Reviews

BERECZKI, ZOLTÁN. *MAGASÉPÍTÉS A KÖZÉPKORBAN: A GÓTIKA TEMPLOMTORNYAI* [HIGH-RISE CONSTRUCTION IN THE MIDDLE AGES: GOTHIC CHURCH TOWERS]. DEBRECEN: UNIVERSITY OF DEBRECEN, FACULTY OF TECHNOLOGY, DEPARTMENT OF CIVIL ENGINEERING, 2021. ISBN 978-963-318-905-4.

In this book, the author deals with a rarely researched topic; but what can be expected from him if, as a school boy – according to his own admission – he wanted to browse Villard de Honnecourt's portfolio? And later in life, after earning an MSc degree in architecture and engineering with a postgraduate specialization in the preservation of built heritage, he began to work on his doctoral dissertation, which he successfully defended in 2017 with summa cum laude honours. In his doctoral work, Zoltán Bereczki dealt with the technical aspects of late–fifteenth-century church tower construction. He tried to reveal aspects of the operation of the construction workshop, which architectural historians do not deal with much, because when the building is completed, the auxiliary structures – scaffolding, lifting machines, ladders – are dismantled and only very few traces of them remain on the building, and those can only be found by those who already know approximately what to look for and where to look (as becomes clear later in the volume).

The doctoral work, however, witnessed a shift of topic during the research. The author had originally planned to explore the portfolio of master builder Hans Hammer of Strasbourg (a remarkable collection of whose drawings and notes is kept by the Herzog August Library in Wolfenbüttel, Germany), since so far only a small amount of literature has dealt with it. The Strasbourg master's work, however, diverted the author's attention to the subject of the unrealized south tower of Strasbourg Cathedral, and thus, researching the construction secrets of other medieval church towers, he turned his research work back to the territory of the medieval Kingdom of Hungary: the Franciscan stone towers of Bratislava and Sopron and the circumstances of their construction were also included in the doctoral work.[1] And so, in addition to the Hammer portfolio, the other main topic of the dissertation became medieval church tower construction – and Bereczki now presents the results of this research in detail in this book. During his research, in addition to exploring original sources and literature, and making 3D models, he also visited several construction workshops where traditional medieval methods are still in use today, in order to compare the results of his research with practice.

In the chapter entitled "Outline of the development of Gothic church towers: Technical difficulties of tower construction", we get a terminological introduction to the topic: an overview of the architectural history of the Gothic towers. The author dates the golden age of Gothic church towers to the fourteenth–fifteenth centuries, when the tower as a structural work becomes an integral part of Christian churches. (It is interesting to observe that towers were not built for ancient temples – previously the tower had only performed a guarding and protective function, and was not an accessory of a religious building.) In Italian territory, the first separate towers appear next to churches as early as in the sixth century: the *campaniles*. But north of the Alps, the author considers stair towers to be the predecessors of church towers. We take a small trip with the author to the churches of Western Europe, where the earliest stair towers were built (Germany: Aachen, Hildesheim, Gernrode, Speyer; France: Normandy and the Benedictine churches). In France, at the end of the twelfth century, the forerunners of Gothic (St Denis and Laon) already indicate the future style, especially the western towers of Laon Cathedral with its baldachin structures carved from stone and flanked by pinnacles (towers also drawn by Villard). In European culture, however, the church tower is not only an observation point "from which one can see far away", but also an object that can be seen "from far away" and from where the ringing of bells can be heard from afar, emphasizes Bereczki. The southern tower of the cathedral of Chartres was built in the middle of the twelfth century, and Gothic church towers thereafter generally adopt this form: lower levels with a square

1 This part of the thesis was partly published in 2020: BERECZKI, Zoltán. The Single Gothic Towers of the Two Franciscan Churches of Bratislava and Sopron and Their Possible Connections to Vienna. In: *ARS: Journal of the Institute of Art History of the Slovak Academy of Sciences*, 2020, vol. 53, no. 2, pp. 138–173.

