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The principle of building processes staging during the renovation of church towers and the exchange of a roof framing in neo-Gothic St. Martin Church in Krzeszowice

Introduction

Decapitalization of buildings constitutes an unavoidable process as the years pass. A technical state and material condition of the building construction show the extent to which it was exploited and its usefulness of further exploitation. There are many factors which decide about the rate of particular parts of the building exploitation. However, the most important are the following: a place of localisation, an influence of the climate conditions and economical possibilities of the owner or investor. In some regions of the world the architects must deal with, for instance, earthquakes, typhoons, hurricanes and frost. The Polish climate with four characteristic seasons is not free from surprising meteorological phenomena (heavy rainfalls, floods, hurricanes and extreme snowfalls) and therefore, a lot of requirements must be met, for example, for a design, construction and restoration lines. There are often complex problems of the geotechnical character, which impose a complicated specificity of the building's foundation. Therefore, during the compilation of a design concept and later a building documentation, the above mentioned aspects must be taken into consideration and expected early on. In the situation where big decapitalisation of the building takes place (e.g. a historical building), material and technological solutions as well as the type and method of refurbishment and restoration works should be appropriately chosen. All these things should be preceded by specialist diagnoses which specify material deprecation and the level of technical wear and tear of the building. The level of subject matter and practice preparation of contractors along with reliability of executed building works constitutes an important criterion in the process of refurbishment works. In order to avoid unexpected exploitation results in, for example, historical buildings, a permanent control and supervision of qualified staff are necessary [2, 3].

Restoration and building issues in St. Martin Church in Krzeszowice

Neo-Gothic church in Krzeszowice, which is an indisputable piece of work of a remarkable Berliner architect Karl Schinkl, after 136 years of a relatively short time of exploitation requires a lot of restoration and renovation works. The first construction works on it started in 1832, but it was fully used after its consecration in 1874. General renovation of the church towers and the whole roof of the church along with the exchange of the roof framing (reconstruction) and the cover were considered to be priority tasks. There were many reasons for such a radical decision as regards the execution of works. The old roof was leaking and decapitalized. The parish priest asked the experts to examine technical condition of the endangered parts of the church and then decide on the method of their protection. The basis for starting any repair works was the compilation of inventory taking into account in particular a restoration method of registering all kinds of decapitali-

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Fig. 1. Fragment of the destroyed roof framing construction

zation processes of the roof framing and cover. On the basis of this inventory, thorough entomological, phytopathological and mycological examinations of fungal condition and the extent of destruction of the wooden elements of the church roof framing were conducted. When the level of destruction of the roof framing constructional elements was specified, a constructional expertise of the roof framing technical condition was provided. Entomological and phytopathological examinations confirmed high biological wood corrosion where constructional elements were depreciated in large parts by the fungus *Coniophora cerebella* which caused brown decay as well as destructive presence of vermin called old-house borer (*Hylotrupes bajulus L*) and house grinder. Additionally, growing moulds from Micromycetes class caused complex processes of biologically depreciated elements of the roof framing [1].

On the basis of the total number of expertises and the level of damage of particular constructional elements it was ascertained that circa 60% of the construction wood was worn out and consequently the final decision was taken as to a complete replacement of the roof framing. During a demolition of the roof framing and a detailed analysis of technical condition wear and tear, it turned out that the particular constructional elements are damaged in 70%. Finally, on the basis of the inspection carried out by Provincial Monument Protection Organisation in Cracow the Restoration Opinion was issued which gave permission to conduct the renovation works. Thanks to these preparatory procedures, the parish was able to apply for a renovation works subsidy in the Ministry of Culture and National Heritage from the program of Cultural Heritage as a priority of Monuments Protection. The whole

Fig. 2. Execution of the reconstructed roof framing trusses

documentation, which was compiled and enclosed to the application, was given a positive opinion by the Ministry of Culture and National Heritage. Thanks to the granted subsidy, the renovation works started. The catastrophic condition of the church roof posed the question as to the possible reasons of such extensive damage. The answer to this question is complex because the existing damage is quite common and refers not only to sacral buildings, but also to historical ones and others. In the case of the church in Krzeszowice, where an accelerated process of decapitalization of the roof and towers took place, at least several factors were decisive. One of the main reasons was the consequences of World War II. At that time, for the needs of the war sheet copper was removed from the roof and replaced by sheet zinc and during the period of war the roof was covered again but not carefully enough. The church location in the area of Silesia and Cracow agglomeration, where emissions of sulphur dioxide and carbon exceeded the permissible concentrations, constituted, among other things, the reason of the accelerated process of the cover corrosion. There were numerous punctures in the cover of the church towers, which were probably caused by machine-guns missiles. The roof projection with a roof slope under the angle of circa 19° was wholly surrounded by an open drain channel (water from roof slopes flowed down to the open drain channel) which adjoined a stone attic. The existing tilts in the open drain channel in the direction of down pipes as well as internal areas of down pipes were not sufficient for draining water from the roof surface. As a consequence, the system did not function well enough as during winter periods the ice from the attic balustrade and arcade cornice melted and leaked into the inner parts of the building. When ice and frozen snow formed there, it was impossible to drain water and remove snow effectively. Post-war poverty and total lack of any building materials as well as problems with experts contributed to the increase in decapitalisation processes.

