VOL. 8, SPECIAL ISSUE (2022)

Remarkable historic timber roofs. Knowledge and conservation practice. PART 1 - Construction history and survey of historic timber roofs

TEMA
Technologies
Engineering
Materials
Architecture

Journal Director: R. Gulli

Special Editors: L. Guardigli, E. Zamperini

Assistant Editors: A.C. Benedetti, C. Mazzoli, D. Prati

Cover illustration: Lattice roof trusses in the nave of Jät church, Småland, Sweden, 1225–1226 by Robin Gullbrandsson. © Robin Gullbrandsson (2022)

e-ISSN 2421-4574
DOI: 10.30682/tema08SI

TEMA
Technologies
Engineering
Materials
Architecture

e-ISSN 2421-4574
ISBN online 979-12-5477-085-6
DOI: 10.30682/tema08SI

Vol. 8, Special Issue (2022)

Remarkable historic timber roofs. Knowledge and conservation practice
Part 1 - Construction history and survey of historic timber roofs

Year 2022 (Issues per year: 2)

Editor in chief
Riccardo Gulli, Università di Bologna

Associated Editors
Annarita Ferrante – Università di Bologna
Enrico Quagliarini – Università Politecnica delle Marche
Giuseppe Margani – Università degli Studi di Catania
Fabio Fatiguso – Università Politecnica di Bari
Rossano Albatici – Università di Trento

Special Issue's Editors
Luca Guardigli – Università di Bologna
Emanuele Zamperini – Università degli Studi di Firenze

Editorial Board Members
İhsan Engin Bal, Hanze University of Applied Sciences – Groningen
Antonio Becchi, Max Planck Institute – Berlin
Maurizio Brocato, Paris – Malaquais School of Architecture
Marco D'Orazio, Università Politecnica delle Marche
Vasco Peixoto de Freitas, Universidade do Porto – FEUP
Stefano Della Torre, Politecnico di Milano
Giuseppe Di Giuda, Università di Torino
Luca Guardigli, Università di Bologna
José Luis Gonzalez, UPC – Barcellona
Francisco Javier Neila Gonzalez, UPM Madrid
Alberto Grimoldi, Politecnico di Milano
Antonella Guida, Università della Basilicata
Santiago Huerta, ETS – Madrid
Richard Hyde, University of Sydney
Tullia Iori, Università di Roma Tor Vergata
Raffaella Lione, Università di Messina
John Richard Littlewood, Cardiff School of Art & Design
Camilla Mileto, Universidad Politecnica de Valencia UPV – Valencia
Renato Morganti, Università dell'Aquila
Francesco Polverino, Università di Napoli Federico II
Antonello Sanna, Università di Cagliari
Matheos Santamouris, University of Athens
Enrico Sicignano, Università di Salerno
Lavinia Tagliabue, Università di Torino
Claudio Varagnoli, Università di Pescara
Emanuele Zamperini, Università di Firenze

Assistant Editors
Cecilia Mazzoli, Università di Bologna
Davide Prati, Università di Bologna
Anna Chiara Benedetti, Università di Bologna

Journal director
Riccardo Gulli, Università di Bologna

Scientific Society Partner:
Ar.Tec. Associazione Scientifica per la Promozione dei Rapporti tra Architettura e Tecniche per l'Edilizia
c/o DA - Dipartimento di Architettura, Università degli Studi di Bologna
Viale del Risorgimento, 2
40136 Bologna - Italy
Phone: +39 051 2093155
Email: info@artecweb.org - tema@artecweb.org

Media Partner:
Edicom Edizioni
Via I Maggio 117
34074 Monfalcone (GO) - Italy
Phone: +39 0481 484488

TEMA: Technologies Engineering Materials Architecture
Vol. 8, Special Issue part 1 (2022)
e-ISSN 2421-4574

Editorial 5
Remarkable historic timber roofs. Knowledge and conservation practice
Part 1 - Construction history and survey of historic timber roofs
Luca Guardigli
DOI: 10.30682/tema08SIm

Wooden structures of the Clock Tower in Castle Bruntál 9
Lucie Augustinková
DOI: 10.30682/tema08SIa

Historic hanging partitions: analysis of a relevant application in Palermo 17
Enrico Genova, Giovanni Fatta
DOI: 10.30682/tema08SIb

