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Research method in recognizing the causes and level of destruction of the roof construction in the neo-Gothic 19th century St. Martin's Church in Krzeszowice designed by Karol Fryderyk Schinkel

Historical outline

The St. Martin's neo-Gothic parish church in Krzeszowice (Little Poland Province) has been preserved in an unchanged condition until today. The church was built thanks to the artistic patronage of Count Potocki – the owner of Krzeszowice holdings who decided to build the church and very carefully selected the best design conception. The first drafts of the design of the church were made by two excellent Parisian architects Percier and Fonteine. The final design, however, which was the basis for building the church was made by a famous architect from Berlin Karl Schinkel. In 1832, the design was approved and the construction of the church without its interiors was completed in 1844. It was another architect from Berlin and his student Wilhelm Hofbauer who was the direct builder and executed Schinkel's vision. The works, including the furnishing of the interiors, were completed in 1872. Over the period of about 140 years the church has been used without any problems despite the fact that since its erection the number of people living in Krzeszowice has grown a few times. The church is on the permanent conservation list. It was built with the use of stones and bricks as a single-nave church on the layout of a Latin cross closed with a polygonal chancel. The front facade, pedestals, the rose window above the entrance, cornices, window frames, traceries and some details of interior decoration were built of stone (sandstone) and they demonstrate excellent workmanship.

The external walls were built of bricks with characteristic buttresses and two towers with octangular spires and a decorative viewing terrace between them. The nave is covered with a pointed ribbed groin vaulting with lunettes. The church has pointed windows with neo-Gothic traceries and one of its characteristic features is a stone attic with an ogival motif on arcade cornice.

Above the nave there is a gable roof with a gradient of 18° and a polygonal (pentagonal) one above the chancel. When looked at from the man's eyes' level the roof is not visible as it is concealed by the attic. The roof framing is made from different species of conifers (spruce, pine and larch) with the original strutting beam structure with full roof boarding for copper sheets [1, 2].

Current condition of the church

The general condition of the church building, with the exception of the roof framing, is good (assuming the necessary maintenance works are conducted). The result of different destructive exposure to which the roof framing has been subjected over about 150 years is a serious technical and biological decapitalization. In order to determine the condition and degree as well as the reasons of its destruction a number of special tests have been conducted and a number of expert opinions have been made.

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Program of tests

The basic criterion of evaluation was the necessity to make a survey of the roof framing indicating its decapitalized fragments. The survey was the basis of further works such as statistical and strength analysis aimed at determining the safety of construction elements of the roof framing with conclusions and recommendations regarding the necessity to save the building from unpredictable consequences of such loads as e.g. of snow, ice, wind, etc. In order to get the full picture of the damage of the roof framing it was necessary to conduct phytopathological, entomological and mycological tests [3].

After conducting expert evaluations and thorough analysis it was possible to determine the scope of threats and their origin. This was the basis of conclusions as to the method and effectiveness of corrective actions regarding the historical roof framing. All tests and expert evaluations evidently indicated a very serious technical destruction and extensive damage of the biological loadbearing structure of the roof framing. The wood samples which were taken for analysis (phytopathological, entomological and mycological tests) demonstrated a huge degradation caused by the destructive activity of insects – mainly old-house borer, deathwatch and wood-rotting fungus (*Poria vaporaria*). The condition of damaged construction elements, sheathing and roofing indicates that the loss of structural strength of those elements exceeds 60% and they should be either repaired or replaced. Otherwise and in the case of additional unpredictable exposure to the elements the roof might collapse.

Selected examples of survey measurements

One of the characteristic features of historical sacred buildings is their individualism. This is the surveying method which was applied in the case of the St. Martin's church in Krzeszowice.

