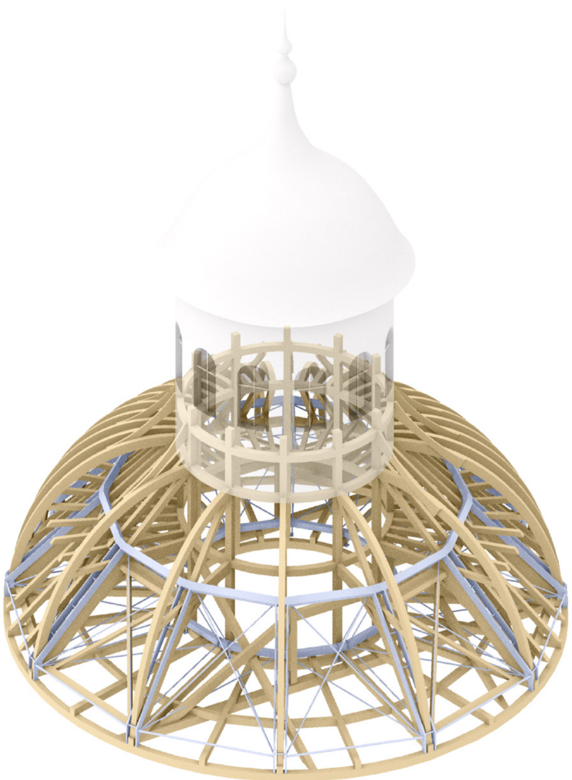
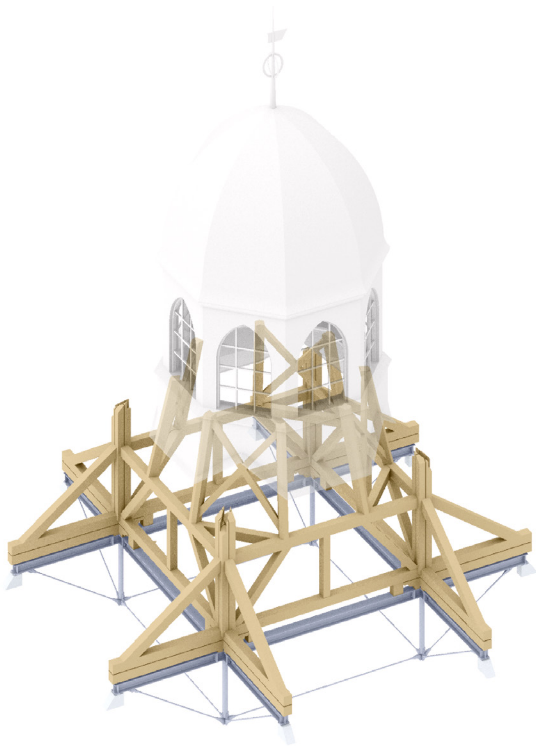
Strengthening measures for historic timber domes

individual and monument-friendly solutions

Jörg Rehm
Dr.-Ing. Architect
Lecturer, Technical University Munich, Germany





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TUM, School of Engineering and Design,
Lehrstuhl für Entwerfen und Konstruieren,
Bereich Lehramt Berufliche Bildung
Arcisstr. 21
80333 München

www.arc.ed.tum.de/lek/team/vita-joerg-rehm/

Contents

1. Abstract

The pilgrimage church Maria Birnbaum and the former pilgrimage chapel and today's parish church Maria Loreto both in Upper Bavaria were built in the 17th century. However, their fates took very different courses thereafter. While Maria Birnbaum still serves as a pilgrimage church today and its Baroque furnishings have been preserved in their original form, the Loreto Chapel was rededicated as a parish church and fundamentally rebuilt in the 19th century.

Both churches have centrally-located timber dome supporting structures, which became defective shortly after their completion. In the course of their maintenance history, various attempts were made to strengthen the structures. Nevertheless, the damage process continued in each case. It was only in recent years that the churches could be repaired sustainably from a structural point of view. The solutions implemented varied greatly. Both are convincing in their consistent application of the requirements of historic preservation regulations in the architectural and engineering interventions. In cooperation with the Bavarian State Office for the Preservation of Historical Monuments, the Bavarian Chamber of Engineers awarded both works the Bavarian Award for the Preservation of Historical Monuments ("Bayerischer Denkmalpflegepreis") achieving gold and silver awards, respectively.

Keywords: Bavarian church; timber dome; structural restoration; conservation

Fig. 1: Raumsau, exterior view (Peter Kifinger)

2. Building description and historical appreciation

2.1 Parish Church of Maria Loreto, Ramsau Reichertsheim

The present parish church Maria Loreto is located within a walled cemetery in the centre of the village some 50 km east of Munich. The building has external dimensions of about 31 m long and up to 14.5 m wide. The church consists of the barrel-vaulted east choir with a single-storey chapel aisle running around three sides, the nave over a square ground plan, and the west building, which accommodates an organ loft and above which a four-storey bell tower is erected. The 45° pitched gable roofs of the choir and west building intersect with gables inscribed flush with the nave façade on the north and south sides and, with equal heights of the eaves and ridge, form a cross shape in plan, with the crossing dome rising in the centre (Fig. 01 photo exterior view).

