

## Rehabilitation of Orthotropic Steel Deck Bridges Using a Modified Ortho-Composite Deck System

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**Abstract :** Orthotropic steel deck bridge consists of a deck plate, longitudinal stiffeners under the deck plate, cross beams and the main longitudinal girders. Due to the several advantages, Orthotropic Steel Deck (OSD) systems have been utilized in many bridges worldwide. The significant feature of this structural system is its high load-bearing capacity while having relatively low dead weight. In addition, cost efficiency and the ability of rapid field erection have made the orthotropic steel deck a popular type of bridge worldwide. However, OSD bridges are highly susceptible to fatigue damage. A large number of welded joints can be regarded as the main weakness of this system. This problem is, in particular, evident in the bridges which were built before 1994 when the fatigue design criteria had not been introduced in the bridge design codes. Recently, an Orthotropic-composite slab (OCS) for road bridges has been experimentally and numerically evaluated and developed at Technische Universität Dresden as a part of AIF-FOSTA research project P1265. The results of the project have provided a solid foundation for the design and analysis of Orthotropic-composite decks with dowel strips as a durable alternative to conventional steel or reinforced concrete decks. In continuation, while using the achievements of that project, the application of a modified Ortho-composite deck for an existing typical OSD bridge is investigated. Composite action is obtained by using rows of dowel strips in a clothoid (CL) shape. Regarding Eurocode criteria for different fatigue detail categories of an OSD bridge, the effect of the proposed modification approach is assessed. Moreover, a numerical parametric study is carried out utilizing finite element software to determine the impact of different variables, such as the size and arrangement of dowel strips, the application of transverse or longitudinal rows of dowel strips, and local wheel loads. For the verification of the simulation technique, experimental results of a segment of an OCS deck are used conducted in project P1265. Fatigue assessment is performed based on the last draft of Eurocode 1993-2 (2024) for the most probable detail categories (Hot-Spots) that have been reported in the previous statistical studies. Then, an analytical comparison is provided between the typical orthotropic steel deck and the modified Ortho-composite deck bridge in terms of fatigue issues and durability. The load-bearing capacity of the bridge, the critical deflections, and the composite behavior are also evaluated and compared. Results give a comprehensive overview of the efficiency of the rehabilitation method considering the required design service life of the bridge. Moreover, the proposed approach is assessed with regard to the construction method, details and practical aspects, as well as the economic point of view.

**Keywords :** composite action, fatigue, finite element method, steel deck, bridge

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