Firstly, new surveying methods should be mentioned. They apply CAD, photogrammetry and laser scanning in measuring historical and contemporary architecture, technical infrastructure and industrial installations. Engineering geodesy and photogrammetry have been employed for years in performing comprehensive architectural surveys. The measurements were taken with the use of a reflectorless tacheometer (close range surface measurements of e.g. walls), e.g. semi-metric camera to make ortophotoplans. At present as a result of the digital technology development new measuring devices have been developed such as lasers and laser scanners, in particular with the use of 3D measurement technique (vector file with refraction linesand a grid of points). These tools take measurements of hundreds of thousands of points, recording the geometry of large objects. Despite their great capabilities the new measuring devices do not perfectly render the reality of objects (e.g. the 'edge sliding effect' which ultimately generates a corrupt measurement). It is true that the use of new photogrammetric technology in taking measurements in connection with a laser scanner, visualizations and animations influence the duration and effectiveness of the measurement work. When deciding to use the new generation equipment, one should analyze the object and a possibility to get with that equipment to the place of measurements. Nowadays, the application of the above-mentioned measuring methods is required. There are, however, situations, especially in historical objects when making manual drawings and measurements is more useful (especially in the case of inaccessible and concealed places).

The method of performing the architectural survey of the roof framing of the church in Krzeszowice

The nave and the pentagonal chancel are covered with a pointed ribbed groin vaulting above which there is a strutting roof framing system with a very unusual construction. The shape of the vaulting and the location of roof trusses in relation to it created a limited accessibility of the place needed to take measurements with the use of new generation equipment. Some places needed for the inspection of the construction system as well as to make drawings and measurements were practically inaccessible or at best one needed to crawl to get there.

The unusual character of woodwork solutions as well as geometry required a precise manual measurement.

In order to make a drawing of the roof framing of the church the following were performed first: a detailed survey of the church floor plan at ground level, cross and longitudinal sections with views of the church interior, plan of the vault above which there is a roof framing, cross sections of the roof framing with views of special main trusses and plan of the fifth elevation that is of the roof with gradient of planes and water drainage system. The other type of performing a survey was photographic documentation which resulted in the development of so called research cards. The objective of this type of survey was to precisely establish the location and type of construction, details and degree of technical decapitalization. A specially developed method of assigning numbers to construction elements (trusses and woodwork connections) corresponding to their specific location in the plan and cross sections was applied in each research card. This

