Increased Service Life of Fatigue Effected Structures through High Frequency Mechanical Impact Treatments

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Abstract

The effectiveness of increasing fatigue strength by high frequency mechanical impact (HFMI) treatments has been verified on several welded construction details. Within the main research projects on the different HFMI techniques on welded construction details, suggestions on how to consider the fatigue improvement have been conducted. Since those research projects had their focus on different construction details and techniques of HFMI, no uniform design rules for the improvement of fatigue strength in design by the use of the most common techniques could be developed. So by now, there is no valid German or European guideline, giving general rules on the fatigue design of HFMI treated welded connections. Therefore, the aim of the German research project “Development of a DASt-guideline for HFMI treatments”, is to develop a draft for a design guideline for the so far investigated appropriate welded connections, clearly giving application limits and considering several influencing effects onto the fatigue strength.

Keywords: post-weld treatment; high frequency mechanical impact (HFMI); fatigue design; sustainable structures; long-living structures; fillet weld; fatigue strengthening; large-scale welded structures.

1 Introduction

The increasing demand on sustainable long-living structural solutions for infrastructural constructions forced the steel industry in the last few years to react on that claims in order stay competitive to other construction materials. Thus long-living infrastructures such as bridges are mainly determined by the fatigue design; the approach to improve the fatigue resistance of steel structures seemed expedient. This aim could be reached by the development of the most modern kind of post-weld treatment, the high frequency mechanical impact (HFMI) treatment. By giving high-frequency mechanical impacts onto a fillet weld`s toe, three main fatigue strength improving effects concerning welded connections are applied. The plastic deformation of the weld toe region causes a decreasing of the critical notch. Additionally the process of the local compression closes possible micro cracks appearing close to the surface. But the most significant effect is the introduction of compressive residual stresses at the weld toe of the fillet weld, where there usually are tensional residual stresses caused by the cooling process after welding in the size of the yield strength. Those positive effects could be proven within several research projects, which ended up in three main design approaches considering the advantageous effects of the application of such a HFMI treatment.

But since there is no common, valid guideline regulating a proper fatigue design considering the improved fatigue resistance by using the HFMI

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