREbridge reuses the existing structure, an inspection and re-analysis must be available for the concrete construction.

Ideally, there are also results of material tests, so that the actual strengths and also the depth of chloride penetration, for example, are known. The owner must have a package of requirements in terms of load (traffic class and traffic intensity) and functionality (cross section). Then the feasibility can be determined. This is not only about structural aspects, but also about practical aspects such as panel geometry and execution.

Various engineering firms can carry out such feasibility studies from their range of services offered. The FRP expertise will initially be provided from the SUREbridge consortium, but the expectation is that the consultancies will become more and more self-sufficient. If the feasibility is promising, then a detailed analysis follows, on the basis of which a cost estimate and duration of the works can be determined. This will be a combination; FiberCore Europe can work closely together with a contractor.





Building the future

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