Analysis of Material Properties and Weldability of Steel in Old Railway Bridges

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Abstract

The paper presents an analysis of the material properties of structural steels in 16 railway bridges constructed in the second half of the 19th century. There was little general standardisation in the steel industry and a wide variety of steel grades and types were in use at that time, some of which originated in railway bridge engineering. The chemical compositions and mechanical properties of structural steels were tested in plate girder and truss bridges. For assessing the steel grades, static tensile and hardness tests were used. The weldability of the steels was also determined. Analysis of the current material parameters of the steels was usually carried out on a small number of samples. The tests were extended if there was additional material available from bridges undergoing repair, which avoided any damage to existing bridges. The properties of the steels assessed made it possible to draw up repair or upgrade schemes for the structures tested.

Keywords: railway bridge; riveted bridge; cast steel; ageing; hardness, weldability.

1 Introduction

The history of structural steel is also the history of the construction of steel railway bridges. Intensive development of steel railway bridges began during the 1830s and 40s, initially as wrought iron (steel) structures and, according to German data [1], from 1856, using early structural steels with low phosphorus content. These steels are traditionally called cast steel (Fluβstahl). There were no general standardisations nor requirements in the steel industry at that time; each iron works used its own specification for production purposes and trading. Rail steel grades prevailed and the Bessemer steelworks did not have much in the way of producing other grades [2]. Slowly, the production of different shapes increased, and the Martin steelworks began to make steel of all grades. Improvements in plant and practice allowed increases in production with a corresponding decrease in costs. A wide variety of steel grades and types were in use at that time.

On Polish National Railway lines there are nearly 8 000 engineering structures, with the majority of bridges metallic structures (42 %). The greater part of these are advanced in years as they were constructed in the later decades of the 19th century, with 43,4 % over 100 years old and 33 % aged between 50 and 100 years. Due to a range of factors, the structures have degraded and very often require repairs or upgrade. Along with standard issues arising from low levels of maintenance, the bridges also suffer from problems with their materials which require attention in order that design strength and weldability for strengthening or upgrading with the use of welding can be calculated. An additional issue in this calculation is that the properties of steels change over time due to

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