In the foreseeable future, a growing number of historical metal structures will require remedial works. Maintenance, repair and strengthening interventions aim to preserve their state and extend their service life. The appraisal of load-bearing metal structures usually includes their connections. Between the 1840s and 1940s, rivets were the primary fastener used to fabricate these connections through a technique called hot riveting.

The inspection, structural assessment and intervention strategy of existing riveted connections raise numerous theoretical and practical challenges for decision-makers and workmen – i.e., riveting teams. It is tough to decipher how they were fabricated and designed given the obsolescence of hot riveting. In addition, the inadequacy of available literature makes their structural assessment delicate. Ultimately, hot riveting is a technique hard to master and for which specialists barely exist. Engineers, architects, heritage care specialists and riveting teams all need support when appraising and renovating riveted connections. Which materials and techniques were used to fabricate them? What can be learned from their design? Which parameters affect their structural behaviour?

In an attempt to answer those questions, we reviewed international historical literature to unravel the original technology and design of riveted connections. In particular, we discussed the evolution of the riveting technology by referring to historical patents (1830–1940). To examine the actual use of former techniques and design methods, we assessed the geometry and microstructure of dismantled riveted connections. We also performed shear tests on simple configurations of connections – for which we managed the fabrication – to assess their structural behaviour before and after intervention.

This study provides information relevant for the appraisal of historical riveted connections. It assesses a wide range of parameters that may qualitatively or quantitatively affect their structural behaviour. The research output can help decision-makers and riveting teams. It focuses on standard configurations of riveted connections fabricated through the hot-riveting technique between the 1840s and 1940s in France and Belgium. The study relies on a multidisciplinary approach that brings historical, technological, analytical and experimental results together. The first two parts of the study relate to the technology and design of riveted connections, respectively. The technological part unravels rivet manufacture and installation while the design part discusses the geometry, theory and design methods. The third part reviews the findings of the two previous ones by means of experimental investigations. A closing chapter provides the reader with assessment tools and intervention recommendations intended for engineers, architects, heritage care specialists as well as riveting teams.

The technology and design of riveted connections evolved markedly between the 1840s and 1940s. The expansion of metal construction required the mechanization of rivet manufacture and installation. Wrought iron was gradually replaced by steel from the 1880s onwards but the use of steel rivets depended on the development of convenient riveting machines. In the 19th century, rivets could be installed either by hand or with a machine. Portable riveting machines supplanted hand riveting from the 1910s onwards. Machine riveting has a positive influence on the structural behaviour of riveted connections. The design of riveted connections was merely empirical before the 1880s and became analytical from then on. Riveted connections were usually oversized because of a high safety level and practical constraints.

Given the major changes in technology and design, appraising the connections of riveted structures built in 1880s–1920s calls for additional care. The analysis of the geometry permits to identify the rivets used and the results of past experiments allow to estimate their load-bearing capacity. Hence, the amount of destructive tests can be reduced. The investigations showed that the strength of wrought-iron rivets complies with present standards. When the structural assessment necessitates the installation of new rivets, the guidelines provided by the study help decision-makers limit the impact of the intervention.

Although further research should be conducted on the theory of riveted connections and the shear behaviour of complex joining configurations for instance, the study adds to our knowledge on historical riveted connections. It contributes towards the preservation of both the heritage value and the service life of historical riveted structures for the decades, and hopefully centuries, to come.