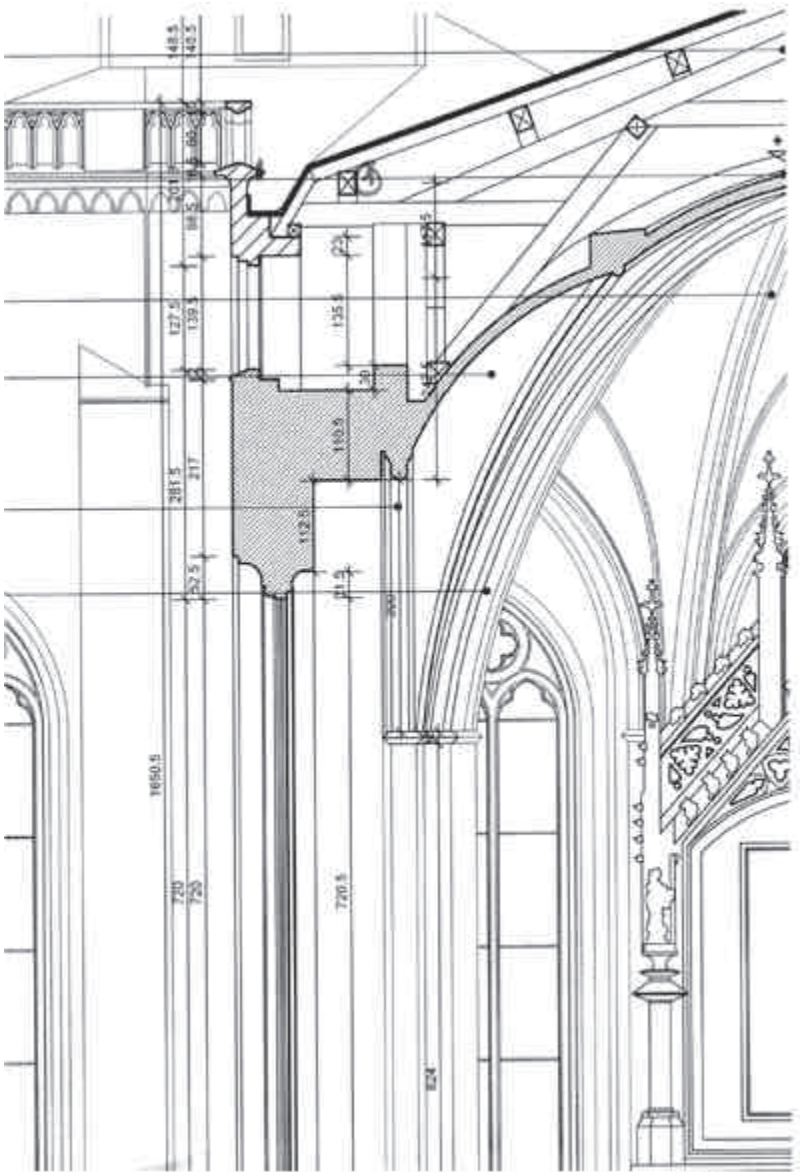

Fig. 1. Cross section of the nave of the church with the view of one of the main trusses

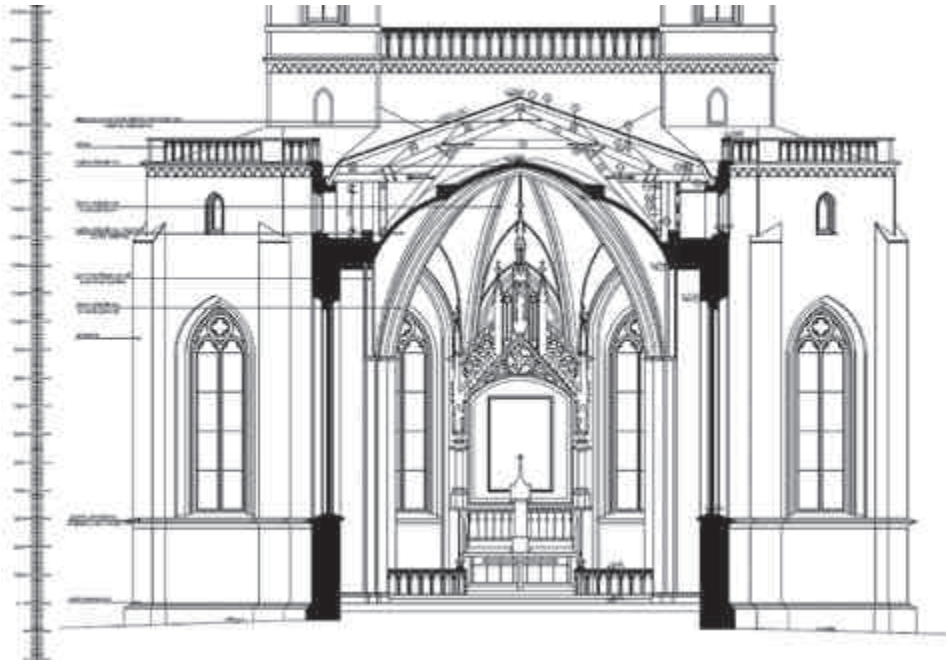

Fig. 2. Initial plans of the particular fragments of the church in order to check the accuracy of measurements with the use of laser equipment