The genesis of timber trusses: "unexpected" affinities between roofs carpentry in Etruria and Phrygia during the Antiquity 28
Nicola Ruggieri
DOI: 10.30682/tema08SIc

Historic timber roofs in Belgium: overview of materials and structures (1150-1960) 39
Louis Vandenabeele
DOI: 10.30682/tema08SId

Ancient wooden roofs in the area of Genoa: the structure with a curvilinear profile of the parish church of Cogoleto 51
Daniela Pittaluga, Cristina Accomasso
DOI: 10.30682/tema08SIe

Ancient wooden roofs in the area of Genoa: an almost intact 17th century salt warehouse 64
Daniela Pittaluga, Giacomo Calvi
DOI: 10.30682/tema08SIg

A review of Scandinavian research on medieval church roofs 76
Robin Gullbrandsson
DOI: 10.30682/tema08SIf

Lost roofs - case studies from Munich 90
Clemens Knobling
DOI: 10.30682/tema08SIh

Coffered ceilings in the churches of Rome, from the 15th to the 20th century 109
Arianna Tosini
DOI: 10.30682/tema08SIi

Technique at the service of a new liturgical model: the timber roof of the church of Saints Marcellino and Pietro in Cremona 120
Angelo Giuseppe Landi, Emanuele Zamperini
DOI: 10.30682/tema08SIl

WOODEN STRUCTURES OF THE CLOCK TOWER IN CASTLE BRUNTÁL

Lucie Augustinková

TEMA Technologies Engineering Materials Architecture

e-ISSN 2421-4574

Vol. 8, Special Issue part 1 - (2022)

DOI: 10.30682/tema08SIa

This contribution has been peer-reviewed.
© Authors 2022. CC BY 4.0 License.

Abstract

The article deals with the timber structures of the Clock Tower in Castle Bruntál (Czech Republic). In the text, the development of the Clock Tower is explained, and timber structures are described and classified. Presented knowledge is based on the partial historic building investigation of the roof truss of the castle and the Clock Tower, which was achieved with the help of art history and architectural methods. The constructional solution is explained in the context of towers built at a similar time and the purpose of which was similar as well.

Keywords

Castle Bruntál, Tower, Renaissance, Half-timbered structure, Timber-framed structure.

Lucie Augustinková
VŠB - Technical University of Ostrava, Faculty of Civil Engineering (Czech Republic)

Corresponding author:
e-mail: metis@centrum.cz

1. INTRODUCTION

Renovation of the castle Bruntál (Fig. 1) started to be prepared in 2020. Atelier 38 worked out a design "No. A382013 Renovation of the roof of an object of Muzeum in Bruntál" that had been ordered by the Muzeum in Bruntál, a state-funded organization. Even if the castle has been a national cultural heritage since 2002, there is only minimal knowledge about its construction development. Performing partial historic building investigation of the castle focused on the roof truss of the castle, and the Clock Tower was part of pre-design work [1].

2. METHODS

New knowledge of the castle Bruntál was achieved with a set of methods of historic building investigation. These are, first of all, archival search, history of structures, and history of art methods. Employing natural science analyses was principal, especially dendrochronology for dating elements of castle and tower roof truss. The ARCHICAD images were used, and proficiency in historic building projecting was utilized to mediate obtained knowledge of the structure [18].

Fig. 1. *Map of Czech Republic with the recording of the town Bruntál, 2020 (Drawing M. Ferko)..*

3. CASTLE BRUNTÁL

The town of Bruntál was established as the king's town, probably at the beginning of the 13th century. The precursor of the castle, the town castle Bruntál, dates back

to the first half of the 15th century [2]. From the second half of the 15th century, Bruntál was in the pledge of Lords of Vrbno, who moved their seat there and started to call themselves the Bruntal family of Vrbno. Jan Bruntal of Vrbno the Younger participated in a rebellion of the Bohemian nobility against the Habsburg monarch. After the resistance movement was defeated at the Battle of White Mountain (Schlacht am Weißen Berg, Bitva na Bílé hoře), he left the country, and his property, including Bruntál demesne, was confiscated. In 1621 Bruntál became the property of the Order of Brothers of the German House of Saint Mary in Jerusalem (the Teutonic Order), the Grand Master of which at that time was the brother of the winner of the Battle of White Mountain, the brother of the Roman Emperor and the Czech king Ferdinand II, the Bishop of Wrocław, Charles of Austria (Carl von Österreich) (1620-1624). The demesne was in property of the order on a modified scale until 1848; afterward, the order owned the castle until 1939 [3].

