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Influence of the clamping effect of deck slabs in the area of the transverse frames and transverse bulkheads of composite bridges ICR No.: 21679N

Summary of the research project ICR No.: 21679N

Steel composite bridges are a well-established type of construction that can be used to create efficient and cost-efficient structures. In the design phase, a distinction is made between longitudinal and transverse systems. This project focuses on the transverse system, which absorbs the loads acting eccentrically to the shear center and transforms them into a bending or torsion state in the longitudinal system. In composite bridges with a box girder cross-section, the transverse system consists of the concrete deck slab and transverse frames, which can be supplemented by transverse bracing depending on the cross-sectional design.

The currently valid design standard EN 1994-2 allows the assumption of an articulated transition between the transverse frame and the deck slab in the calculation of the transverse system, provided that specific design conditions are met. A potential clamping moment resulting from the transverse bending stiffness of the composite joint at an acting plate rotation angle can therefore be neglected. While this assumption represents an accurate description of the stiffness conditions in the ultimate load-bearing capacity limit state, damage cases that have occurred show that this does not necessarily apply to fatigue-inducing loads. The primary objective of the project is therefore to identify the actual stress situation at the cross-frame connection so that a reliable design is also possible for the fatigue limit state.

First, the actual stresses on the cross-frame connection in the real structure are recorded by two monitoring measures. For the recalculation of targeted test loads, a numerical model is also being developed which allows the consideration of the transverse bending stiffness of the composite joint and represents the numerical basis for further investigations in the project. The findings from the test loads are deepened by component tests, which are tested both statically and dynamically. This allows statements to be made about stiffness ratios and stress distributions, and the fatigue behavior of the examined detail can be analyzed in more detail. In addition, the component tests validate the created numerical model so that a secure numerical parameter study can be carried out in the next step. This creates a statistically representative database that enables the derivation of design recommendations and dimensioning concepts.

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A total of three different verification concepts are developed, which, with conservative verification, enable a fatigue-resistant design of the connection between the transverse frame and the roadway slab. In the first concept, the existing design rules are supplemented by a criterion for limiting the slenderness of the road slab. Furthermore, a semi-empirical design approach is proposed to determine the design-relevant structural stresses from the acting road slab rotation angle. A modeling concept is also proposed which allows the numerical calculation of the transverse frame stress based on a detailed shell model.

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