plan, upper levels with an octagonal plan, topped by a high spire. And again, we are making a study of form development with the author about the symbolism conveyed from Carolingian reliquaries and French lanterns of the death through Gothic tower-shaped sacrament houses to the church towers. And when, in the early fourteenth century along the Rhine, instead of the solid covering the towers the first openwork stone spires appeared, both Cologne and Freiburg claimed precedence: the former's original medieval design was preserved, only to remain unbuilt, while the latter saw the construction of the first such Gothic stone lace. The author discusses the western facade of Strasbourg Cathedral: the south tower, built in several stages, became the tallest building in medieval Europe in 1439 (at 142 meters – ahead of the 137-meter–high south tower of the Stephanskirche in Vienna, completed in 1433), and the literature has also elaborated its history. After a short comparison, the author states: "the time of the Gothic towers ended with the fifteenth century" – the preserved plans from the end of the century were not realised during the Gothic period. And here we return to the beginning of the tower biography: "the Gothic tower is a building element that has no antique predecessor". With this tour, we accompany the author in his research endeavour to unravel the methods and auxiliary structures employed in the construction of the mentioned tower giants, particularly when the tower structure surpassed the height of the roof structure of the connecting nave. Special attention is paid to the appropriate geometry of stone towers – the stone masonry is an excellent load-bearing structure as long as it has only vertical loads – but since the stone spire has tension and dynamic load too, several steel elements and clips were used here, and the joints were filled with lead; the author states that these procedures essentially "anticipate reinforced concrete from a structural perspective".

The next part, entitled "Reconstruction of a construction site from the late fifteenth century based on graphic and material sources" deals with the unrealized north tower of the Stephanskirche in Vienna, emphasizing that the book does not show "how this particular tower was built", but uses contemporary sources to discover "how such a tower could have been built". The author, while supplementing his text with numerous illustrations, notes that there are several technical works featuring a comparable series of informative illustrations addressing the construction of the Brunelleschi dome in Florence, south of the Alps. This is evidently linked to the survival of a contemporary collection of drawings depicting Brunelleschi's machines. And so, in the words of the author, the series of illustrations in this volume "is the northern counterpart of the drawings showing the construction of the dome, since the construction of the large Gothic towers required similar engineering preparedness and performance".

The following section, entitled "Presentation of the sources used", lists the sources based on which the progress of the construction can be most accurately reconstructed: in an ideal situation, plans of the tower to be built, structural drawings of the machines to be used, and drawings of the scaffolding would be required. Thousands of Gothic architectural drawings have survived in various collections, they are accessible, and most of them have been published several times in scientific publications. Medieval machine drawings were also published, but these were usually not made for construction, but followed military objectives, and researchers very rarely dealt with construction machines. From this point of view, the portfolio of the Strasbourg master builder Hans Hammer is very valuable,[2] including as it does many machine drawings. In 1992, the entire portfolio was published in the journal of Strasbourg Cathedral; so far, however, only two master's theses have dealt with the drawings, and these have not been published, which is why it is useful to browse through Hammer's drawings and compare them with the known data of the north tower in Vienna, which was being built at the same time. Unfortunately, in the absence of drawings of medieval scaffolding, only the visual arts can convey additional source material for the small number of surviving medieval scaffolding structures. However, the author emphasizes that although the earliest technical drawings for tower scaffolding only date back to the nineteenth century – these primarily helping in the construction of the neo-Gothic towers – since the construction of a neo-Gothic tower itself was made using the Gothic architectural form and technology, it can be assumed that the nineteenth

2 Available online at: http://diglib.hab.de/wdb.php?dir=mss/114-1-extrav&distype=thumbs

century construction machines and scaffolding may also have resembled those of the Middle Ages to a certain extent.

The section entitled "The plans of the north tower in Vienna" briefly explains the Gothic construction and reconstruction history of the Stephanskirche, mentioning also its elevation to the episcopal seat of Vienna, which also had a stimulating effect on the construction of the north tower. Here, the author provides an explanation of late Gothic architectural drawings in general, and agrees with other researchers that "these drawings can be considered the forerunners of modern architectural representation". With the exception of dimensioning, the majority of medieval drawings also meet today's requirements – the floor plans and elevations were also made with orthogonal projection and, where necessary, precisely constructed abbreviations were also used. The scale of the drawings does not yet use today's decimal units, so the scale of the drawings is based on the twelve number system – and today's researcher must also take into account the shrinkage of the parchment. The level of detail of the elevation drawings is related to their scale, and the profiles in the detail drawings are probably at the scale of 1:1, so these can be considered as production plans of the stone carving templates. Consistency can be observed in the different but related drawings of a building – the drawings are on the same scale and can be compared. Gothic drawings are also characterized by the method wherein different levels are drawn on top of each other on the same page (anticipating today's digital design layers?). If the planned work was to be connected to an existing building, survey drawings were also made – such can also be identified in the collection of Viennese plans (Hans Koepf's catalogue – 1969, most recently Johann Josef Böker's catalogue – 2005).[3] Of these, 18 drawings can be associated with the north tower of the Stephanskirche, but the volume only deals with the following six drawings, three depicting the entire tower and three showing facades:

From the collection of the Akademie der Bildenden Künste:

- 16.872v: ground plan of the north tower, work plan by Laurenz Spenning, dated around 1470;
- 17.061: elevation drawing of the north tower dated around 1465, signed by Hans Zierholt of Brünn (Brno, CZ).

