

Brücke über den Seeblickweg

New Timber-Carbon Concrete Composite Bridge (HBV)

Executive Summary:

Conventional pedestrian bridges with steel-reinforced concrete decks are vulnerable to corrosion, require expansion joints and bearings, and demand long-term maintenance interventions.

The new pedestrian and cycle bridge over Seeblickweg in Stuttgart demonstrates an alternative structural approach: an integral timber-carbon reinforced concrete composite bridge (HBV) with a 290 mm thick composite slab incorporating non-metallic carbon reinforcement.

By eliminating steel in critical tensile zones and integrating carbon grids within the slab, the project achieves enhanced durability, controlled crack widths (≤ 0.15 mm), and reduced lifecycle maintenance.

The 69.2 m long structure, completed in February 2025, represents one of the first large-scale applications of carbon reinforcement within an HBV bridge system and was internationally recognized at the IABSE Awards 2025 in the Innovation category.



Project Background

Context

The Seeblickweg bridge was constructed to provide a safe, barrier-free pedestrian and cycling connection across a major roadway in Stuttgart-Neugereut.

The design objective was not merely replacement of an existing crossing but the realization of a durable, low-maintenance and materially efficient infrastructure solution aligned with modern sustainability targets.

Instead of a conventional steel-reinforced concrete superstructure, the design team selected a hybrid concept combining:

- Timber primary girders
- Reinforced concrete composite slab
- Non-metallic carbon reinforcement

The project integrates structural engineering innovation, sustainable material selection, and long-term durability strategy within a publicly funded urban infrastructure asset.

Location

Structure: Foot and Cycle Bridge over Seeblickweg

City: Stuttgart, Germany

District: Stuttgart-Neugereut

Client: Landeshauptstadt Stuttgart - Tiefbauamt

Geometry:

- Total length: 69.20 m
- Span arrangement: 30.23 m - 7.86 m - 29.92 m
- Bridge width: 4.00 m
- Usable width: 3.20 m

The bridge is part of Stuttgart's urban mobility network and ensures safe separation of pedestrian and bicycle traffic from vehicular traffic.

Scope and Objectives

Scope:

- Design and construction of a new integral HBV bridge
- Implementation of carbon-reinforced concrete slab
- Integration of composite action between timber and concrete
- Structural monitoring integration
- Completion and commissioning (April 2023 - February 2025)

Objectives:

- Eliminate corrosion-sensitive steel reinforcement in exposed zones
- Achieve crack width limitation ≤ 0.15 mm
- Minimize maintenance requirements
- Ensure structural robustness for long-term service life
- Optimize embodied CO₂ of the superstructure
- Demonstrate scalability of carbon reinforcement in bridge engineering

Methods and Materials

1. Structural System

The bridge is designed as an integral three-span HBV composite system, consisting of:

- Longitudinal timber main girders
- 290 mm thick reinforced concrete composite slab
- Central V-shaped intermediate support
- Monolithic connection between superstructure and substructure

The integral configuration eliminates bearings and expansion joints, reducing inspection and maintenance requirements.

2. Carbon Reinforcement System

Carbon reinforcement was integrated within the concrete slab in critical tensile regions.

Carbon mesh system from **HITEXBAU** GmbH (Typ 1 - 48K carbon rovings):

Key parameters:

- Tensile strength longitudinal: 2956 N/mm²
- Tensile strength transverse: 2871 N/mm²
- Elongation: 1.4 %
- Grid spacing: 45 × 33/25 mm

Approximate total installed carbon reinforcement: ~1.5 t

Additional non-metallic reinforcement elements include carbon shear connectors and GFRP reinforcement bars in selected zones.

3. Concrete System

- Structural slab thickness: 290 mm
- Crack width limitation: ≤ 0.15 mm
- Directly exposed walking surface (no additional waterproof membrane)
- Optimized fine-grain mix in reinforced zones

The carbon reinforcement enables reduced crack formation and eliminates chloride-induced corrosion risk.

Execution

Timeline:

- Construction start: April 2023
- Completion: February 2025
- Official opening: 12 February 2025

Engineering responsibility:

- Structural design and full technical planning: **Harrer Ingenieure GmbH**
- Scientific collaboration: **Technische Hochschule Augsburg**

The works included prefabrication of timber girders, installation of composite slab reinforcement, integration of monitoring systems, and staged assembly on site.

The project employed BIM-supported planning and detailed coordination during execution.

Challenges and Solutions

Composite Interaction

Challenge: Reliable shear transfer between timber and concrete under service and ULS.

Solution: Use of carbon shear reinforcement and optimized composite detailing.

Durability

Challenge: Exposed pedestrian bridge surface subject to weather and de-icing salts.

Solution: Non-metallic carbon reinforcement and controlled crack width ≤ 0.15 mm.

Structural Efficiency

Challenge: Achieving slender spans over 30 m while maintaining stiffness.

Solution: Integral system with central V-support and composite HBV behavior.

HITEXBAU GmbH

Innovative Carbon Grid Reinforcement

Sustainability

Superstructure embodied carbon: $\approx 95 \text{ kg CO}_2\text{-eq/m}^2$

Estimated reduction vs conventional steel-reinforced RC superstructure (engineering baseline comparison): **$\approx 35\text{-}45\%$ reduction** (assumption-based comparative model).

Outcomes

Structural Performance

- 69.2 m integral composite bridge
- 290 mm structural slab
- Corrosion-free reinforcement in critical zones
- High stiffness-to-weight efficiency

Environmental Performance

- Approx. $95 \text{ kg CO}_2\text{-eq/m}^2$ (superstructure)
- Reduced lifecycle maintenance demand
- Elimination of steel corrosion repairs

Innovation Impact

- Large-scale application of carbon reinforcement in HBV bridge system
- Research-monitored structure
- Recognition at IABSE Awards 2025 (Innovation category)

The bridge has been operational since February 2025 and serves as a reference project for hybrid timber-carbon composite bridge systems.

Conclusion

The Seeblickweg Bridge in Stuttgart exemplifies a shift toward material-efficient, corrosion-resistant and low-maintenance infrastructure.

By combining timber primary structure with carbon-reinforced concrete composite slab technology, the project demonstrates how hybrid systems can enhance durability while reducing embodied carbon and lifecycle costs.

The integration of non-metallic reinforcement within a 290 mm structural slab confirms the structural viability of carbon reinforcement in large-span pedestrian bridges and establishes a benchmark for future HBV bridge applications.