Carbon tension members for bridges: Sustainable and economically efficient construction

About this project

NeZuCa

Carbon tension members for bridges: Sustainable and economically efficient construction

Markets:

Material: Carbon fibres, Carbon-fiber reinforced plastics (CFRP)

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Energy.

Technology Transfer Program Leichtbau

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Context

Network arch bridges with innovative carbon fibre tension members allow for a slim, CO#-efficient and economically advantageous design. This makes them particularly suitable for bridges with medium and large spans, including railway bridges subject to high loads from heavy goods traffic. Carbon tension members offer significantly higher strength and a longer service life under fatigue loading than steel tension members. The carbon fibre design enables much thinner cross-sections for the tension members. In addition, the lower modulus of elasticity of the carbon fibres reduces local load concentrations and allows savings to be made on the overall structure through the use of a lighter deck slab.

The high-performance fibres used fundamentally change the load-bearing behaviour of the system. For this reason, questions regarding load-bearing behaviour, actual fatigue resistance and equivalence under fire exposure still need to be investigated and the findings standardised in a further step.

Purpose

The aim of the NeZuCa research project is to establish carbon tension members as a technically recognised alternative to steel tension members in network arch bridges. The project team is carrying out extensive fatigue tests to determine the load-bearing behaviour and fatigue strength in a generally valid manner.

The extensive fatigue tests on various cross-sections are intended to lay the foundations for a general technical approval or a product release by DB InfraGo for this construction method. To date, bridges with carbon tension members can only be used with approval in individual cases.

The innovative construction method with carbon hangers offers enormous potential for the construction of bridges with large spans. A current example of realisation with approval in individual cases is the railway bridge over the Oder near Küstrin, which will be completed in 2024 (German Bridge Construction Award 2025). NeZuCa project partners were directly involved here. The savings potential in the overall structure also results in advantages in terms of the carbon footprint.

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Procedure

The project team includes representatives from research institutions, operators, clients and planners. In the test halls of the participating research partners, investigations are carried out on various cross-sections under static and dynamic loads and the behaviour of the carbon tension members is analysed until failure in order to derive a failure function for the fatigue resistance. The researchers are investigating the behaviour under increased load conditions in the low frequency range. The investigations are rounded off with component fire tests in special test rigs to evaluate the behaviour of the carbon components under fire load in comparison to classic steel tension members.

The project team uses the data obtained directly to develop standardised calculation models and design rules. These findings will help to establish the use of carbon tension members as a generally recognised solution for bridge construction projects in the railway sector. There is also considerable potential for future application on road bridges and in the renovation of bridges.

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Funding duration:

Funding sign:	03LB3013	**Funding amount:**	EUR 2.5 million

Final report

Further websites

foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3013A - NeZuCa in the federal funding catalogue

www.brueckenbaupreis.de/dbbp-2025/#kuestrin2025 - German Bridge Construction Prize 2025

www.bam.de/Content/DE/Projekte/laufend/NeZuCa/nezuca.html - BAM's NeZuCa project website

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Project coordination

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DB InfraGO Aktiengesellschaft

Lightweighting classification

	Realisation
Offer	
Products Parts and components	✓
Services & consulting Testing and trials, Validation	✓

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Lightweighting classification

	Realisation
Field of technology	
Design & layout Others (Infrastructure)	✓
Functional integration	
Measuring and testing technology	
Modelling and simulation Loads & stress, Reliability validation	✓
Plant construction & automation	
Recycling technologies	
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Filament winding, Pre-preg processing	✓
Forming	
Joining	
Material property alteration	
Primary forming	
Processing and separating	
Textile technology	

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Carbon-fiber reinforced plastics (CFRP)	✓
Fibres Carbon fibres	✓
Functional materials	
Metals	
Plastics	
Structural ceramics	
(Technical) textiles	