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 Climate Action.

Technology Transfer Program Leichtbau

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Context

Network arch bridges with innovative carbon fibre tension members allow for a slim, CO2-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 construction allows much thinner cross-sections for the tension members. In addition, the lower modulus of elasticity of the carbon fibres reduces local load concentrations and improves the dynamic properties.

The high-performance fibres used fundamentally change the load-bearing behaviour of the system. For this reason, issues relating to load-bearing behaviour, fatigue safety 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 load tests to determine the load-bearing behaviour and fatigue strength in a generally valid manner.

The extensive fatigue load 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. Up to now, bridges with carbon tension members can only be built with approval in individual cases, which makes construction considerably more expensive.

The innovative construction method with carbon hangers offers enormous potential for the construction of bridges with large spans. A current example of a 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's project partners were directly involved here. The high strength and long service life of carbon also have advantages in terms of the carbon footprint.

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Procedure

The project team is focussing on a large number of load tests with different cross-sections. Tests under static and dynamic loads are carried out in the test halls of the participating research partners and the behaviour of the carbon tension members is analysed until failure in order to derive a failure function for the fatigue strength resistance. The researchers are investigating the behaviour under increased load conditions in the low frequency range. The investigations are completed with component fire tests in special test benches in order 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.




Funding duration:

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

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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English (EN){{ Projektpartner }}

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	