From the collection of the Wien Museum Karlsplatz:

- 105.062: a mid–19th-century copy of Spenning's elevation drawing No. 17.061, with the master mark of Hans Zierholt;
- 105.063: ground plan of the tower dated around 1465, Laurenz Spenning design, early design phase, probably the earliest version;
- 105.064: completed and refined version of the above drawing, with Georg Hauser's master mark – probably an updated copy by Hauser around 1516;
- 105.067: elevation drawing of the tower, dated around 1465, by Laurenz Spenning.

In the chapter "Hans Hammer's machines" the author deals in detail with Hans Hammer's activities and biographical data, and the surviving 29 pages from his original 34-page portfolio. In this, Hammer, who was the master builder of Strasbourg Cathedral in two periods, made various drawings: fictitious sketches, sketches related to specific buildings, detailed architectural plans and drawings of the construction machines and instruments related to the construction. According to the literature, Hammer's biography and works can be compiled relatively well. The years recorded on the drawing sheets provide the dating of the collection: the earliest is 1476, the latest is 1507. Bereczki provides a detailed description of the contents of the pages, emphasizing: that both the text and the drawings are the works of a well-known personality, whose executed works are also known; that the drawings of machines, ladders and instruments belong to the rarer, so-called workshop drawings; and that the portfolio has

3 KOEPF, Hans. *Die gotischen Planrisse der Wiener Sammlungen.* Wien – Köln – Graz: Hermann Böhlaus Nachf., 1969; BÖKER, Johann Josef. *Architektur der Gotik: Bestandskatalog der weltgrößten Sammlung an gotischen Baurissen.* Salzburg: Verlag Anton Pustet, 2005.

survived almost in its entirety, missing only five sheets. And there is an interesting aspect that the author draws attention to: if we compare Villard de Honnecourt's sketchbook with the slightly later portfolio of Hans Hammer, the importance of the latter is highlighted by the fact that, according to the currently accepted position of the research, Villard was a layman, while Hammer was an experienced master builder.

"Hans Hammer and the Kingdom of Hungary" – it is clear from the note text next to the drawings in the portfolio that Hammer returned to Strasbourg from Hungary in 1481. And since we also find a Hungarian–German glossary at the end of the portfolio, it was obviously a longer visit, and we can only regret that we don't know any other sources about his stay. Previously, the Hungarian literature believed that Hammer's journey was in Transdanubia; according to another researcher, the master came at the invitation of the king, therefore St Elizabeth's Church in Košice would offer itself as a location, and several foreign scholars deal with this assumption. According to the latest research, the building parts previously attributed to Hammer in Košice were already ready at the time of his trip to Hungary. Bereczki found only one drawing in the folder in which a reference to the Košice church can possibly be found: a double spiral staircase, the like of which existed in Europe during Hammer's time only in Košice. Hammer paid a lot of attention to stairs. Approximately 30 percent of his architectural drawings depict stairs, and he made a drawing of the staircase of Peter Parler in Prague: one of the prototypes of the double staircase in Košice.

As Bereczki guides the reader through Hammer's drawings in detail, mentioning the views of earlier researchers (with rich footnotes), he comes to the conclusion that Hans Hammer was already interested in complex stair structures even before he was the master builder of Strasbourg Cathedral: it can be assumed that the already existing stairs of the northern tower spire in Strasbourg may have served as inspiration. The author believes that Hammer really wanted to finish the uncompleted south tower, and he supports this assumption with several drawings that further develop the motif of the spiral staircases of the north spire, as well as the survey drawing of the north tower. Particularly interesting is Bereczki's observation that if the Gothic north tower spire had not been built and its eight complicated spiral staircases winding around its edges were only known from a drawing, we would surely consider it only a fictitious drawing, which, looking at it from today's eyes, "would be impossible to realise with the technology of that time". A similar thought crossed my mind when the double spiral staircase of Košice Cathedral was being renovated: if today's reinforced concrete technology were used to design and then realize the double spiral staircase – a task that a small group of stonemasons experimented with in the first quarter of the fifteenth century – modern engineers would face a daunting challenge, due to the slender, pillar-supported, tracery-like openwork structure of its three sides (the fourth being the buttress to which it was built). If Hammer really visited Košice, then he could have already walked on this staircase, and the mirror-like reel doubling could have caught his attention.

