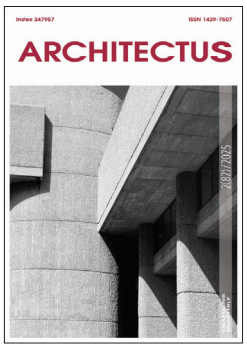

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Architecture and building technology of the 16th-century half-timbered church in Byków

Abstract

An architectural survey of the former Evangelical church, now the Church of Our Lady of the Rosary, in Byków (Długołęka municipality, Wrocław district) was conducted in 2022. Its erection dates back to 1574. The church underwent significant expansion and reconstruction in the following centuries, which dramatically changed its form.

The purpose of this article is to present the results of this research with regard to the original form of the church, particularly the construction technique used in the 16th century, and to reconstruct its probable form when it was erected. The research covered the structural layout, the type of building material used and its fabrication, the timber framing sides and the system of carpentry assembly marks, the carpentry joints used, and the material used to fill the fields of the framework and its colours.

Based on these, the authors were able to determine that the original church was erected in a timber-frame construction and consisted of a nave and an elongated, trilateral closed choir on the east and a tower on the west. The corpus and choir were covered with gabled roofs with king post trusses. Much of this structure has been preserved in the present church structure.

Key words: church, 16th century, framework construction, architectural research, Byków

Introduction

The construction of the church in Byków dates back to 1574. The church at that time is described in sources as a single-nave, half-timbered structure (Anders 1867). Today's church is a building with brick perimeter walls, a hall structure, on a rectangular plan: three-aisles with matronea integrated with the side aisles, a single-storey structure, with a choir enclosed from the north and south by a pair of auxiliary rooms, covered with a gable roof, with a tower surmounted with a spire with an octagonal lantern. Its roof structure is a single-collar beam type with double-standing truss. The narrower side aisles are separated by single rows of columns supporting richly decorated matronea, which in the choir section turn into former patrons' boxes; in the western part of the main nave, there is an organ matroneum. In 2009, the church was entered into the register of historical monuments[1] (Fig. 1).

At the request of the Lower Silesian Voivodeship Conservator of Monuments, in 2022 a measurement and drawing inventory (reasearch base; Jagiełło, Kumorowicz-Brzeska 2022) and architectural research of the church were carried out. Their aim was to identify the building history of the church, mainly in its 16th-century shape and construction (Schaaf et al. 2022)[2]. The substantive scope

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[1] The church was entered into the register of monuments under the number A/1380 by the decision of the Lower Silesian Voivodeship Conservator of Monuments of 26 October 2009 (Narodowy Instytut Dziedzictwa… 2024).

[2] We would like to thank the Parish of St. Michael the Archangel in Długołęka for making the building available and the Lower Silesian

Fig. 1. Church of Our Lady of the Rosary in Byków, southern elevation, view towards the north-west (photo by M. Prarat, 2022)

Il. 1. Kościół pw. Matki Bożej Różańcowej w Bykowie, elewacja południowa, widok w kierunku północno-zachodnim (fot. M. Prarat, 2022)

included, first of all, the analysis of the existing material substance of wooden structures. The conclusions drawn were compared with knowledge about the church's construction history, which made a chronological stratification of the building possible.

In this article, the authors of the aforementioned documentation will present the results of the conducted research, including the reconstruction of the original appearance of the church (the form at the time of construction) and the characteristics of the construction technique used at that time, which was analysed in terms of the structural system, the type of building material used and its processing, the sides of timber framing and the system of carpentry assembly marks, the carpentry joints used, and the material used to fill the panels and its colour.

Reconstruction is based on the existing historical substance, the results of analyses enabling the reconstruction of historical solutions, and, in cases where there were no other premises, on the search for analogies among buildings of similar date and nature, and in a related area of influence.

State of research

The history of the church, including its construction, has not been the subject of in-depth research so far. Information about the history of its construction is mostly limited to date notes referring to the time of construction, renovation, or extension (sometimes ambiguous: Anders 1867; 1886; Hultsch 1977)[3] and short notes characterizing the structure (Brzezicki et al. 2006; Donath et al. 2012). The church was captured by Friedrich Bernhard Werner (1754) in a drawing showing the palace with Baron Haugwitz's garden of 1754) (Fig. 2). The 19th-century works are mentioned in the Files of the Conservator of Monuments of the Province of Lower Silesia (Archiwum Państwowe… ref. no. 1172) – the following were enumerated: replacing the half-timbered construction of the walls with bricks and changing/reconstructing the roof[4]. The authors make the reservation, however, that the research in question did not include a full archival search. The history of the church and the parish is presented in more detail in *Dzieje gminy Długołęka* [History of the Commune of Długołęka] by Zbigniew Fras (1998), although the information contained in the publication does not contribute anything new to the subject of the construction history of the church.

Outline history

The first mention of a church located in the town of Peuke (today's Byków) dates back to 1385 (Brzezicki et al. 2006). It was a wooden construction, with a form not specifically described in the literature on the subject (Hultsch 1977). In 1538, the Reformation was introduced in the villages belonging to the Duchy of Ziębice and Oleśnica (Ziębice-Oleśnica), on whose territory Peuke was located (Hultsch 1977).

The current church (Donath et al. 2012) is a layered construction which has undergone numerous and quite significant changes in the subsequent years of its operation. Its building history can be divided into four main phases.

Voivodeship Conservator of Monuments for enabling architectural research.

[3] In individual texts, the year 1574 is associated with the "construction or renovation" of an earlier church (see: Anders 1848).

[4] We would like to thank Dr. Grzegorz Grajewski for providing his extracts from the Files of the Conservator of Monuments of the Province of Lower Silesia.

Fig. 2. Church of Our Lady of the Rosary in Byków depicted in a fragment of a drawing by Friedrich Werner from a publication published in the mid-18th century (source: Werner 1754)

Il. 2. Kościół pw. Matki Bożej Różańcowej w Bykowie przedstawiony na fragmencie rysunku Friedricha Wernera pochodzącym z publikacji wydanej w połowie XVIII w. (źródło: Werner 1754)

The first was the construction of the church – at that time it had a single nave, a tower, and a three-sided closed choir (a detailed description will be presented further in the text).