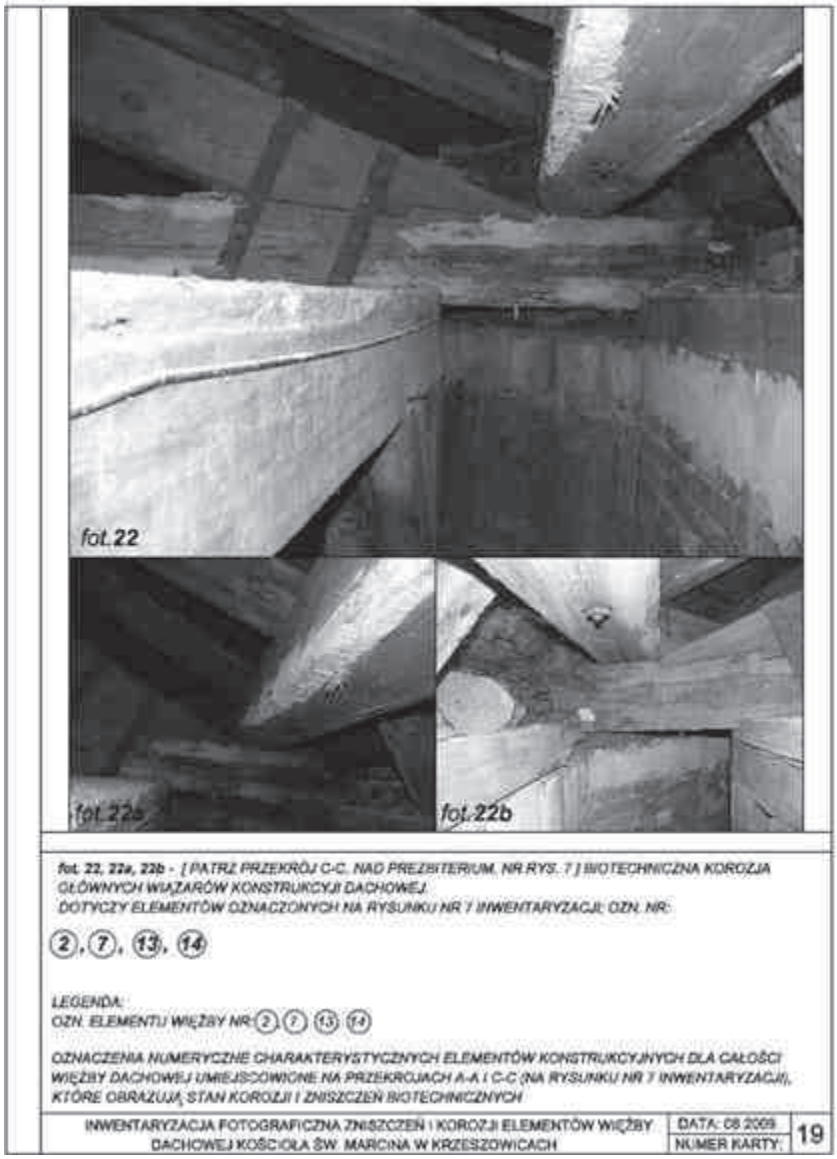

Fig. 3. Research Card

Fig. 4. Markings of various types of main trusses and places of destruction

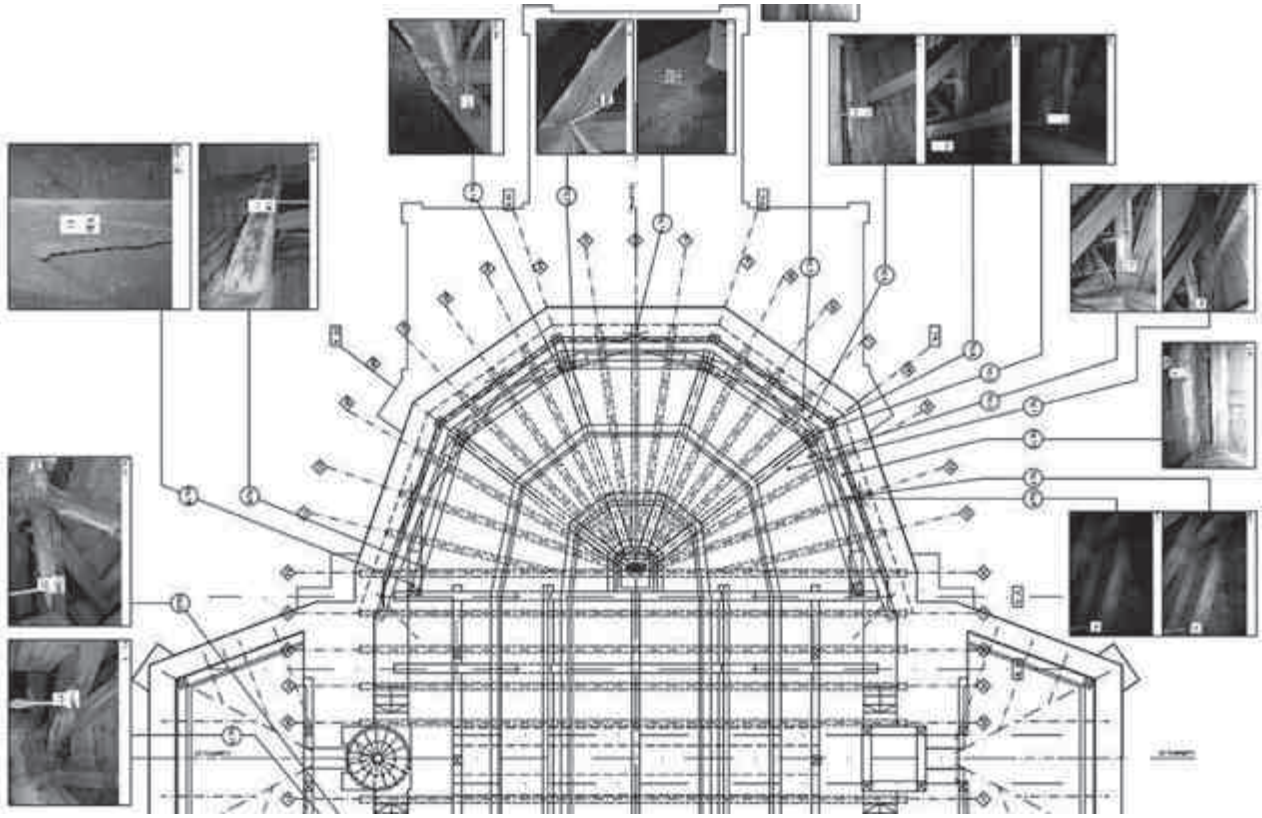

Fig. 5. Fragment of roof truss projection with the accepted system of markings in relation to research cards

method significantly facilitated the detection of damaged places and their scope. Because of very special and unusual joints and woodwork connections, all details required a careful analysis, inspection and measurement from all sides with the use of traditional manual technique. What proved especially helpful in recognizing the complicated woodwork details was the free-hand sketches drawn in perspective which helped to precisely reconstruct the original roof framing. The complicated system of the main trusses, which were applied in different variations, required a precise determination of different gradients of the roof planes above the nave and the chancel as well as side chapels. The precisely performed survey was the basis of the design of the whole roof framing replacement. The bigger interior spaces which were not concealed were measure with laser equipment; these measurements were in special cases verified by manual measurements with the use of measure tapes. The whole architectural survey documentation was ultimately made with the use of computer graphic in the following scales 1:50, 1:10 and 1:2. Color icons of pictures which presented appropriate places and their degree of destruction were placed on the basic plans of the location of specific construction elements of the roof framing.

Conclusions

In conservation works in historical buildings, the basis for the beginning of any work is the necessary detection of different details in the scope of damage, repair or replacement of necessary elements, etc. The complete and precisely performed survey is the basis of precise analysis of different kinds of damage. An architectural survey