At the end of the Middle Ages, the town castle Bruntál developed into a three-wing building, the northeastern, northwestern, and southern. In the Renaissance period, the town castle was converted into a castle [4], and four pillar arcades were built in the castle courtyard (Fig. 2). In 1764, the castle was destroyed by fire. From 1765 to 1768, a new roof truss was installed [1]. Construction conversion of the castle in the second half of the 18th century is proven by a set of historical designs from Deutschordens-Zentralarchiv [5].

During the conversion of the central part of the southern wing into a stair hall at the end of the 18th century, proven by design documentation, the roof truss of this wing was converted. In the second half of the 19th century, the ceramic roof covering of the castle was to be replaced by a roofing slate.

When the Grand Master of the order was the archduke Eugen of Austria (Eugen von Österreich), an extensive repair of the castle was performed. Corbels were installed in the roof truss; these corbels served as auxiliary structures and helped to operate scaffolding or platforms for façade conversion. The condition is evidenced by historic photographs of 1913.

Renovation in the Modern age was performed in the second half of the 20th century. The roof of the castle and tower was repaired in 1963. The roof truss was significantly renovated in the first half of the 1990s [1].

Fig. 2. *Castle Bruntál, aerial photo.*

4. CLOCK TOWER IN BRUNTÁL – STRUCTURE CHARACTERISTICS

The Clock Tower (Fig. 3) is part of the northwestern wing of Castle Bruntál. It extends the ground plan of the wing into the castle courtyard. The ground plan of the bottom part of the tower is rectangular, while the top part forms an octagon. The roof of the tower is formed by two onion domes and a lantern located between them. The bottom onion dome continues into the plated lantern and the top onion dome. In the lantern, there is a fixed bell in a static position and a bell of 1672 with colored relief of Our Lady, cast by Johan Grosch in Nysa [8]. The top onion dome continues into a finial with a circular tin case. The bottom part of the tower is lined with stones mostly; the upper floors are usually lined with bricks. There is a half-timbered structure in the top part of the tower, the timber parts of which are made of spruce, fir, and larch [6]. The timber framework is located on two top floors of the brick part of the tower and was placed on the inside face (Figs. 3 and 4). The structure is formed by wooden frames and St. Andrew's crosses between them (Fig. 5). The bottom part of the structure is composed of standard beams. The St. Andrew's crosses are located in the top part, below the roof truss. The elements are connected with woodworking joints with pegs. Thus, the half-timbered structure can be seen inside only. On the top floor of the brick part of the tower, the timber framework con-

Fig. 3. *Castle Bruntál, Clock Tower elevation, the roof of the Clock Tower, Bell with the bas-relief of Our Lady in the Clock Tower. (Photos by the Author, 2020).*