The portfolio includes a total of 19 machine drawings, one of which also has a written commentary. It presents two main groups of lifting devices: *frame cranes* and *cantilever cranes*, and machines that do not belong to either main group can also be grouped separately. *Ladders* form the fourth group of machine drawings. Hammer outlined eight different types of frame cranes, all with winch drives and block-and-tackle systems, some with ratchet backstops. These hoists could primarily lift heavier loads, larger stone elements or bells. Eight drawings of cantilever cranes show a crane column on wheels or standing on scaffolding, and in both cases the crane column can be rotated. The angle of the boom can be adjusted in most cases, and the drive is usually a lever winch, but in one of the drawings there is also a treadwheel. Machine drawings were not made to scale and were not proportional drawings – detailed drawing of important elements was more important than proportional dimensions. The cantilever cranes obviously transported smaller loads and were used for the precise placement of finished stone elements, and they could be quickly installed on the scaffolding or moved further. Among the special machines, there is a lifting machine with a double flywheel, a one-man lifter that can be attached to a column, and a chicken griller machine with metal gears which obviously caught Hammer's attention here (in his other drawings the gears are made of wood). In addition to the machine drawings, there is also a series of different drawings of clever hooked ladders: rigid ladders and rope or belt ladders, often in a modular system. According to the author, it is likely that Hammer was already acquainted with numerous military manuscripts at that time, and it is possible that he outlined from these – hence the more extensive commentary on the drawings of the levelling instruments. We do not find such remarks on machine drawings, which he presumably knew better.

The excursion titled “The drawings of Hans Hammer in the context of fifteenth century machine representations” is interesting: it provides an overview of the history of technical drawings, including Italian precedents and their spread north of the Alps. According to the literature, several aspects play an important role in the development of technical drawings: technical drawings were formed in circumstances where traditional workshops were replaced by a complex system of cooperation, responsibility and instructions, with several different specialist groups with their own leaders belonging to a leading master – cathedral construction paved the way in this regard, shipbuilding and mining then following similarly. The use of drawings was also promoted by newer forms of spreading knowledge, when the path of personal wandering and gaining experience was no longer enough to advance more complex technologies. Bereczki also examines Hammer’s portfolio from the aforementioned points of view, and researches in detail the differences between drawings of building elements and machine drawings, with a small detour to the presentational drawing collections of military technology of the time. Comparing the work of the Strasbourg master with a Weimar manuscript volume of several hundred pages, he came to the conclusion that the author of the Weimar drawings knew Hammer’s drawings – and copied from them. Hammer’s machine drawings are easy to understand and interpret precisely because the master’s goal was to understand their operation, not the accurate and proportional technical representation. It is not possible to know which of the machines Hammer designed (according to Bereczki, one seems to be certain), which he intended to use during his work, or which he only observed and drew. The structure of the machines follows mostly the so-called German school, but we also find an Italian solution among them – according to the literature, it is possible that Hammer could have studied Italian military technical manuscripts in the library of King Matthias I during his trip to Hungary.

In the “Scaffolding” chapter, the author deals with *centre scaffolds* (i.e. “formwork” in order to comply with the planned form of the building) and *work scaffolds*, which serve the work – noting that the Gothic spire is a structure where the same scaffold fulfilled both functions. Since we don’t know any medieval scaffolding plans, information about contemporary scaffolding structures is to be found almost solely in the visual arts, and a catalogue of such works, on which we can find depictions of construction work, has been compiled at the University of Cologne. According to them, in the Middle Ages, scaffolding was only used for work, materials not being stored upon it: we know of cantilever scaffolding and of scaffolding standing on legs or standing on trestles, and the workers mainly moved between two work levels on a ladder, less often on a ramp. The construction of a higher scaffold also included braces. The scaffolding holes are often still preserved in the facade walls – in the case of cantilevered scaffolding, the beams were built into the wall, and the ends of the crossbars of the scaffolding standing on legs were attached to the wall. In order to get closer to the scaffolding of the past, Bereczki carefully examines technical drawings from somewhat later: a drawing of the scaffolding built in 1601 to repair the lantern of the cathedral in Florence, a drawing of the 21-storey wooden scaffolding made in 1838 for the demolition and reconstruction of the spire of the Stephanskirche in Vienna (which was made after the construction of the scaffold), a drawing from France from the middle of the fifteenth century, and the scaffold drawing in Viollet-le-Duc’s dictionary. In the next chapter, the focus shifts to scaffolds and scaffold components that have survived to this day in their original locations, inside church towers, primarily with the function of bell stand: Freiburg (DE) – *Glockenstuhl*; Salisbury Cathedral (UK) – “a unique medieval metal, timber and stone structure that survived inside the crossing tower”; and another one, of which only a drawing is left, Vienna – the former bell stand of the south tower of the Stephanskirche. Smaller construction scaffolds, or at least their traces, can be found in the spires of other churches as well: an imprint of a former scaffold from the fourteenth century in the simple stone spire of the Church of St Matthäus in Murau (AT); remnants of a scaffold in the southwest spire of St Stephen's Church in Vienna; a fourteenth century timber structure in the northern tower of Saint Martin's Church in Spišská Kapitula; a functionless wooden structure reaching out to the walls in the northern tower of the Church of St Elizabeth in Košice, and beam nests in the interior of the stone spire of the former Franciscan church in Sopron.

