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Eiserne Eremitage - Bauen mit eisen im russland der ersten hälfte des 19. Jahrhunderts (iron hermitage: Iron construction in russia in the first half of the 19th century)

By sergej G. Fedorov, bernhard heres and werner lorenz. Two volumes in german. Vol.1, 442 pages; vol.2 (plates), 271 pp. A total of over 1000 illustrations (colour and black and white). Berlin: Ernst und sohn, 2022. 149€ (HB). ISBN: 978-3-433-03156-8.

Bill Addis

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Review

Eiserne Eremitage - Bauen mit Eisen im Russland der ersten Hälfte des 19. Jahrhunderts (Iron Hermitage: Iron Construction in Russia in the first Half of the 19 th Century). By Sergej G. Fedorov, Bernhard Heres and Werner Lorenz. Two volumes in German. Vol. 1, 442 pages; Vol. 2 (Plates), 271 pp. A total of over 1000 illustrations (colour and black and white). Berlin: Ernst und Sohn, 2022. 149€ (HB). ISBN: 978-3-433-03156-8.

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In December 1837, a devastating fire destroyed the centre of power of the Russian Empire, the Winter Palace in St. Petersburg (built 1754-62). Its reconstruction commissioned by Tsar Nicholas I marked the beginning of a large-scale restoration of the surviving masonry shell and the use of fireproof iron structures to replace the traditional timber floor structures and roofs. After restoration of the Winter Palace (1840), the timber roofs of the other buildings of the imperial residence — the Small Hermitage (1764-75) and the Great Hermitage (1771-87), both built to house Catherine the Great's growing art collection, and the New Hermitage (1842-51), built as a public art gallery — were also replaced by iron structures and many of the timber floor structures were replaced with iron. By 1852, this group of buildings, known today as the State Hermitage Museum, contained

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the largest ensemble of iron structures in Russia from the first half of the 19th century comprising an astonishing variety of different construction techniques. At this time, Europe was beginning to explore the possibilities of building with iron and to formulate the first rules and practices for its use. The iron structures hidden behind the façades and suspended ceilings of the Hermitage provide a unique insight into the very heart of this period of revolution in building construction.

The result of a long-term research project, this two-volume monograph opens up a completely new perspective on this world-class building complex and the result is a record, documentation and interpretation of a historical iron construction of remarkable depth and breadth. The study exemplifies the potential of historical building research with an engineering focus, which not only includes the evaluation of extensive archival holdings, hands-on in-situ examinations, laboratory analyses of materials and analyses of structural behaviour, but also the placing and evaluation of the buildings in the contemporary context of the history of building technology.

In their detailed treatment of the construction history of the buildings, the authors trace the development of the iron industry from its roots in the mining and smelting of the ore in the Urals to the blast furnaces and rolling mills producing the sections needed for construction. This study unfolds the context within which the construction of the Iron Hermitage could take place, presenting the impressive history of Russian iron production and hitherto almost unknown pioneering achievements in building with iron in the 18th and early 19th centuries. The results of this work change our view of the early history of iron construction, our understanding of the design, construction and building processes of such a large-scale project and, above all, our appreciation of the contribution made by the Russian tradition of iron construction.

After a short chapter giving an overview of the research project that led to the production of the book, Chapter 2 gives a history of the iron industry in the Ural Mountains from around 1700 to around 1850. Iron production was dominated by one family — the Demidov family — which began using iron to make weapons and armour in the late 17th century and survived until the revolution in 1917. Until 1800 Russia produced more iron than any other country. In 1794 Russia was exporting two thirds of its iron, of which more than 90% went to Britain. By 1850 Russia's production had fallen behind that of Britain, France, Sweden Germany and the USA, and Britain was producing more iron than the other five countries put together. Given this data, it is not surprising that Russia began using iron (wrought iron) in building construction in the 1740s, earlier than both France and Britain; and, given the strong trade links with Britain, nor is it surprising that many British iron makers and engineers went to Russia from the 1770s, mainly to St Petersburg, to take advantage of the growing market for iron (especially for weapons) and for iron-based construction. The most prominent of these was Matthew Clark (1776-1846), born in Scotland, who moved to St Petersburg with his father, an iron master, and who eventually ran various ironworks including the Alexandrovski Works which provided most of the iron for the rebuilding of the Winter Palace. He was also prominent in supplying much of the ironwork used elsewhere in St Petersburg during the first half of the 19th century — indeed; his name has more references in the index to the book than anyone else. Charles Baird (1766-1843), and his nephews William (1793-1850) and Andrew (1805-87) Handyside, also from Scotland, were also prominent in the St Petersburg iron industry.

The third chapter gives an overview of the use of iron in building construction in Russia. This began with several examples, mainly in churches, from the 15th to 17th centuries and grew significantly during the 18th century. Two roof structures are particularly spectacular: the 60° pitched roof over the porch of the bell tower at Nev'jansk, with a span of 7.15 m, completed around 1740; and the pitched roof over the refectory at the monastery Trinity Lavra of St. Sergius in Sergiev Posad around 70 km north-east of

Moscow, with a span of 20.2 m and length of 50.4 m, completed in 1749. From the beginning of the 19th century the use of iron proliferated, especially in St Petersburg, not only for roof structures but also for a number of modestly sized arch and suspension bridges. During this period, the use of cast-iron for columns in buildings also grew. Among the most notable iron structures in St Petersburg from this period (apart from the Hermitage) are the roof of the Aleksandrinskij Theatre (with arches spanning 29 and 21 m, 1828-32, Matthew Clark,), the Moscow Gate (36 m wide comprising 6 Doric columns 25 m high, 1834-38, Matthew Clark), the iron dome of St Isaac's Cathedral (26 m diameter, 1838-41, Charles Baird), and the roof of the Moscow Station in St Petersburg (1849-51).

