Fatigue analysis of existing railway bridges: strengthening through geometry improvement

Hans Pétursson

Swedish Transport Administration, Sweden

Contact: hans.petursson@trafikverket.se

Abstract

Fatigue analyses of steel bridges are usually based on nominal stresses and available detail categories. Assessment of existing railway bridges often show that the theoretical service life has expired although there are no visible cracks on the bridge. This is partly because results from fatigue testing have large scatter, leading to low design values. Another explanation is that the calculation methods are simple and not very accurate and that the many conservative simplifications that are made lead to an overestimation of the actual fatigue stress range and an underestimation of fatigue strength.

To carry out better assessments, the Swedish Transport Administration has studied a structural detail that consists of a gusset plate welded to a flange. This paper will present results from fatigue test of three steel beams with details corresponding to detail number 5 in table 8.4 EN 1993-1-9 [1]. Furthermore, fatigue tests and research in literature are analysed to investigate if the detail category can be elevated from detail nr. 4 by grinding a radius that is smaller than the radius that is specified in EN 1993-1-8 for detail nr 5 in table 8.4. The results have been introduced in the Swedish codes for assessment and maintenance of bridges.

Keywords: old steel bridges; fatigue improvement; detail category

1 Introduction

Fatigue analysis of old steel bridges is almost always performed based on nominal stresses and available detail categories. Details categories can be found in the Eurocodes ([1]). When assessing the bearing capacity of existing railway bridges, the theoretical stress widths are often larger than what the codes allows. Despite that cracks have not been found during inspection. The next step in an assessment is usually to check damage with The Palmgren-Miner rule. The results often indicates that the service life of the bridge is already reached. One reason why reality and theory are inconsistent is that the scatter of results from fatigue testing are large. Another explanation is that the calculation methods are simple and not very accurate and that the many conservative simplifications that are made lead to an overestimation of the actual fatigue load and an underestimation of the fatigue strength.

In EN 1993-1-9 there is a detail category for a gusset plate welded to a beam flange, detail number 5 in table 8.4 EN 1993-1-9. The fatigue strength of the detail is very low in cases where the corner radius is smaller than 1/6 of the width of the flange. This paper describes that even with a smaller radius the detail category can be increased.