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Vom Eisenbau zum Stahlbau: Tragwerke und ihre protagonisten in Berlin 1850–1925 (From iron to steel construction: roof structures and their protagonists in Berlin 1850–1925)

Ines Prokop. Mensch und Buch Verlag, Berlin, Germany, 2012, ISBN 978-3-86387-077-5, £66·00, 500 pp. (plus CD)

This book offers a thorough review of iron and steel structures, especially their use in roof construction, in Berlin, during the 75 years from 1850. It is the fruit of many years' research among original drawings, calculation reports and photographs that have survived, as well as contemporary books and periodicals. The book aims to assess the influence of new techniques of structural analysis, new alloys of iron and new manufacturing technologies on the design and construction of structures, but most of all it presents a full review of a large part of Berlin's engineering heritage that, hitherto, has been poorly covered. There are three main sections – two chapters outline the aims of the study and set the context regarding Berlin, structural theory and the material, iron, itself; three chapters each cover the key developments during a period of 25 years; and the final section – nearly half the book – presents detailed studies of 38 structures ranging from railway stations to opera houses.

Between 1850 and 1900 Berlin experienced a fivefold growth in population from 400 000 to 2 million, due mainly to the expansion of industrial production of large machinery and the railways. These industries, based on iron and steel, gave Berlin a head start over other regions of Germany in using these materials for building construction. Conversely, by the way, when reinforced concrete construction developed at the end of the nineteenth century, this occurred mainly in the south of Germany.

Developments during the first 25-year period are driven by a series of events around 1850. The rolling of wrought-iron – initially flat, L and inverted T-shaped sections – made it viable for large-scale manufacture. Hydraulic riveting machines became available for use both in engineering works and on site. The art of materials testing developed significantly, especially by August Wöhler, who also discovered and measured the phenomenon of metal fatigue. The analysis of statically determinate, two-dimensional trusses was developed, especially by Johann Schwedler. Not least, there was a growing acceptance of the new construction material in place of masonry and timber, for structures in which the structure was visible – especially truss bridges and roof trusses. Manufacturing these trusses to replicate, as nearly as practical, the mathematically ideal pin-jointed truss brought great advantages as the structure was made to behave in a predictable way, in contrast to the highly redundant and statically indeterminate traditional timber roof trusses. Wrought-iron arched roofs, made by riveting together many small lengths of iron, were used to span railway stations and large halls; and a number of ribbed domes were built using the same technique. However, being made with iron lattice construction, these were highly redundant structures (statically indeterminate). To reduce this redundancy, at least for the structure as a whole, the three-pin arch gained some popularity, most famously in Peter Behrens' AEG Turbine factory of 1909.

The following quarter century saw great developments, by Heinrich Müller-Breslau in particular, in the analysis of statically indeterminate structures by taking into account the elasticity of the material and the stiffness of connections. This resulted directly in a great many larger-scale iron and, from around 1870, steel structures that were both more complex and stiffer. Nevertheless, this period also saw the development of the first statically determinate three-dimensional frames by Schwedler, August Föppl and Hermann Zimmermann. A discovery by the author, of particular interest, was the virtually unknown structural engineer, Richard Cramer (German, despite the apparently English name), who designed a large number of elegant and spectacular structures in iron and steel.

The final period saw the maturing of the structural steel industry – the end of the era of wrought iron, and the standardisation of rolled sections, materials specifications, connection details and calculation procedures. There also emerged another, little known engineer, Otto Leitholf, who took up Cramer's mantel as the leading structural engineer in Berlin.

The most impressive aspect of this book is that it brings to light such a large number of remarkable structures, many of which have now been lost, that have hitherto been little known and, most remarkably, all built in just one city. The most unusual of these structures is perhaps the airship hangar, built in 1912. Not only was it large – 135 m long and 32 m high – it could also be rotated to enable the airship to enter and leave, whatever the direction of the wind.

The author has done well to fulfil the aims she set herself, although, despite its size, there is still an impression that so much was omitted. For example, there is very little about columns and beams used in steel-frame construction, or the means of providing fire protection of these structural elements, or the issue of wind bracing and lateral stability. Although the importance of being able to calculate structural behaviour in order to design a structure with confidence and economy is covered, there was little mention of other aspects of design – design loads, including wind loading, factors of safety and design codes of practice. While the book is about structures in Berlin, it would also have been interesting to know more about interactions with the 'outside world'. Despite this, the book is a rich source of information and understanding about this important period of construction history.

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