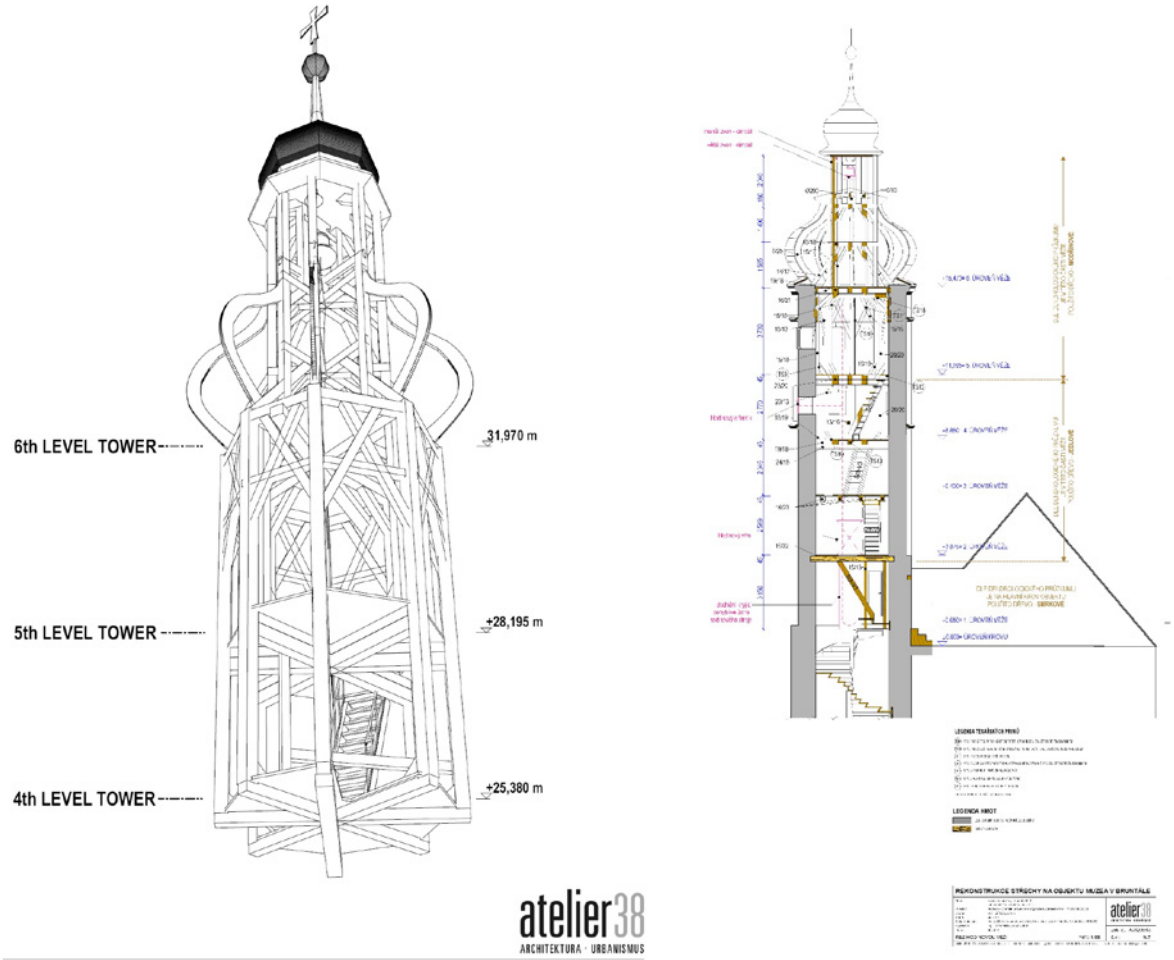

Fig. 4. *Clock Tower, construction scheme of timber structure. (Drawing, Jakub Sollich, Atelier 38).*

Fig. 5. *Clock Tower, half-timbered construction, the traces of the older timber construction. (Photo, 2020).*

sists of two polygons and posts – the internal and the external. Ashlar pieces complement the posts. There are horizontal mortise holes on the floor below on posts of the timber framework. These holes might have been left after a previous structure without any woodwork joints with the timber framework. There are noticeable imprints of round wood on walls at the level of the St. Andrew's crosses. It is not sure whether they relate to the bottom line of mortise holes.

The roof truss of the tower leans against an octagonal frame formed by plates of the half-timbered structure of the top floor of the brick part of the tower (Fig. 6). On this structure, another structure of octagonal ground plan forms the saddle of the tower roof truss. This saddle passes through the bottom onion dome to the lantern. It makes up the supporting structure of the lantern there. Timber centering is cut out of board which is the youngest way of timber centering production. The bottom part of the onion dome is made up with the help of timber sprockets as it was commonplace then. On the roof truss of the tower, there are a few initials and the date "1927" written with paint there. The top onion dome was not accessible when the historic building investigation was performed.

The communication scheme of Castle Bruntál is quite simple. The central vertical communication axis is the Clock Tower. The roof truss of the castle is accessible from two staircases. The first one is located in the tower, and the other leads to the entrance closed with a trap door in the central part of the southern wing. The roof space is divided by gable walls into several fire zones. A timber spiral staircase from the tower can access the roof space.

A right-angled portal into the tower is in the bottom arcade, therefore, at the level of the first floor of the castle. Above the portal is a stone relief with a coat of arms of

Fig. 6. *Clock Tower, half-timbered construction, timber construction in the tower, the traces of the older timber construction, photo, 2020.*

Commander Heinrich Karl Alois von und zu Werdenstein (1739-1770). The relief was placed there secondarily.

