Investigation into the cause of cracks and the opportunity to refurbish steel Vierendeel railway bridges

Philippe Van Bogaert, Hans De Backer

Civil Engineering Department, Ghent University, Belgium

Bart De Pauw

TUCRAIL Ltd, Brussels, Belgium and Civil Engineering Department, Ghent University, Belgium

Contact:philippe.vanbogaert@ugent.be

Abstract

The oldest of a set of 3 steel Vierendeel bridges, carrying railway tracks across the canal from Mechelen to Leuven, shows various cracks, mainly in the vertical members. Material testing demonstrates that the early age steel characteristics show a large variation for strength, yield point, impact notch energy and chemical composition. A thorough investigation into both the ULS and the fatigue resistance does not imply these to be the cause of the cracks. Comparing the location of the cracks and those of the dynamiting and subsequent repair of the steel structure, reveals that the brittleness of the material must be the cause of the damage.

Keywords: Vierendeel bridge, historic structure, material testing, brittleness, fatigue of riveted structure, dynamiting.

1 Introduction

In Belgium, during last century, longer and medium span steel railway bridges were frequently designed utilizing the Vierendeel system. In the town of Mechelen, three railway lines cross the canal to Leuven by three bridges of that specific kind, offering a singular illustration of this type of application. In 2021–2022, two of these bridges—which were built in 1958 and had suffered severe deterioration—underwent renovations that included the installation of a new rail fastening system. Constructed between 1933 and 1935, the third bridge connects Brussels and Antwerp directly by rail. This bridge's tracks were the nation's first to be electrified. The bridge suffered severe damage during World War II.

At the height of the first and seventh bays, it fractured in half. German engineers restored the bridge in July 1940. A fourth bridge, which spans the canal and carries the new bypass line, was constructed next to the oldest one in 2017 and allows for faster connections. This bridge's design, which is a beam construction with varying heights and both ends clamped in the RC abutments, reverses the idea of an arch structure and contrasts with the old bridges.

In 2020, the oldest bridge was found to have several cracks. Additionally, the cross sectional area of various secondary parts of the bridge, such as the rail supporting the longitudinal beams and crossbeams, looked to have significantly decreased, and the anti-corrosion protection appeared to be inadequate. Because of this and the

https://doi.org/10.2749/manchester.2024.0486
Distributed by structurae