New possibilities with the use of automated laser- laser-hybrid welding methods for steel bridges

Johannes Veie, Cato Dørum, Tore Askeland

Norwegian Public Roads Administration, Hamar, Norway

Contact: johannes.veie@vegvesen.no

Abstract

The development of automated laser- and laser-hybrid welding has made it possible to fabricate bridges in a new way. Traditional orthotropic decks based on steel-plates with longitudinal trapezoidal stiffeners may experience challenges with fatigue cracks developed at the welds and the edge of cut-out holes. The use of laser- and laser-hybrid can improve fatigue properties in general, but the technology also opens for new designs that improve fatigue properties with use of less material, reduced environmental impact and reduced production costs. A closed multi-box steel panel, also denoted as a steel sandwich element is a promising alternative to conventional orthotropic steel decks. The panels may also replace the concrete slab for traditional composite steel concrete box girder bridges.

Keywords: steel bridge; laser; laser-hybrid; welding

1 Introduction

In the development of bridge concepts for crossing the Norwegian fjords along the E39 coastal highway E39 route, the Norwegian Public Roads Administration (NPRA) has been challenged to reduce both cost and environmental impact. Motivated by the experience from shipbuilding and automotive industry, a technology qualification programme has been launched to enable the use of automated laser- and laser-hybrid (laser-MIG/MAG) welding in production of steel bridge structures [1]. Laser- and laser-hybrid welding is less energy intensive compared with traditional arc welding methods, give less distortion, and reduces the need for heat straightening.

Traditional orthotropic decks based on steel-plates with longitudinal trapezoidal stiffeners may experience challenges with fatigue cracks developed at the welds and the edge of cut-out holes. The use of laser- and laser-hybrid welding can improve fatigue properties in general, but the technology also opens for new designs that improve fatigue properties with use of less material, reduced environmental impact and reduced production costs. A closed multi-box steel panel, also denoted as a steel sandwich element is a promising alternative to conventional orthotropic steel decks. The panels can also replace the concrete slab for traditional composite steel concrete box girder bridges. The Norwegian Public Road Administration has as a part of the E39 fjord crossing project initiated a R&D program to gain experience with this new welding technics, use of digital twins and new bridge deck designs. This paper presents the design, and experience gained for two pilot bridges that are constructed. In addition, the paper presents a proposed design for an 865 meter long multispan box girder bridge to