5. THE RENAISSANCE TOWER IN CENTRAL EUROPE

Timber was common building material applied in the construction of towers in the past. The upper parts of towers were timber-framed or half-timbered from the Middle Ages. In the Early Medieval Period, timber structures of upper parts of habitable towers were recorded, especially in Western Europe [9]. Timber-framed or half-timbered structures were usually used in fortifications to build hoarding (brattice, brattice).

Timber towers can be seen very rarely in European sacral architecture nowadays. They might be compared to bell towers from Western and Southern Europe [19]. An example of such towers can be a recently renovated bell tower in Pembridge in Herefordshire; dendrochronologically dated back to 1207-1223 [17]. Timber-framed towers with slab shuttering were constructed in the Late Medieval Period, mainly in churches [14]. Towers were either timber-framed in their full heights (St. Catherine's Church, Ostrava - Hrabová), or the timber-framed structure was installed on upper floors only (Štramberk, the tower of a former parish church which was also a tower of a town wall) [11].

There were many towers with various purposes constructed in the 16th century. The amount of available information on the architecture of towers in the 16th century is influenced by a large number of these structures that have been preserved, at least in Central Europe. They are mostly church towers or town towers that served as guard towers or watchtowers as well. These towers might be constructed similarly. Towns often paid for the construction of the church towers since they served as watchtowers and guard towers afterward and were owned by the towns. By the Church of St. Thomas of Canterbury, the town had built a tower still in its property. In 1587 the non-Catholic patricians in Nový Jičín paid for the construction of a church tower that served as a guard and watchtower. The Church bought the tower from the municipality in the first half of the 20th century.

Only two objects of similar age have been documented in the Moravian-Silesian Region; the city tower called Hláska (former watchtower) in Opava [15] and the Church of St. Nicolas tower in Bílovec [16]. The upper floor of Hláska in Opava from 1614 was, as well as in Bruntál, constructed with the help of a half-timbered structure on the inside face. The inside structures on the upper floors of the tower are similar to the ones in the tower of the Church of St. Nicolas in Bílovec from 1614-1615. Although the tower has been rehabilitated, the timber framework has not been preserved.

Baroque towers offer interesting structural parallelism. The half-timbered structure was also used in the tower of the Former City Hall in Moravian Ostrava (nowadays Ostrava Museum). This structure was placed on the outside face of the tower; therefore, it was visible from the outside [11].

The development of tower roof trusses is similar to other roof truss structures. Traditional Gothic roof trusses were commonplace in tower roofs by the mid-16th century, as well as in other roofs. The Renaissance brought a new element – Onion domes (structures by Baldassare Maggi in Southern Bohemia). The round shape of these towers is formed by a set of timber centering supported by supporting structures with posts into which the timber centering was fixed afterward [14].

6. RESULTS - THE DEVELOPMENT OF THE CLOCK TOWER IN CASTLE BRUNTÁL

There is no information about the roof of the town castle. The oldest mention of the castle's roof comes from the 16th century. The principal pictorial source is a map of Bruntál demesne of 1579 [7]. On this map, there is a veduta of the aristocratic seat in Bruntál depicted in quite a simplified form; even then, it had the character of a castle. The age of the hipped roof, with reference to the veduta and the battlemented parapet, is unknown.

Researcher Samek dated the construction of the Clock Tower to the end of the 16th century or the turn of the 16th and 17th centuries [3]. However, the construction of the tower consisted of more phases of building development. The disposition of the tower indicates that the bottom part of the rectangular ground plan, covered with sgraffito work nowadays, is much older than the arcades of the inner courtyard. The bottom floors of the masonry part of the tower date back, according to the disposition analysis, before the 1550s. No tower is depicted on the veduta of the map of Bruntál demesne of 1579 (Fig. 7). However, the veduta might be significantly simplified, and the tower is not necessarily depicted there. Dendrochronological dating confirms that. Since the dendrochronological dating of the timber ceiling on the bottom floors of the octagonal tower failed, its age cannot be defined. The bottom level of the timber framework was constructed after 1577 [6], i.e., when the castle was still the property of the Bruntál family of Vrbno. It might have been built by Hynek Bruntal of Brno the Elder (1559-1596). Above mentioned dating relates to the tower up to the height of the bottom cordon in the octagon. There is no evidence of the appearance of the upper floors or the roof in those days. We may speculate about it being damaged or destroyed by fire; on two posts of this bottom half-timbered, the 4th floor of the octagon, there are signs of burning [1].