Owing to the reduction in the number of Protestant churches in the Duchy of Wrocław, from 1662, the Byków church served as a refuge church for the faithful deprived of their own church (in areas where freedom of religion did not apply) and for the local Evangelical community (Anders 1867; 1848; Hultsch 1977). The general renovation of the church is dated to 1693 (Anders 1867; 1848; Donath et al. 2012), including external renovation (Hultsch 1977). Owing to the increased needs resulting from the above-mentioned reduction, in 1702 the church was expanded with wooden side galleries and patrons' lodges (Anders 1867; 1848; Brzezicki et al. 2006)[5]. The rich polychrome interior also dates back to 1702 – probably by Karol Hoffmann (Brzezicki et al. 2006). According to records, in 1720, work was carried out on the church tower (Donath et al. 2012)[6] most likely coming down to the putting of a new helmet on it and casting a new, larger bell from the old one (Anders 1848; 1867).

19th century sources document subsequent events in the history of the church and the church itself, including its good state of preservation[7] in 1825; renovation of the roof/roof covering (*Bedachung*) – 1829, or damage to part of the roof and bell structure and the hanging of a new bell – 1839 (Archiwum Państwowe… ref. no. 1172). In the years 1846–1852 the frame structure of the peripheral walls was replaced with a massive brick wall and the interiors were plastered (Anders 1867; Brzezicki et al. 2006; Donath et al. 2012). According to the information contained in the Files of the Conservator of Monuments of the Province of Lower Silesia, in addition the roof was rebuilt and the tower was straightened. Future plans include partial repairs to the ceilings, construction of pews, repairs to the altar, construction of doors and windows, as well as the construction of the organ matroneum (Archiwum Państwowe… ref. no. 1172). The wooden structure of the tower in its upper part remained unchanged (Hultsch 1977).

The building history of the church in the 2nd half of the 19th century and in the 20th century is not rich. Shortly after the renovation, in 1858, the church was damaged by lightning. Four years later, the archives noted the need to replace the roof covering on the north side, which was to take place a year later (Archiwum Państwowe… ref. no. 1172). Therefore, the last phase is related to the period of 20th-century repairs and additions, mainly observed in the area of the structure and tower[8]. It seems that those activities were carried out rather ad hoc, never having a clear impact on the form or structural arrangement of the preserved church structures. In 1945, the church was taken over by Catholics and the Evangelical parish was liquidated. Currently, it serves as a branch church of the Roman Catholic parish of St. Michael the Archangel in Długołęka (Fig. 3).

The original structure and building technique of the church

The original church was built on a plan consisting of a rectangular nave and located on a longitudinal axis: an elongated choir with a three-sided ending from the east, narrower than the nave, and a square tower from the west. It was a church with a half-timbered construction, with the panels filled with clay on staves and a timber-clad upper part of the tower constituting an integral element of the

[5] The need for expansion is also mentioned by Gerhard Hultsch (1977).

[6] Also known as "tower elevation", see: (Brzezicki et al. 2006).

[7] Indicated date of construction: 1664 [!].

[8] Detailed research results expanding the existing knowledge on the building history of the church (including information not included in this chapter on the subsequent (II to IV) building phases) are included in the author's documentation (Schaaf et al. 2022).

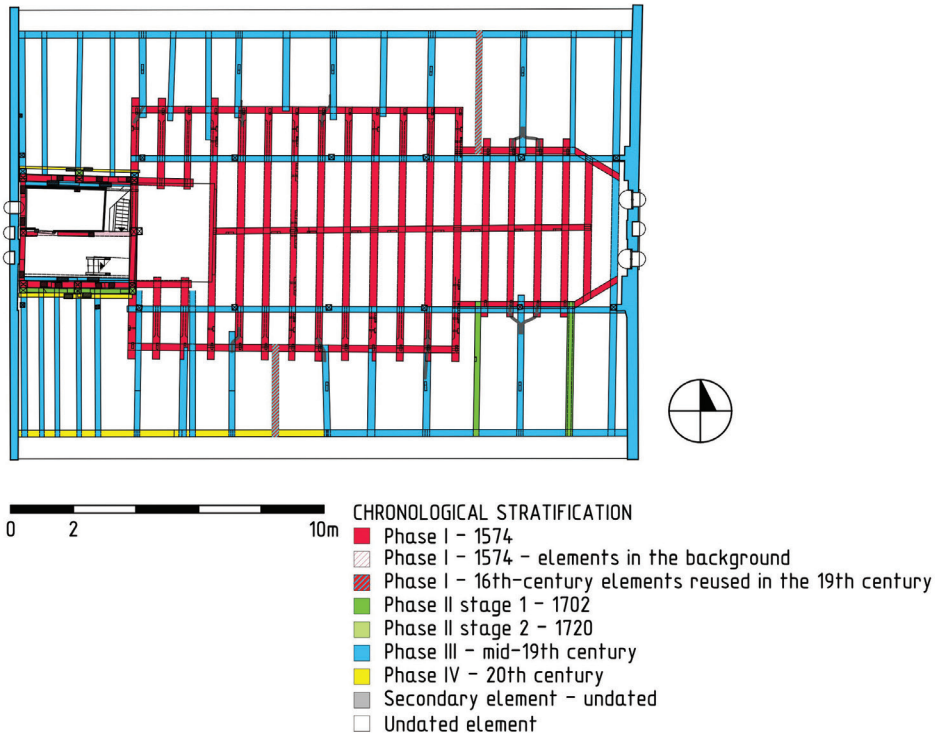

Fig. 3. Church of Our Lady of the Rosary in Byków, chronological stratification of the church, projection at the level of the entablature (elaborated by M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

Il. 3. Kościół pw. Matki Bożej Różańcowej w Bykowie, rozwarstwienie chronologiczne kościoła, rzut na poziomie belkowania (oprac. M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

body of the church: its eastern wall and the western wall of the nave formed one structure. The nave and the choir were closed with gable roofs with a significant angle of inclination of about 65°. The original form of the tower's coping is unknown[9].

The dimensions of the nave body were 10.50 m long and 7.80 m wide. The choir, 5 m long, was narrower, its width in the western part is 5 m, in the extreme eastern part it is estimated at 2.60 m. The tower was built on a plan of 3.60 × 3.60 m.

Structural layout

The nave and choir were built as a half-timbered construction: it consisted of posts and studs running from the ground plate, through the entire height of the, to the up-

[9] In order to maintain the readability of the text, the authors have decided to use consistently the past tense in reference to the reconstructed original form, and the present tense in the analysis of the construction technique conducted solely on the basis of preserved elements, sometimes with limited access or few in number.

