Parametric study of orthotropic steel decks with open ribs using FEA

Heng Fang, Gilles Van Staen, Hans De Backer

Ghent University, Ghent, Belgium

Contact: heng.fang@ugent.be

Abstract

For orthotropic steel deck (OSD) bridges, the open ribs are less used because of their relatively lower torsional stiffness. However, with the design focus of OSD shifts from strength design to fatigue design, the system of open ribs shows the potential to be more considered for future projects. In this paper, a newly built OSD bridge is investigated focusing on the rib-to-crossbeam joint. Based on the in-situ measurements of the existing bridge, the numerical modeling of the whole bridge is finished. Furthermore, a simplified local model is developed focusing on the rib-to-crossbeam joint. Then, the influences of design parameters i.e. the crossbeam span and the spacing between ribs are investigated. Research results reveal that the global behavior of the bridge can be modeled. However, calculation results of points close to the connecting weld and the cope hole do not fit well with the measurements. In this case, increasing the crossbeam span will decrease the stresses of points close to the weld toe of the connecting weld. Increasing the spacing between ribs is more effective to reduce the tangent stress around the cope hole. The most unfavorable load position does not change with these two parameters.

Keywords: orthotropic steel decks; open ribs; FEA; cope hole

1 Introduction

Orthotropic steel decks (OSD) are broadly used around the world, due to their light weight, yet high stiffness, which results in cost effectiveness [1]. A typical OSD structure is composed of the deck plate, the horizontal stiffeners (i.e. crossbeams) and the longitudinal stiffeners (i.e. ribs). There were numerous types of ribs in the development history of OSD. In general, two categories of the ribs can be distinguished: the open ribs (e.g. bulb cross-sections) and the closed ribs (e.g. trapezoidal cross-sections).

At present, most OSDs adopt the closed ribs. The trapezoidal cross-section represents almost half of the total types of longitudinal ribs used in OSDs [2]. The open ribs are less used because of their relatively lower torsional stiffness. However, the open ribs still possess some merits over the closed ribs. Firstly, when compared to the closed ribs, the open ribs can be welded to the deck plate in an easier and more reliable way. Due to the limitation of the structure itself, the closed ribs can only be welded from the external side, which increases the construction difficulty. Secondly, the cracks initiate from the root of the rib-to-deck joints when adopting the closed ribs are quite common yet very hard to detect unless the crack has propagated and damaged the deck plate and the wearing courses. Nevertheless, since there is no enclosed area when adopting the open ribs, it is quite convenient to inspect fatigue cracks even at an early stage. Lastly, the approaches of improving the local stuffiness of OSD, such as by introducing a rigid pavement system [3] or an additional reinforcement plate [4],

https://doi.org/10.2749/ghent.2021.0877
Distributed by structurae