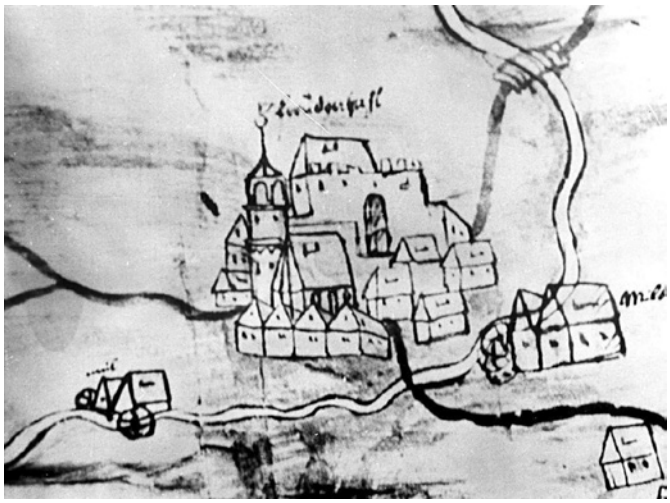

Fig. 7. *The map of the Bruntál demesne, 1579 (A. Peschke, Die Karte der Herrschaft Freudenthal im Jahre 1579)..*

The half-timbered structure of the two top floors of the tower indicates that there have been two building phases of the construction. The posts of the framework are doubled; on some plates, there are noticeable mortise holes left by a structure that had been removed; this can be seen in the entry to the upper floor. The top level of the timber framework, i.e. the 5th floor of the octagon with the St. Andrew's crosses, was added after 1618. We do not know whether it was when the castle was the property of Jan Bruntál of Vrbno and in Heraltice the Younger (1617-1621) or the property of the Teutonic Order.

The age of the tower's roof, comprising of two onion domes and the lantern, is not certain, either. The construction might relate to the report of 1667 from the Teutonic Order archive, mediated by Ph.D. Niesner. The roof of the castle, covered with ceramic tiles, was repaired then [10]. In the tower's lantern, a bell was still cast by Johan Grosch in Nysa in 1672 [8]. The bell is fixed in the static position (only the clapper moves) in the tower, as well as another bell in the static position. The age of the roof of the tower can be dated back to the end of the 1660s or the beginning of the 1670s.

Two vedutas by Friedrich Bernhard Werner from the first third of the 18th century are a precious source of information on the development of the castle (Fig. 8). These vedutas have been preserved in the form of hand-drawn replicas from 1763 [12]. The time relationship between the shape of the roof truss and Werner's vedutas is not very straightforward. The drawing has red roofs of the castle and green tower domes. The report from the Teutonic Order archive defines the roof covering as made of fired ceramic; the tower might have been covered with either copper plating with patina or painted shingles.

The fire of the town and castle in 1764 did not threaten the Clock Tower. However, given the three wings of

Fig. 8. *F.B. Werner, Castle Bruntál. (Drawing, 18th century, Biblioteka universytecka Wroclaw).*

the castle, the fire might have been the cause why a new roof truss was installed in the period of Grand Master Charles Alexander Emanuel of Lorraine (1761-1780), the brother-in-law of Queen Maria Theresa [13].

In the Modern Age, the entrances between the floors in the Clock Tower were shifted. Ladder staircases were used again.

The tower's roof was reconstructed in 1927; the roof cladding and the timber centering might be from that time. On the roof truss, the number "1927" is written with paint [1].

7. CONCLUSIONS

The historic building investigation of the roof truss of the Castle and Clock Tower in Bruntál showed some interesting facts and connections. The tower is older than the professional literature stated. The bottom part of the rectangular ground plan might be even from the late Gothic period. The central part of the tower, of the octagonal shape, was added before the 1550s.