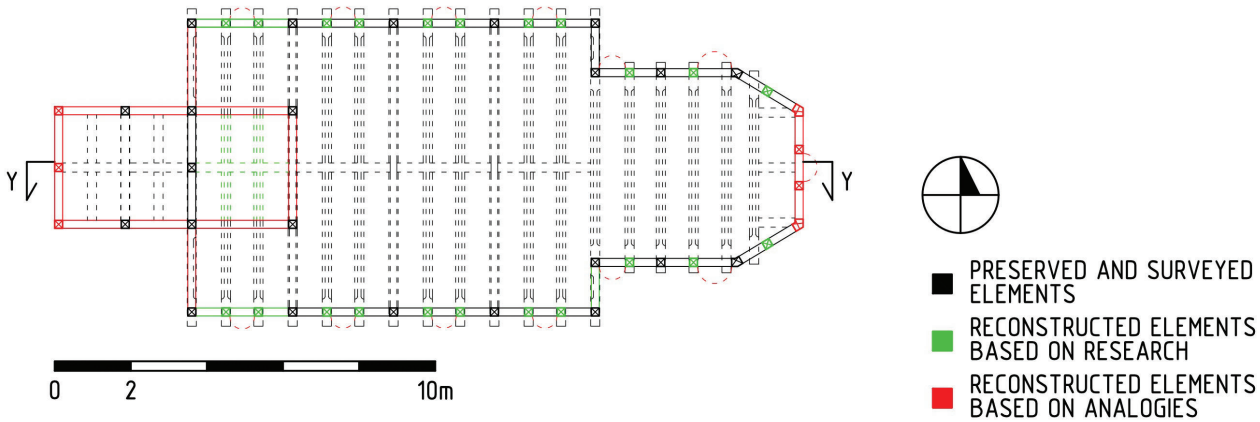

Fig. 4. Church of Our Lady of the Rosary in Byków, reconstruction of the original form of the church (16th century), ground floor plan at window level (elaborated by M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

Il. 4. Kościół pw. Matki Bożej Różańcowej w Bykowie – rekonstrukcja pierwotnej formy kościoła (XVI w.), rzut przyziemia na poziomie okien (oprac. M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

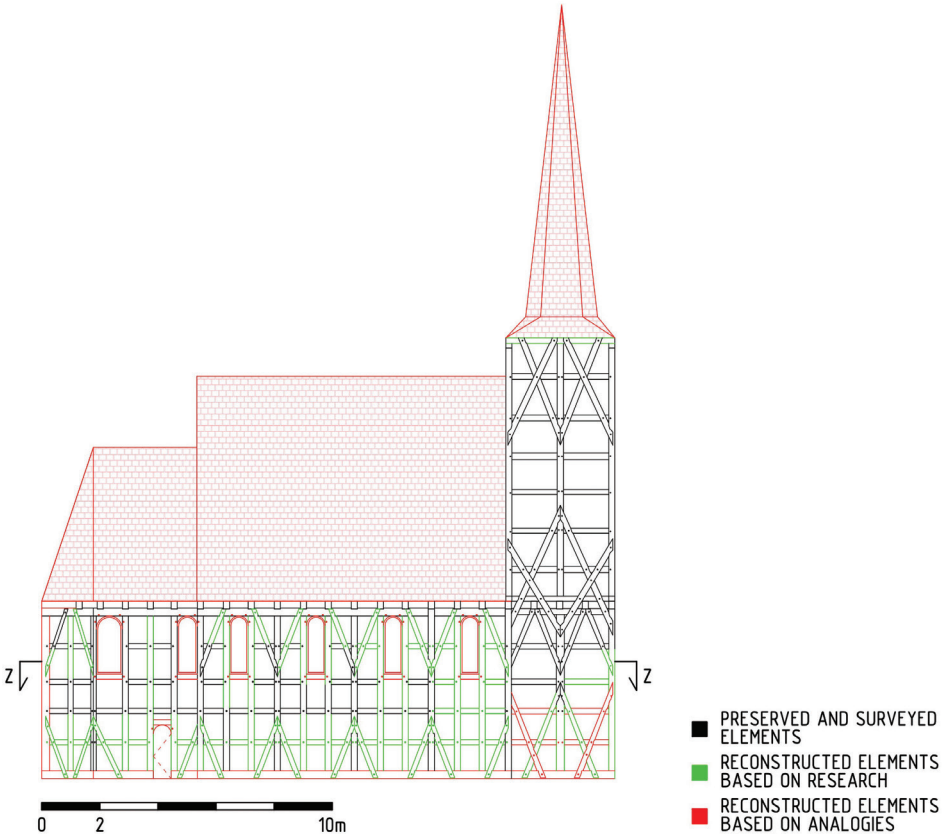

Fig. 5. Church of Our Lady of the Rosary in Byków, reconstruction of the original form of the church (16th century), northern elevation (elaborated by M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

Il. 5. Kościół pw. Matki Bożej Różańcowej w Bykowie – rekonstrukcja pierwotnej formy kościoła (XVI w.), elewacja północna (oprac. M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

per plate, between which four rows of rails were stretched, creating a regular lattice with square panels. Additional stiffening was provided by braces and passing braces (Fig. 4).

The body consisted of two longitudinal frames (north and south) and transverse frames: two main ones (east and west) and three internal frames providing additional stiffening.

The longitudinal frames were created analogously[10]. The structure of both included five posts (spacing[11] 2.35–2.65 m), located at regular intervals, and two studs were placed between them (spacing approx. 0.85–0.90 m). The frame was stiffened at the top and bottom with pairs of passing braces, in the lower part inclined inwards[12] (ground plate–rail 1–main post), and in the upper part, inclined outwards (main post–rail 4–upper plate)[13]. The reconstruction of the original layout was possible thanks to the preserved large sections of walls – timber-clad and constituting internal wall bonds in the nave body. On the basis of the known analogous solutions of similar dating[14], it can be assumed that in the central field of each bay there were single window openings, closed at the top in segments, with a height slightly lower than the height of two frame fields[15] (Fig. 5).

Plastering and re-bricklaying made possible only partial reconstruction of the original form of the eastern frame of the body. It consisted of four posts: two corner ones and an inner pair framing the choir (the distance between the corner and inner posts was about 1.40 m)[16]. The rails were located at a level above the rails of the longitudinal frame (carpenters used this procedure so as not to weaken the element by cutting a pair of carpenter's mortises at the same

[10] Examination of internal bonds was impossible owing to the covering of the half-timbered elements with boards, which is why their documented dimensions and identified carpentry joints were illustrated with single examples. On these, and on the clear spacing of posts and the course of rails despite the covering, the structure was identified and conclusions were drawn with regard to delamination and final reconstruction.