The first part of Chapter 4 deals with the construction history of the refurbishment of the Winter Palace. This includes the activities of the commission appointed to oversee and direct the rebuilding of the Winter Palace and the commission appointed to expand the capacity of the Alexandrovski ironworks, under its director Matthew Clark, to provide the iron and iron components for the structures. Details are also given of the financing of the project, the types and numbers of the craftsmen engaged and the organisation of the construction site and the production processes. The iron commission undertook a wide-ranging search for fireproof flooring and roofing systems, soliciting ideas from Germany, France and Britain, and a comparison of their various merits and suitability. With up to 2000 workers employed on site, the restoration was already almost complete by March 1839 — just 16 months after the fire. The second part of the chapter looks at activities after the completion of the main restoration, from 1840 to 1851. These include the design and construction of the New Hermitage, a gallery open to the public which also made substantial use of fireproof construction, the production of a report by Clark on the manufacture of the iron structures for the Winter Palace and the lessons learned from the project and, finally, the refurbishment works undertaken on the Small and Great Hermitage buildings, dating from the 1770s-1780s, which had not suffered serious damage in the fire, but which were upgraded with a number of fire-proofing measures including the provision of iron roof structures.

For historians of structural engineering, Chapters 5 and 6 contain the most engaging aspects of the book — a detailed study of the many extravagant iron structures designed and built to cover the various rooms of the Winter Palace. This study comprises over a hundred pages of the book and a great many excellent photographs and drawings, both in these chapters and in 106 of the full-page plates in volume 2 of the book. Chapter 5 focuses on the structures as found and Chapter 6 deals with the manufacture and assembly processes. The key structural types fall into two categories: structures to support floors or ceilings, and roof trusses. Among the first are: beams with an elliptical cross section made from riveted wrought-iron plates and top and bottom flanges made using back-to-back L-profiles (e.g. 11.3 m span, 0.55 m deep); frames comprising parallel top and bottom chords, strengthened and stiffened with an arch (e.g. 15 m span, 1.1 m deep); frames comprising parallel top and bottom chords, strengthened and stiffened with an tension rods (e.g. 22.5 m span, 2.9 m deep); frames comprising parallel top and bottom chords, strengthened and stiffened with both an arch and tension rods, similar in form to a lenticular truss (e.g. 20.55 m span 2.2 m deep); and a braced hog-backed (arch) truss (e.g. 12.8 m span, 1.6 m deep). Many of the ceilings were of fireproof construction consisting of jack arches made with hollow clay pots. The roof structures are all variations of statically-determinate Wiegmann-Polonceau trusses of various spans up to 22.4 m span, with pitches between about 18° and 34°.

The photographs of the structures are especially impressive, given the location of the structures in poorly lit roof voids. I have visited many of these structures and can testify that they were very difficult to see and understand when illuminated by only a few light bulbs and hand-held torches. The photographic team used in this project merit high praise

indeed. (Several papers about these structures, in English, can be found using the Internet.)

Chapter 7 is entitled 'The Iron Hermitage and Europe: in search of a new construction language'. It gives an overview of how iron construction established its own, unique expression of a new idea of 'structure' in engineering and architecture during the first half of the 19th century. This is followed by a critical assessment of the contribution to this theme made by the iron structures in the Hermitage, including, most importantly, a record of how and where the Hermitage structures were included in various books on construction during the following decades, including for example the classic textbooks by Sganzin (1839/40), Krasovski (1851), Breymann (1854) and Vierendeel (1902).

The final Chapter presents extracts from nearly 40 contemporary publications and reports on various aspects of the restoration of the Winter Palace published or written between 1838 and 1841 in Russian (translated into German), German, French and English.

Volume 2 of the book is devoted entirely to 125 full-page plates. These are grouped in four sections: graphical sources related to contemporary iron structures in Russia; graphical sources related to the iron structures in the Hermitage buildings; documentation (drawings and photographs) of the iron structures in the Hermitage buildings; and a selection of views created using digital visualisations of the iron structures in the Hermitage buildings. Their quality and usefulness are exemplary.

It should be clear that this reviewer considers this exceptional book to be a landmark contribution to the histories of technology, engineering and construction. I should note, however, that my reading of the text was impaired by two issues: it was often difficult to find the key information relating to the various buildings and structures described — location, date, designer/contractor, and dimensions such as spans. While this information was usually to be found in the text, it often required much searching and even resorting to Internet searches. The second issue, which aggravated the first, was that many of the 1000 or so images in the book are not referred to in the text. Too often, it is not possible to ascertain exactly why certain illustrations have been included as they are not mentioned in the text. It would have been helpful if the relevance of all the illustrations had been clearly explained. Otherwise, I commend this book wholeheartedly to anyone interested in the history of iron construction, whether they read German or not.

Bill Addis
Newcomen Society, London, UK
bill.addis@cantab.net
http://orcid.org/0000-0002-9933-630X

Bill Addis is an engineering historian and author of *Physical models: Their historical and current use in civil and building engineering design* (Berlin, Ernst und Sohn, 2021).