The upper part of the tower, of the octagonal ground plan, was added after 1618. During further construction, the timber framework was placed on the inside face of the tower, and this timber framework was fixed into pre-installed posts. There are several other towers of similar composition in the neighborhood, i.e., in Moravia and Silesia, that are of similar age. It is, especially the city tower Hláska beside the city hall in Opava. The tower is a bit older, its upper floors are also half-timbered, or more precisely, they are timber replicas of the original timber framework from 1614.

The purpose of the tower in Bruntál seems to be mixed, at least in the Renaissance period. The mortise holes in posts and marks left by round timber might indicate the existence of an inner timber structure. The use of the structure, with regard to good visibility of the courtyard and its neighborhood from this floor, might be defensive and also guarding. I think that this structure was disegned only for crossbowmen. The using of the firearms leave trases – blackening caused by smoke.

In the mid-seventeenth century, the tower got its current appearance, with two onion domes and a clock, and it served as a bell tower as well. The tower in Bruntál is an exciting example of a polyfunctional tower modified in the 16th and 17th centuries.

8. REFERENCES

[1] Augustinková L (2020) Zámek v Bruntále – krov zámku a Hodinové věže. Dílčí stavebněhistorický průzkum. Ostrava

[2] Kouřil P, Prix D, Wihoda M (2000) Hrady českého Slezska, Archeologický ústav Akademie věd ČR, Brno

[3] Samek B (1994) Umělecké památky Moravy a Slezska. Ústav dějin umění Akademie věd ČR, Praha, Díl I A – I, pp 267–274

[4] Štěpán V (2009) Historie zámku Bruntál. Muzeum v Bruntále, Bruntál

[5] Niesner T (2015) Zámek Bruntál. Historická rešerše. Bruntál, Nepublikovaný strojopis uložený v knihovně Muzea v Bruntále

[6] Kyncl T (2020) Dendrochronologické datování krovu zámku a Hodinové věže v Bruntále. Výzkumná zpráva. Brno, Nepublikovaný materiál uložený na KÚ MsK Herrschaft

[7] Peschke A (1934) Die Karte der Herrschft Freudenthal um 1579. Freudenthaler Ländchen 14: 37–42

[8] Lednický J (2000) Ojedinělý Groschův zvon na zámku v Bruntále. Sborník bruntálského muzea: 76–77

[9] Altwasser E (2004) Hölzerne Turmbauten im Mittelalter. In: Hofrichter H. Holz in der Burgenarchitektur. Braubach, pp 105–116

[10] Deutschordens-Zentralarchiv Wien, fond Meisterthum, sign. Mei 256/12, Mei 256/13, 88/3

[11] Augustinková L (2016) Příklady rámových a hrázděných konstrukcí v Moravskoslezském kraji. In: Svorník 14, Roubené a hrázděné kosntrukce historických staveb. Sdružení pro stavebněhistorický průzkum z. s. Praha, pp 31–43

[12] Werner FB (1783) Silesia in Compendio seu Topographia das ist Praesentatio und Beschreibung des Hertzogthums Schlesiens. In: Topographia Silasiae (Vol.1 - IV F 113 b) Pars I. Biblioteka uniwersytecka Wroclaw

[13] Thannabaur J (1931) Schloss Freudenthal. Freudenthaler Ländchen 11:7, 54

[14] Škabrada J (2003) Konstrukce historických staveb, Argo, Praha

[15] Ausficír J et al (2006) Paměť místa / místo paměti. Almanach u příležitosti rekonstrukce opavské Hlásky v roce 2006. Opava

[16] Indra B (1958) Stavba věže farního kostela v Bílovci roku 1615, její stavitel a vzor. Bílovecko 6:10–11

[17] Boucher A R, Morriss RK (2011) The Bell Tower of St Mary's Church, Pembridge, Herefordshire, Vernacular Architecture 42:22–35

[18] Currà E, D'Amico A, Angelosanti M (2021) Representation and Knowledge of Historic Construction: HBIM for Strunctural Use in the Case of Villa Palma Guazzaroni in Terni. TEMA Technol Eng Mater Archit 7(1):8–20. https://doi.org/10.30682/tema0701b

[19] Attilio Mondello (2017) Traditional bell towers: Knowledge and safety in two compared areas. TEMA Technol Eng Mater Archit 3(3):124–135. https://doi.org/10.17410/tema.v3i2.147