[11] Unless otherwise stated, the spacing of elements is given in their axes.

[12] For a pair of braces/passing braces located within one panel (from post to post), the "outside" arrangement means a pair of elements connected at the bottom to the rail/ground plate/upper plate etc., at the top to the posts, while the "inside" arrangement means the elements are connected at the bottom to the posts, and at the top – to the rail/ground plate/upper plate, etc. For a pair of braces/passing brace located within two adjacent panels, the "outside" arrangement means that the element is connected to the post at the bottom and to the rail/ground plate/upper plate etc. at the top, while the "inside" arrangement means that the element is connected to the rail/ground plate/upper plate etc. at the bottom and to the post at the top.

[13] Such stiffening was used, among others, in churches in Pracze Odrzańskie (1550), Świniary (1570), and Godzięcin (1583).

[14] Similar solutions can be found in the churches mentioned in footnote 17 or in Swojczyce in Wrocław (1537).

[15] Owing to limited availability of elements it was not possible to determine the location and form of the original door opening(s). Analogies can be found in, among others, the solutions used in the non-existent Salvator Church in Wrocław (1561).

[16] The northern post is currently cut off at a height of about 90 cm, and the southern one – probably preserved in the wall structure, is partially visible in the southern room near the choir. The middle pair is probably preserved under plaster in the upper part of the frame (matroneum level).

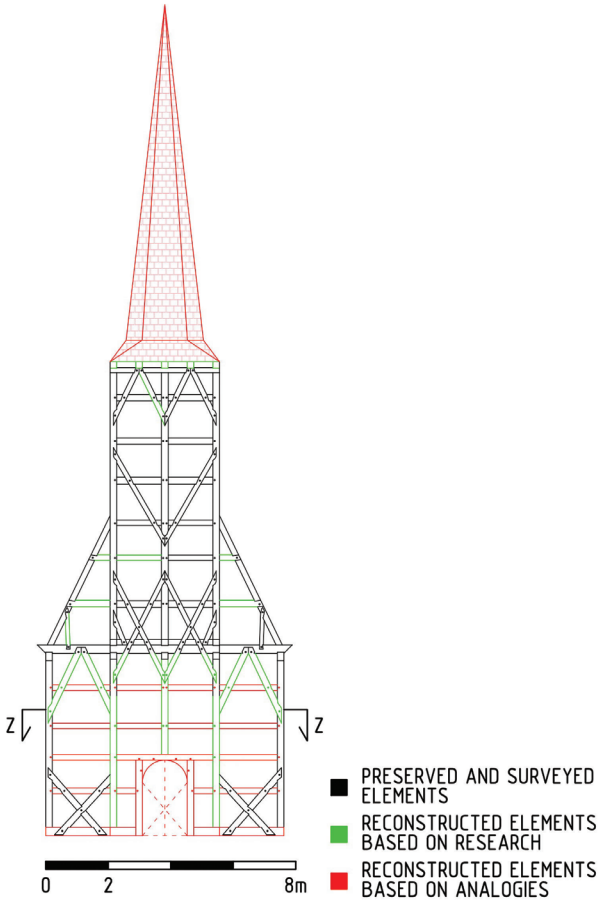

Fig. 6. Church of Our Lady of the Rosary in Byków, reconstruction of the original form of the church (16th century), western elevation
(elaborated M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

Il. 6. Kościół pw. Matki Bożej Różańcowej w Bykowie – rekonstrukcja pierwotnej formy kościoła (XVI w.), elewacja zachodnia (oprac. M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

level). At the northern post, a fragment of one of them has been preserved, marking the lower level of the course. Behind the board nailed to the lintel of the door to the pulpit, the rail of the next level is visible. Confirmation of the presence and possible arrangement of the lower diagonal stiffeners was not possible owing to lack of data[17].

It can be assumed that the western frame was brought into being in a similar way – currently, it is most strongly transformed, integrally connected with the structure of the eastern wall of the tower (an element of the church wall frame extended towards the north and south), as evidenced by the mortises, and pegged tenon joints preserved in the corner posts on the outside. The lower stiffening of the frame between the northern and southern pairs of posts could have been pairs of scissor braces, which are probably hidden by the present V-shaped "structure" (timber-cladding[18] (Fig. 6).

The transverse stiffening of the internal frames consisted of two extreme posts of longitudinal (main) bonds, which were connected at the top with a tie beam resting on the upper plate of the northern and southern frames and with a rail located approximately 0.50 m below. The structure was stiffened by three pairs of symmetrical passing braces inclined inwards, running from the main post, through the rails, to the entablature, as evidenced by the preserved empty mortises in the tie beams (access from the roof structure level) (Fig. 7). On the longitudinal axis of the nave, resting on the rails stretched between the posts of the internal frames, there was a binder that served as a support for the tie beams. Their profiling suggests that they

[17] The reconstruction was made, on the basis, among others, of fragments of the structure preserved in the choir and as an analogy to the churches in Pracze Odrzańskie and Swojczyce.

[18] We do not know if the bay was divided by an intermediate post.

Fig. 7. Church of Our Lady of the Rosary in Byków, the end of the brace connecting with the entablature of the body (red) and the empty mortise after the lap joint of the king strut frame (green)
(photo by M. Prarat, 2022)

Il. 7. Kościół pw. Matki Bożej Różańcowej w Bykowie – zakończenie miecza łączącego się z belkowaniem korpusu (kolor czerwony) oraz puste gniazdo po nakładce ramy storczykowej (kolor zielony) (fot. M. Prarat, 2022)

were visible from below – the interior was probably covered with a flat ceiling installed at the same height above the nave and the choir.

The **choir** was closed on three sides. The north and south wall bonds were built as two-piece structures with the western longitudinal part and the eastern diagonal part. There were two main posts in both walls, in the longitudinal one with three intermediate posts, and in the diagonal part with single ones. The lower panels were stiffened by passing braces arranged as in the longitudinal frames. This arrangement is preserved and partially visible in the southern auxiliary room and at the level of the northern patrons' box.

The transverse stiffening of the choir bonds was probably limited to the short upper braces (main post–tie beam), which are now preserved under the timber cladding. Owing to the complete reconstruction of the wall, there are no data on the eastern frame.

The original **tie-beams** were based on the longitudinal walls of the body and the choir (north-south arrangement). The last pair of beams from the eastern side above the choir was probably significantly shorter than the others (currently the length of the penultimate one is 4.65 cm) owing to its three-sided closure.

