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Optimization of Sealing Plates for Hanger Connections at Tied Arch Bridges

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Abstract

Railway bridges are a central component of the rail network in Germany and all over the world. These bridges, particularly in the case of large spans, are often designed as tied arch bridges with flat steel hangers. There are several variations for the connection between these hangers and the main support elements (bows or stiffening girders), whereas the most common connection type is an intersection between the hanger extension and a partition plate located inside the main support element. In this case, the hanger has to transverse one of the flanges of the main support element which leads to a hole in the flange. Usually, a sealing plate of 6 to 12 mm thickness is used to close this hole in order to protect the main support element from humidity. The sealing plate is welded circumferentially to the hanger at its inner side and to the flange at the external edges.

In the past, several damages were noticed at the outside welds of such sealing plates. Therefore, the question arises, how to optimize the sealing plates in order to increase their robustness and lifetime. For this purpose, finite element simulations are carried out for this detail and different shapes of sealing plates are compared. Amongst other results, it is shown that roundings of the corners do not always lead to a reduction in the relevant structural stresses.

In order to validate the simulations, fatigue tests on scaled models are also carried out. The surface stresses are measured with strain gauges.

In this paper, the results of the simulations are compared with the results from the fatigue tests and recommendations for the shape and manufacturing of the sealing plates are given.

Keywords: Tied arch bridges; hanger connections; sealing plates; fatigue; finite element simulation, welding.

1 Introduction

Tied arch bridges are a typical bridge design for bridging medium and large spans. They are particularly suitable for railway transport, since their load-bearing behavior is optimal under full loading, which occurs significantly more often in railway transport than in road traffic, due to the length of the usual operating trains.

The following investigations aim to optimize a critical detail on the hanger connection, the sealing plate, regarding its durability.

2 Motivation

Hangers on tied arch bridges for railway traffic are usually designed as flat steel hangers.

Often, the connections of the hangers are carried out at the inside of the arch's or stiffening girder's box cross-section, because of aesthetics and susceptibility to weathering. In this case, the hanger plate proceeds into a hanger connecting plate and is then connected to a gusset plate which penetrates the lower flange of the arch or the upper flange of the arch.

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