After thorough preparation, in the third chapter of his book Bereczki guides us step by step – using the example of the north tower in Vienna – through "The stages of a tower construction". Based on the previously discussed medieval tower drawings, he creates an accurate and detailed 3D computer model of the structure, in the next stage he constructs also in 3D the possible scaffold structure, and finally "places the appropriate machines in the appropriate places on the scaffold", based on Hammer's portfolio. Scaffolding with columns is placed on the lower square shaped levels, attached to the outer side of the walls to be built. For the bell level, a scaffold is used that remains in place – originally a working scaffold, later developed into a bell frame. An internal scaffold is constructed for the octagonal level, specifically designed for the construction of the subsidiary giant pinnacles. For the construction of the spire, an internal centre scaffold is developed, along with a gallery scaffold around the spire for the subsidiary pinnacles, while an external scaffold is used at the top.

He also uses data from several contemporary drawings for the crane frame and crane drive chosen as a model for the first stage, since there are very few traces of auxiliary structures in the built parts of the tower today. Hammer's machine drawings were supplemented by the author with the bracings of the medieval Cologne crane, demolished in the nineteenth century – the construction of each wall section can be read according to the height of the crane, and the author also provides a detailed explanation. The heavier stones and the rubble stone used in the core of the walls were obviously lifted with the larger crane, and the carved, smaller stone elements were probably placed using several smaller lifting cranes. The second stage is the free-standing square tower body: the outer wall has a square plan, but the inner one has already changed to an octagon, so the model uses the Freiburg solution (previously a construction scaffolding, a belfry later being built in), on which Hammer's heavy load-carrying frame crane could be used, since heavier loads are possible on the bell stands, and thus stone material storage as well. The smaller carved stones could again be placed with the rotating smaller cantilever cranes. Wall sections built with decorative stone elements between the buttresses could also be built from a cantilever-gallery multi-level scaffold, and the model also uses this on both sides for the tracery gables, where the wall plane jumps out and back. In the window openings, the model uses beams covered with built-in boards. For the third section – the free-standing octagonal tower storey – the scaffold was made according to Viollet-le-Duc's drawing, slightly modified to be suitable for assembling the giant pinnacles, but it could also be used in the octagonal bell storey. On top of this section's stand the largest Hammer tower crane was positioned – the only one with tread wheels. Inside, the heavy frame crane that served the previous levels is still in use, again supplemented by several cantilever cranes. The fourth stage is the openwork stone spire – the construction of this is shown in the model in two parts: first, the lower part of the spire and the forest of pinnacles around it are built, and then the upper level of the spire. Inside the spire, the centre scaffold temporarily supports the stones to be placed on the edges of the spire, and the detailed articulated scaffold for the construction of the pinnacles was made in the gallery around the spire – the nineteenth century scaffolding used for the repair of the southern tower in Vienna served as a model for this. The stones can be lifted to the top of the pinnacles by a smaller, rotating Hammer crane. Above this level, the top of the spire can only be built from the outside – in Salisbury, a change between the inner and outer scaffold can also be observed. The model for the external scaffold here is again the Viennese nineteenth-century drawing, and a Hammer frame crane was placed on top of it. The text is supplemented by many drawings and reproductions, showing in which stages and with the help of which auxiliary structures a medieval church tower with a stone spire could have been built.

As I have been interested in medieval church architecture for years, I have studied numerous studies, books and buildings. Nevertheless, I came to the clear realization that this book is a "gap-filler" for me, as it uncovers a wealth of new data and perspectives. I recommend it to every professional dealing with monuments, building researchers, researchers of medieval architecture and enthusiasts of medieval churches alike – and I caution them not to skip the detailed technical descriptions, as they will likely revisit them later…

And after the reader has followed Bereczki through the phases of his research, gaining insight into lesser-known areas of architectural history, and has perused the extensive footnotes and bibliography, at the end comes further reward – a link to where one can interactively explore every detail of the 3D model, now familiar after reading the publication: https://zbereczki.github.io/gothic-construction/

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