The **roof structure** above the body of the nave consisted of 13 trusses: it was a king strut structure with trusses reduced longitudinally and transversely (a full truss in two variants and an incomplete truss, a king strut in every third truss). The structure of the truss above the choir was brought about in a similar way. It was characterized by a smaller span and consisted of five trusses (Fig. 8).

During the construction, three basic types of trusses were used: king strut type in variant 1. – a truss with a king strut suspended probably from the ridge[19] and on a pair of up passing braces; two-collar beam, with a pair of down braces, located in every third truss; king post in variant 2. – two-collar truss with three rails, probably with two pairs of scissor braces, up passing braces, and down braces as in the full version, located at the gable walls of the nave body; reduced – two-collar truss. Two levels of rails were stretched between the trusses. The longitudinal stiffening, next to the ground plate and two rows of rails, consisted of St Andrew's crosses connecting the ground plate of the king strut frame with a king strut.

Because of the extension to include the side matronea and as a consequence of the later work, the rafters of the roof structure now do not now lie on tie beams of two types: the internal entablature of the original structure and the secondary entablature located above the matronea. The design of the truss itself was also significantly changed. However, numerous original elements (including rafters, fragments of the king strut and its ground plate) were preserved and relocated and were incorporated into the current structure. Thanks to the clear carpentry marks and the type and processing of the building material used, it was possible to identify them, and the mortises inside them made the reconstruction of the original shape of the roof structure.

[19] The method of hanging the king strut has not been fully recognized. It is known that the two-piece collar beams were connected to it with a tenon joint and, therefore, did not suspend the element.

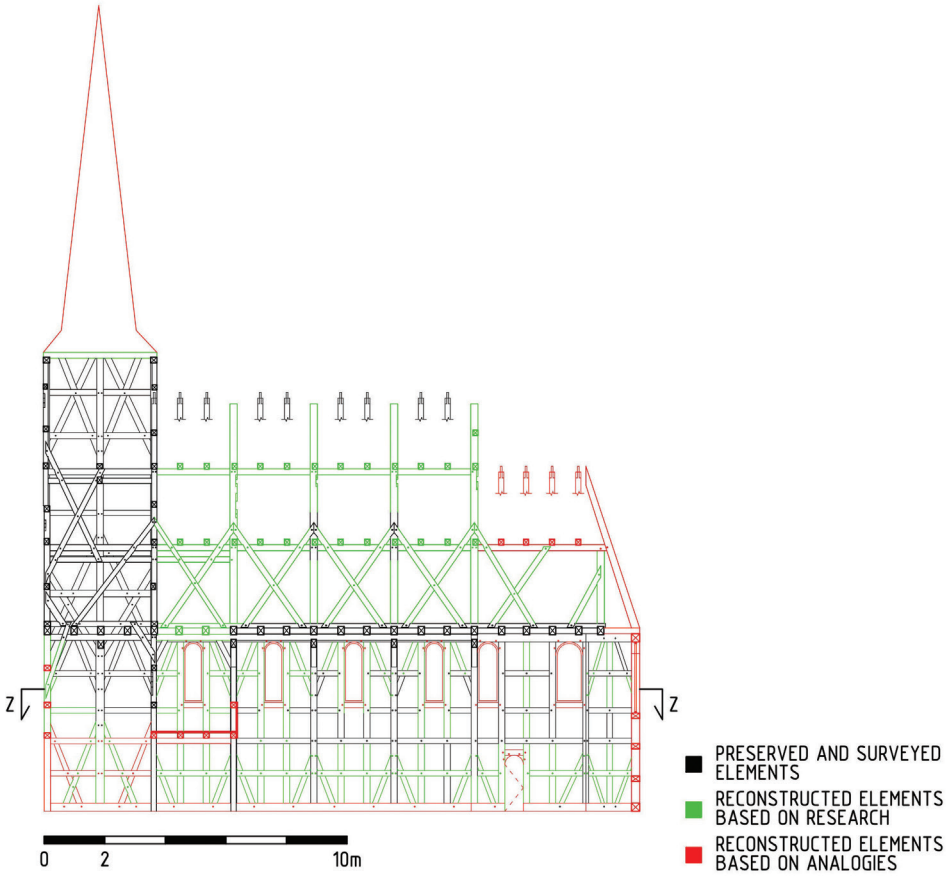

Fig. 8. Church of Our Lady of the Rosary in Byków, reconstruction of the original form of the church (16th century), longitudinal cross-section (elaborated by M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

Il. 8. Kościół pw. Matki Bożej Różańcowej w Bykowie – rekonstrukcja pierwotnej formy kościoła (XVI w.), przekrój podłużny (oprac. M. Kumorowicz-Brzeska, U. Schaaf, M. Prarat, D. Jagiełło)

The tower consisted of a square-shaped shaft and a coping, the original form of which is unknown (no records). Its structure was created by two multi-storey structures – the lower part (storeys I and II) and the upper part (storeys III, IV, and V), composed of three longitudinal frames (northern, southern, and middle) and three transverse frames (eastern, western, and middle) (Fig. 6). This original structure has survived in an almost complete form (loss mainly at the second storey level) – only later it was reinforced (mainly by adding frames). Currently, identifiable layers are visible.

The bonds of the perimeter walls were created analogously (differences in the arrangement of braces and passing braces). Each of them was formed by a pair of corner posts and a middle post (which was also the edge post of the middle frame), running from the ground plate to the upper plate.

The posts of the lower part (I and II) reached from the church floor to the upper plate[20], with probably four rows of rails placed between them. The longitudinal (northern and southern) walls of the lower part of the tower were probably stiffened with passing braces as in the body. These elements, however, were probably slightly longer than those in the body and ran to about half the height of the lower part. This is evidenced by the mortises of the northern frame: traces of the pegged notched lap joint on the central (double-sided) and eastern (single-sided) posts. The structure on the second floor level was stiffened by two pairs of passing braces inclined inwards (corner post–rail 4.–upper plate) in the longitudinal bonds and a pair inclined outwards (middle post–rail 4.–upper plate) in the eastern frame. Owing to the tight construction of the elements and the removal of a large portion of stiffeners and almost the entire western frame, there is no detailed information on some of the techniques used. Nor did the timber framing on the western outside frame make possible the tracing of the mortises on the upper plate of the frame that could confirm or eliminate the thesis of a solution analogous to the preserved longitudinal or transverse (eastern) bonds.