The principle of renovation processes staging as regards the church roof and towers

Fig. 3. Fixing the roof truss on the wall crown

A decision as to the replacement of the roof construction, planking and cover, which consisted in the exact reconstruction of the roof framing construction, was made as a result of expertises. This complicated 'operation' required thorough logistic preparation in the scope of the conducted works sequence as well as ensuring people's security and protecting the church against water leaks caused by the rain. During the execution of works, the church had to continue its liturgical functions in a normal way, which additionally hindered and complicated the range of indispensable operations. Firstly, a part of the church surroundings was cut off during the renovation period so that the people were effectively isolated from the places which could be dangerous for them. Considering a strictly determined deadline of the renovation completion, the works were planned in a two-line system from July to the end of November. The works were located in two independent places because of the area around the renovated church was too small. In the first-line system the works were prepared in the church, while in the second line-system the renovation material was prepared, which took place in the area outside the church.

Before starting the demolition works on the church, a special base on a separate place outside the church was organised, where particular roof trusses as well as woodworking and wood preservation works took place.

Fig. 4. One of the fixing stages of the roof truss above the presbytery

A necessary restoration requirement was a total and exact reconstruction of the roof truss (of all elements and details along with carpenter's joints). It should also be mentioned that the size of wood in the roof truss was, for example, 25×31 cm. The size and weight of these elements caused many difficulties in the execution of the works. On the designated place outside the church, a special wooden platform was made in order to conduct on it a precise process of fixing the roof trusses. All parts of the roof trusses were made on the basis of the previously detailed inventory. The smallest mistake or inaccuracy could rule out a possibility to conduct the process of fixing and connecting the roof trusses with other elements of the roof framing construction. The reconstructed elements of the roof framing were numbered and described and then the roof construction trusses were put together according to the principle regarding the roof truss typing, which was established some time earlier. The sizes of the roof trusses were very big; therefore, they had to be taken apart in order to be transported to the church. Finally, the process of the whole construction fixing took place at the yard near the church. The particular roof trusses were fixed by means of the crane according to an established order.

The roof trusses were additionally reinforced by means of special steel anchors which were regained after the removal of decapitalized elements of the roof framing. Owing to the necessity of guaranteeing safety and in order to avoid roof leaks (taking into account the weather anomalies, the year 2010 was not conducive to the execution of such works), the old elements were replaced by the new reconstructed elements after the preparation of the background (plates, floor beams) and the reinforcement of the walls crown. During the execution of the works, absolute precision was required with error tolerance of some millimetres.

The new fixed and embedded roof parts were protected with special canvas covers from which water could be drained down to the newly constructed drainage basin which was in turn connected with down pipes. All of the roof framing and planking elements were subjected to whittling in order to remove characteristic 'moss' from the wood, which appeared after the wood was cut with saw blades. The reconstructed roof framing was covered with a special foil and then planking was made on which sheet copper was to be fixed. The open drain channels, which drained water from the roof by means of appropriate tilts in the direction of baskets into the down pipes, were profiled and properly located. The renovation works of the tower hexagonal copulas consisted in removing the steel, planking under sheet and the corner construction rafters specially moulded. Towers and copulas on the hexagonal projections (in form of pyramid) were made of brick. In the corners the reconstructed elements of corner rafters were fixed, which served the purpose of the support frame for planking under the sheet copper. There were also new crosses made of steel, which surmounted the church towers. The designed crosses refer to the neo-Gothic stylistics. The previous crosses with no style (secondary) were made of steel pipes. One of the reasons why they were replaced was the method of their fixing on the towers, which caused leakiness between the towers construction and the place of fixing the crosses. New crosses were fixed on the towers in such a way as to make it impossible to let the water leak into the inner parts of towers. The roof cover was made of sheet cooper on full planking on the so called narrow strips on a double standing seam made of strips at the width of 25 cm. Prepared strips of sheet were additionally subject to a special method of moulding in order to improve their rigidity. Fixing the sheet to the planking was made on the so called special 'connectors' moved from the stainless sheet. All the roof sheet works on the contact between sheet and wall as well as open drain channels were made with great diligence and introduced a method of leak tightness on the contact between sheet and wall. Three additional elements of styl-