is primarily used as a basis for plotting the scale of damage and different types of deformations on it. A good graphic survey with a photographic survey and other necessary tests should constitute a concise and comprehensive document which is the basis for the determination of the extent and percentage of damage as well as for the selection of repair method and estimation of costs.

References

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Metoda badawcza w rozpoznawaniu przyczyn i stopnia zniszczenia konstrukcji dachowej w zabytkowym neogotyckim XIX-wiecznym kościele św. Marcina w Krzeszowicach autorstwa Karola Fryderyka Schinkla

W artykule przedstawiono zagadnienie wskazujące, że zabytkowe budowle sakralne, których stan techniczny i estetyczny uległ dekapitalizacji, wymagają opracowania indywidualnego programu badawczego, szczególnie w takich branżach, jak: architektoniczna, konstrukcyjna, konserwatorska oraz charakterystycznych specjalistycznych ekspertyz. Specyfiką zabytkowych obiektów sakralnych jest ich indywidualizm wynikający z: okresu powstania (styl), miejsca usytuowania, konstrukcji, budulca, kubatury i kontekstu klimatycznego. W pracach badawczych należy przyjąć sprawdzone metody tradycyjne, nowoczesne oraz indywidualne metody dostosowane do indywidualnych charakterystycznych cech budowli. Wyniki opracowania rozpoznawczego są istotną bazą do przyjęcia prawidłowej logistyki przebiegu wymaganych prac budowlanych i konserwatorskich. Należy nadmienić, że obiekty, które zgłaszane są o dofinansowanie z puli Ministerstwa Kultury i Dziedzictwa Narodowego powinny być wnikliwie rozpoznane, w celu dokładnego określenia kosztów inwestycji. Podjęte działania rozpoznawcze prezentowane są tu na przykładzie neogotyckiego kościoła św. Marcina w Krzeszowicach i dotyczą remontu kapitalnego wież i więźby dachowej

Key words: roof framing, decapitalization, reconstruction

Słowa kluczowe: więźba dachowa, dekapitalizacja, odtworzenie