The ground plate of the upper part (III–V) rested directly on the upper plate of the lower part (I and II) in the transverse frames and on the entablature in the longitudinal frames. Six rows of rails were stretched between the posts. Individual parts of the bonds were stiffened with passing braces (the lower ones additionally strengthened the frame between the lower and upper parts), less often with braces.

The northern and southern frames (III–V) were stiffened at the bottom and top with St Andrew's crosses (spanned between the upper plate and the ground plate / upper plate and the corner/middle post, through two levels of rails). Different stiffeners were used in the lower part of the northern frame in the form of two pairs of passing braces: longer, steep ones, inclined inwards (corner posts of the lower part – upper plate– ground plate – rails 1, 2 – middle post) and shorter, running flat, inclined outwards (middle post of the lower part – upper plate – jetty bressumer – rail 1 – corner post).

The eastern frame (III–V) was stiffened at the bottom with a pair of short passing braces (lower storey upper plate– jetty bressumer– middle post) and a pair of short braces (middle post – rail 2.), above it with a pair of passing braces constituting the rafters of the extreme roof structure frame (leading through rails 4 and 5), which were connected to the central post by a pair of short passing braces inclined outwards. In the upper part is the last pair of passing braces (corner post – rail 6 – upper plate).

The western frame (III–V) was stiffened at the bottom with two pairs of St Andrew's crosses (lower storey upper plate – jetty bressumer–rail 2–corner/middle post) and single, short passing braces inclined outwards (upper plate – jetty bressumer–corner post), above with a pair of passing braces inclined outwards (middle post–rail 3 and 4–corner post). In the upper part, the last pair of passing braces inclined inwards (corner/middle post–rail 6– upper plate).

The central frames (longitudinal and transverse) had a partially different structure from the peripheral frames. In the transverse frame, two double levels of rails were stretched between the posts – the pairs were connected by two short posts located near the central axis (they held the perpendicular transom of the second of the central frames on the sides). Additional stiffening was provided by pairs of symmetrically arranged passing braces: two scissor braces each in the lower section (connecting the post and both pairs of rails at the bottom and top) and single scissor braces in the upper section (connecting the post and both pairs of rails at the bottom). The longitudinal frame used three doubled rail levels. The lower part was stiffened similarly to the transverse frame[21]. Additional stiffening was provided by asymmetrically placed passing braces.

Type of building material used and its processing

The church in its 16th-century form was built mostly of oak wood. This is the material used entirely for the construction of the roof structure and the structure of the tower. The walls of the nave and the choir, which were only partially examined in this respect owing to difficult access to the structure, were made of oak.

Only a whole tree with different cross-sections was used (dimensions for preserved elements), as for the rail of the upper level of the western frame: 25 × 21.5 cm, entablature (its dimensions vary between 20–24 cm and 20–27 cm), upper plates of the longitudinal wall bonds of the nave: 21 × 20 cm (north) and 23 × 19 cm (south), king struts measuring 17–19 × 22 cm, or tower rails 15–18 cm × 15.5–22 cm.

The building material used for the tower posts has the largest cross-sections: 20–23 × 20–30 cm. The most varied seem to be the rafter dimensions: 12–20 × 14–19 cm and oblique elements stiffening the tower structure 13.5–16 × 18–22 cm for the passing braces and braces.

The building material was processed using traditional methods – with an axe and an adze. The elements were

[20] The northern frame upper plate, like the ground plate of the upper part, was extended towards the east (into the roof structure section).

[21] Missing eastern upper passing brace and a possible trace of it in the form of a mortise.

initially logged with an axe, which left notches on their surface, transverse to the side edge. Then the surface was smoothed with an adze: traces in the form of slightly rounded notches, running almost parallel to the edge.

Almost all the tie beams are chamferred, mostly on both sides. The carpenters used one-sided profiling for the outermost elements of the body entablature from the inside[22] and in every third tie beam (no profiling on the timber framing side of the transverse frame[23]).

Timber framing sides and carpenter's assembly marking system

The timber framing side is the side on which carpenters made bonds when framing the individual longitudinal, transverse, and horizontal bonds on the carpenter's bench. After test-connecting a given frame, they marked all the elements with carpenter's marks to facilitate their efficient assembly during the erection of the roof structure. The structural elements, often having varied cross-sections, are generally located in one plane on the timber framing side.

Unfortunately, owing to the few marks found (the walls of the nave, choir, and of the tower), as well as the lack of access to the elements or the external sides of the timber framing of the peripheral walls, it was not possible to recognize the full system. Nevertheless, the information collected makes it possible for us to draw certain conclusions.

During the construction of the church, the carpenters mostly consistently used Roman numerals for the wall and roof structure connections, with a modification in the form of triangles. These marks were hard-made (with an axe or chisel).

The bonds of the **nave body** and of the **choir** were timber framed from the outside: the western frame from the west, the eastern frame from the east, etc. The internal stiffening frames were timber framed from the east[24]. The use of the method of marking elements identified on other structures also in the case of the body is confirmed by the single sign found on the frame structure: "three" [] to mark the eastern passing brace of the third post from the west of the main northern frame.

The **tie beams** of the body were marked from the top, at their southern edges – and numbered from west to east, from (probably) 1 to 13. Although no marking was found on the first four beams from the west, the fifth one has the Roman numeral V, the sixth one – V and the seventh one – V (slightly distorted layout), with not fully legible marks on the following ones, up to the tenth, marked X, the eleventh X and the twelfth X. On the last eastern beam of the body there is a visible mark X applied from the east.

No marks were found on the choir entablature[25].

Owing to the secondary use and relocation of the **roof structure** elements, there is no basis for reconstructing its original system: the numbering of the rafters is strongly distorted, e.g., the northern rafter of the current frame 14 is marked V, while the neighbouring rafter of frame 15 – X. Part of the double standing truss also consists of elements used secondarily, such as one of the northern passing braces of the transverse frame – X, or the eastern brace of the second post from the east – . Among the markings using Roman numerals with triangles, there were no markings that would help distinguish the north from the south side within the truss.

On a brace stretched between the upper plate and the ground plate of the bell structure, in the section extended above the nave, the mark X was found.

In the case of the **tower**, the transverse bonds were timber framed from the west, and the longitudinal ties from the south, except for the northern frame which was timber framed from the north (Fig. 8). This is where the greatest diversity in the methods of marking elements can be seen: Roman numerals and modified Roman numerals supplemented with: a triangle (e.g.,), a semicircular notch (e.g.,), or horizontal lines. Single elements were connected by matchmark[26]. The sanguine marking was found on two elements.