Fig. 5. Final stage of the tower copula renovation surmounted by the cross

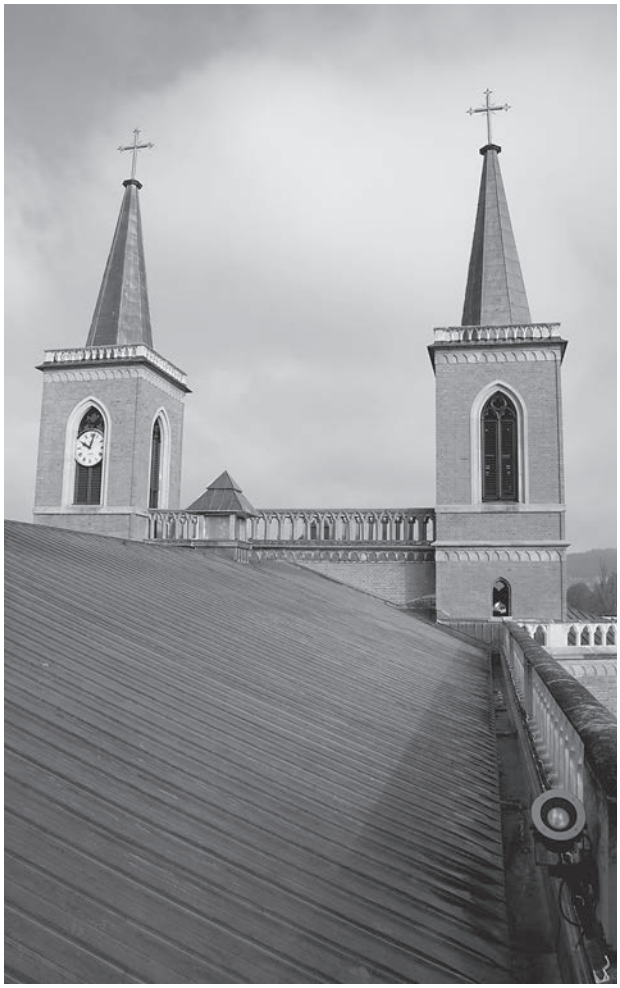

Fig. 6. Final view of the roof slope after renovation

ised small signature forms (which were made earlier before the renovation) were restored, which mainly fulfilled the function of gravitation ventilation from the inner parts of the church. When the roof framing and cover works were finished, insulation of the church vault was made with the use of mineral wool at the width of 20 cm [4].

Conclusions

The method of the roof and church towers renovation as well as the replacement of the roof framing and sheet cooper cover proved that it was necessary to prepare the sequence of logistic activities in the situation in which the building is still used by the congregation for normal church activities during the conducted renovation. During the execution of the renovation works (similarly to the case described by the authors), it is necessary to combine traditions and modern methods of the works in the technical and organizational aspect maximally and universally. Without a detailed research and executive program of the work schedule, we risk unpredictable effects in the renovation process which may endanger the safety of people and buildings. If we neglect a proper inventory measurement, we run the risk of wasting materials, time and money. The precision, quality and aesthetics of conducted works ought to be given a special priority.

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Zasada etapowania procesów budowlanych przy pracach remontowych wież kościelnych i wymianie więźby dachowej w neogotyckim kościele św. Marcina w Krzeszowicach

W zdekapitalizowanych obiektach sakralnych lub w ich częściach dobrze przyjęta logistyka etapowania i kolejności prac montażowo-budowlanych w działaniach naprawczych i remontowych ma decydujący wpływ na pozytywny efekt i czas ukończenia zamierzenia inwestycyjnego. Ważną bazę do opracowania logistyki prac budowlanych stanowią szczegółowe dane etapu rozpoznawczego, zawsze poprzedzającego wszelkie działania w naprawczym procesie budowlanym. Doświadczenia związane z wymianą skomplikowanej więźby dachowej oraz remontu wież kościelnych i pokrycia blachą miedzianą, na przykładzie kościoła św. Marcina w Krzeszowicach, są tematem tego artykułu. Należy też wspomnieć, że konieczność wymiany całej więźby podyktowana była jej totalną dekapitalizacją w około 70%. Z analiz badawczo-rozpoznawczych wynikało, że jedyną słuszną metodą w tym przypadku jest wymiana całkowita więźby dachowej. Przyczyną dekapitalizacji drewnianej konstrukcji dachowej były owady zasiedlające więźbę. Rozpoznano w niej następujące gatunki owadów: kołatka domowego (*Anobium punctatum Deg.*), kołatka upartego (*Anobium pertinax L.*) i spuszczela pospolitego (*Hylotrupes bajulus L.*). Szkodniki drewna rozprzestrzeniły się głównie w konstrukcjach belek drewnianych, krokwiach, stolcach oraz murłatach.

Key words: roof framing, wood vermin, decapitalization

Słowa kluczowe: więźba dachowa, drewnojady, dekapitalizacja