The marks deciphered did not make it possible to understand their system. The structural elements of the lower part (I and II) of the tower shaft were probably marked mainly with Roman numerals. The numbering in the eastern frame was applied from the south: the upper rails were numbered individually (marked on the southern part of the element) – II in the southern one, and III in the northern one[27]. Both passing braces were marked III (3rd column) at the connection point with the central post.

The structural elements of the upper part (III–V) of the shaft are marked mainly with Roman numerals and triangles or semicircular notches referring to them, which is why the structural components at the junction of both parts sometimes have double markings, such as the upper rail of the first level of the central longitudinal frame marked II (like the passing brace that connects to it) and .

It appears that the marking of the eastern and central longitudinal frame elements is limited to differentiating the left and right sides. In the eastern frame, the elements located on the north side are marked with the Roman numeral I, and the elements on the south side of the frame – with the modified Roman numeral . The passing braces converging on the central post, such as the post itself, were marked on both sides and supplemented with a matchmark. The upper plate is marked on both sides in accordance with the adopted scheme. However, this scheme is not applied completely consistently – it is also applied to the first rail from the north[28]. In the central longitudinal line, the

[22] Eastern from the west, western from the east.

[23] Lack of access makes it impossible to determine whether the profiling is on the middle section of the element.

[24] This is visible from the level of the tie beams, on the roof structure floor.

[25] The elements are currently hidden by the formwork introduced on the roof structure.

[26] A line-shaped incision made at the junction of two or more elements.

[27] This confirms the thesis of the extension of the inner western frame of the body, of which the tower frame is an integral element, by one panel to the north and one panel to the south.

[28] At this level, both rails have the same marking, which is why the southern element at the frame is additionally marked with a matchmark (rail – post).

Fig. 9. Church of Our Lady of the Rosary in Byków, list of carpentry joints – lap joints:
a) double dovetail lap joint-shaped, b) single dovetail lap joint-shaped, c) double-notched (photo by U. Schaaf, 2022)

Il. 9. Kościół pw. Matki Bożej Różańcowej w Bykowie – zestawienie złącz ciesielskich – nakładki:
a) o kształcie jaskółczego ogona, b) o kształcie połowy jaskółczego ogona, c) zacięta podwójnie (fot. U. Schaaf, 2022)

mark / was applied to the elements in the western part of the frame, while in the eastern part, they were marked with the sign //. There is no consistency here either (or was the sign not fully legible?) – on one of the long passing braces getting through rails 2 there is a Roman numeral I. On the eastern post there is the marking – //. There was no system for differentiating elements depending on height.

The northern frame elements were probably marked from the west on the middle post – ∿, and on the eastern post – ∿∿. The eastern post was additionally marked with a Roman numeral I, only oblique /. However, the rail stretched between them – ∿∿∿. Since the southern frame elements were marked using the same modification of the Roman numeral, a matchmark ∧ was used. The numbering is from the east on the middle post – ∧∿, and on the eastern post – ∧∿∿. The rail located between them is marked ∧∿∿∿.

Although no hard-made assembly marks were found on the central transverse frame, there are preserved marks made in sanguine on two short posts of the lower part stretched between the rails, however, they are not legible.

Carpentry joints

Three basic carpentry joints (with possible variants) were used to build the wall bonds and the roof structure with the tower body: mortise and tenon joints, lap joints, and cogged joints.

Mortise and tenon joints were mainly used to connect perpendicular elements – posts with ground plates and upper plates (bonds preserved in the tower structure. In the body there is no ground plate or there is a built-up upper plate) or usually in the pegged variant of rails with main posts (body and tower). A mortise was also identified in the ground plate of the king strut, which is how the middle post of the roof structure was connected to it. An oblique mortise and tenon joint was used to set the rafters in the tie beams (mortises are visible in the extreme parts of the upper surface of the elements).

The **lap joint** comes in three basic versions: perpendicular lap joint, an oblique lap joint, a lap joint where one element intersects with another element, all these were determined by the arrangement of structural elements relative to each other, and in several varieties – division according to shape, mostly pegged joints. A straight lap joint was used to connect, among others, the ground plates of the longitudinal and transverse frames (tower) or, less frequently, a passing brace with a rail to which the tower is attached[29]. The notched lap joint was used for connecting passing braces with posts (body and tower[30]), passing braces with an upper plate (tower) or braces/passing braces with tie beams (joint in the beam on the side without the chamfer). An alternative connection for the passing braces with the main post or upper plate (nave and tower) is a single dovetail lap joint, which is also found, among others, when connecting short posts with the rails of the central bonds of the tower (Fig. 9). Crossing lap joints were used, for example, to connect rails with the stud of the bonding of the oblique walls of the choir (perpendicular elements) or passing braces that pass through the jetty bressumer or the upper plate of the lower storey (tower). The more commonly used variant is the notched lap – a connection of a passing brace and a rail (body and tower) or scissor passing braces (tower[31]). Where St Andrew's crosses intersect on the rail, double lap joints were used as in the passing braces of the upper stiffening of the northern frame of the tower.

Cogged joints come in several variants. The single cogged joint was used to connect, among others, the tie beams with the nave upper plate or the upper plate of the lower part of the tower shaft with the ground plate of the upper part of the tower shaft. It was also used to connect parts of the upper plates with the tie beams (body) resting on them. The middle notch was used to connect the tie beams with the choir upper plate, and the cross notch was used to connect the rails of two central frames perpendicular to each other (tower). The upper plates of the longitudinal and transverse frames of the lower storey of the tower, similarly to the upper plate with the tie beams, are connected with a cogged joint protruding approximately 8 cm into the centre of the axis. The jetty bressumners with tie

[29] E.g., connecting the ends of the upper passing braces with the lower rail of the first pair in the transverse central frame.

[30] Upper pair of passing braces of the lower level of the upper part in the transverse frame – double-pegged.

[31] The north frame also shows an example of a double notch.

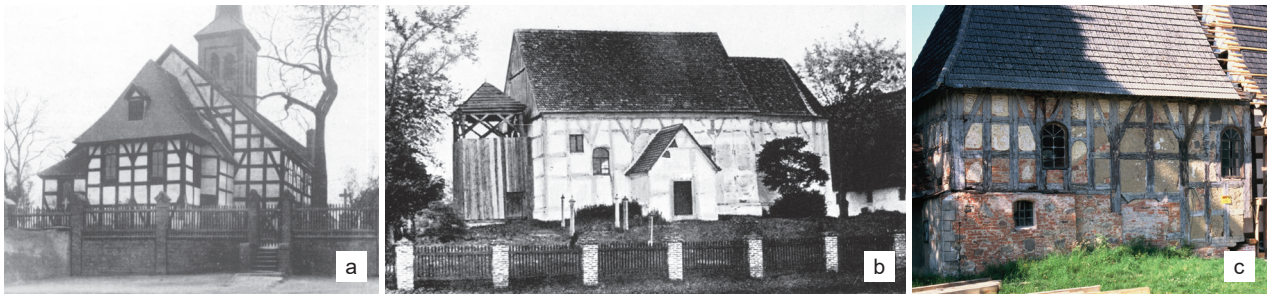

Fig. 10. Churches: a) of St. Jacek in Wrocław (Swojczyce), built in 1537, expanded in 1630–1631 and 1889–1890, condition before 1934, b) in Świniary, built in 1570, condition from 1878, not retained, c) of the Sacred Heart of Jesus in Godzięcin, built in 1583, condition in the 1990s (sources: Burgemeister, Grundmann 1934, 159; Degen 1965, 452; photo by U. Schaaf, 2022)

Il. 10. Kościoły: a) pw. św. Jacka we Wrocławiu (Swojczyce) powstały w 1537 r., rozbudowany w latach 1630–1631 oraz 1889–1890, stan przed 1934 r., b) w Świniarach powstały w 1570 r., stan z 1878 r., niezachowany, c) pw. Najświętszego Serca Pana Jezusa w Godzięcinie powstały w 1583 r., stan w latach 90. XX w. (źródła: Burgemeister, Grundmann 1934, 159; Degen 1965, 452; fot. U. Schaaf, 2022)

beams (tower) and the upper plate of the longitudinal and transverse frame of the upper part of the tower are connected to each other with a single dovetail lap cogged joint.

A pair of eastern frame passing braces (probably like roof structure rafters) are connected to each other by **scarf joint bridled**.

The material used to fill the half-timbered panels and its colours

The panels of the half-timbered construction of the walls of the nave, choir, and partially the lower part of the tower, had a clay filling (clay with chaff), on wooden, vertically mounted staves, which were inserted into recesses (grooves) cut in the rails. The original filling has been preserved, among other places, under the timber-cladding of the northern matroneum. In the northern and southern lower storeys of the tower, longitudinal recesses for staves are visible in the rails, confirming the use of the same solution. The infill of the half-timbered panels was probably whitewashed (or plastered). The wooden structural elements were painted grey, as evidenced by the preserved fragments of painting.

Summary

As a result of the research, it was possible to determine almost completely the original form of the church at the time of its construction in the mid-16th century. On the basis of the comparative analysis, the probable form of the tower's coping, the location and shape of the doors, and the size of the windows were also determined. Importantly, the research has proved that despite numerous transformations in the current structure of the church, a large part of the structure of the original church has still been preserved.

It was a single-nave church with a narrowed and three-sided chancel closed on the eastern side, where in each part (nave and chancel) two main rows of posts (longitudinal external bonds) supported the roof structure. Only the square-shaped tower was characterized by three longitudinal and transverse bonds (two at each end and one in the middle).

The posts divided the peripheral walls of the church into structural bays, while the studs divided these bays into segments. In turn, the ground plates, several rows of rails, and the upper plates divided these segments into panels in which doors or windows were placed, or which were filled with clay mixed with straw on staves. The walls were stiffened in the nave and the chancel by two rows of single passing braces located above the ground plates and below the upper plates, and in the case of the tower, by either single passing braces or scissor braces forming St Andrew's crosses. The main body of the church was crowned with a reduced king strut structure.

The main building material is whole oak, pre-treated with an axe and then smoothed with an adze. The cross-sections were adapted to the function of the elements in the spatial load-bearing structure. The system of carpentry assembly marks is fully identifiable, but marks made with different tools and in different shapes made it possible for carpenters to subordinate easily each element to the correct frame and the correct place in that frame.

In the case of structural elements connected at right angles in one plane, mortise and tenon joint were generally used (e.g., a post with an upper plate), and only in the case of crossing of such elements was a lap joint used (e.g., a stud with a rail). The oblique elements were connected to the vertical and horizontal elements mainly using lap joints of various shapes (e.g., a passing brace with a ground plate, a rail, and a post), which enabled their assembly after the main load-bearing structure had been set up. In various variants, a cogged joint was used to connect two structural elements not in one plane, but superimposed on each other (e.g., a truss beam on a cap).

In the context of the Silesian Protestant half-timbered architecture of the 16th century, the original church in Byków is a church that is typical of that period and region, owing to the architectural and construction solutions used. Other examples include churches in Swojczyce (1537), Winiary (1570), Godzięcin (1583), and Masłowo (1592) (Fig. 10).

Translated by
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Streszczenie

Architektura i technika budowlana XVI-wiecznego kościoła o konstrukcji szkieletowej w Bykowie

W 2022 r. przeprowadzone zostały badania architektoniczne dawnego kościoła ewangelickiego, obecnie kościoła pw. Matki Bożej Różańcowej w Bykowie (gm. Długołęka, pow. wrocławski), datowanego na 1574 r. Kościół na przestrzeni kolejnych stuleci podlegał znaczącej rozbudowie i przebudowie, które diametralnie zmieniły jego formę.

W artykule zaprezentowano wyniki przeprowadzonych badań w odniesieniu do pierwotnej formy kościoła, w szczególności zastosowanej w XVI w. techniki budowlanej oraz rekonstrukcji jego prawdopodobnego wyglądu po wzniesieniu. Badaniami objęto układ konstrukcyjny, rodzaj wykorzystanego budulca i jego obróbkę, strony odwiązania i system ciesielskich znaków montażowych, zastosowane złącza ciesielskie, a także materiał wykorzystany do wypełnienia pól szkieletu i jego kolorystykę.

Na ich podstawie udało się ustalić, że pierwotny kościół wzniesiono w konstrukcji szkieletowej, składał się z części nawowej (korpusu nawowego) oraz wydłużonego, trójbocznie zamkniętego chóru od wschodu i wieży od zachodu. Korpus i chór kryte były dachami dwuspadowymi o więźbie storczykowej. Duża część z tej konstrukcji zachowała się w obecnej strukturze świątyni.

Słowa kluczowe: kościół, XVI w., konstrukcja szkieletowa, badania architektoniczne, Byków