Above the nave, which is designed as a central room with interior dimensions of 11.50 x 11.50 m and a clear height of about 7 m, is the 18.5 m high copper-clad timber crossing dome (Fig. 02 dome construction). The dome rises above a square opening in the flat ceiling measuring 5.4 x 5.4 m. The dome is connected to the octagon via the octagon's roof. The transition to the octagon is achieved with pendentifs. Above it rises an octagonal tambour with windows. The dome ends with a two-part closed cupola. The timber trusses supporting the dome have an effective height of 2.3 meters. The ridge lines of the respective roof sides also start at this height. The trusses consist of a system of compression struts (W x H = 20 x 24 cm), an upper and lower chord and suspension members (composite cross-section 4 x 19 x 19 cm), connected to each other and to the lower chords by iron straps and bolts. The bottom chords also serve as a circumferential support for the ceiling construction. The floor beams are arranged in the same plane as these bottom chords and are thus covered with these and with each other. The aforementioned trusses take the loads from the dome and the surrounding roof geometries and transfer them to the exterior walls of the central room. The walls were built with hard-fired solid bricks in wall thicknesses of 75 to 105 cm.

The present church building has its origins in a pilgrimage chapel built in 1628/29, which belonged

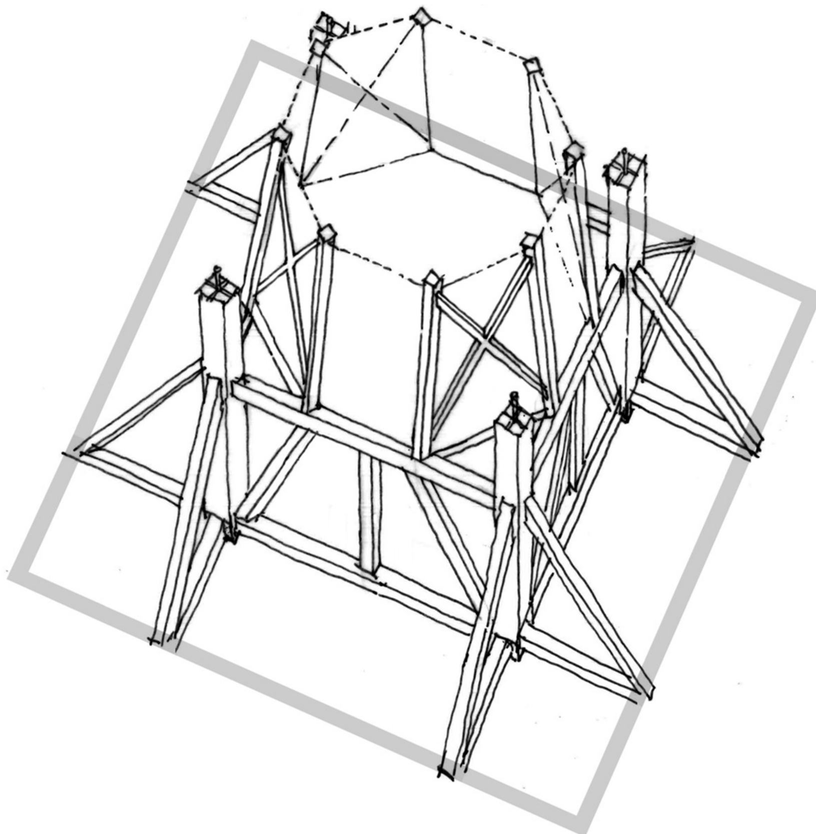

Fig. 2: Raumsau, dome construction (Kayser + Böttges, prev. Barthel + Maus)

to the nearby monastery of the Augustinian Hermits in Ramsau. This first construction phase is documented by a survey that was drawn up in 1859, shortly before a fundamental remodelling of the church. Like many Marian chapels that were built in the 17th and 18th centuries, the complex is inspired by the 15th century shrine in Loreto, Italy, dedicated to St. Mary. To the central high sanctuary, the „Santa Casa“ in the case of Ramsau was connected directly to the main building at ground-floor level via an arcaded passageway. The western end was enclosed by two flanking tower-like corner chapels. To the east, a sacristy was added to the gallery. Two entrances on the north and south existed. The peculiar ensemble stands out due to the lively roof landscape, which was composed of monopitch and gable roofs. Stylistically, the complex can be attributed to the early Baroque period. The pilgrimage chapel was an early and probably unique example of a Loreto shrine. Chapels built later, as they can still be found in Bohemia, for example, were freestanding in the courtyard of an overall ensemble, and the arcade was thus detached from the shrine and surrounded by small chapels.

In 1802, in the course of secularization, the Augustinian monastery in Ramsau was dissolved. The Loreto Chapel became the new parish seat and soon became too small for the growing congregation. In 1859, the building was extended under state direction during which work the appearance of the early baroque pilgrimage chapel was completely changed. However, parts of the original building were preserved, which determined the ground plan and, in part, the shape of the future parish church. A comparison of the dimensions of the original structure with the overall appearance that still exists today suggests that the overall dimensions of the former Santa Casa, the arcaded ambulatory and the corner chapels correspond exactly to the dimensions of the present church (Fig. 03 Floorplan). The square nave with the high timber dome was placed on the former western porch. The Santa Casa was somewhat shortened and rededicated as the choir room. To the west, an annexe was added across the width of the choir loft to accommodate the organ loft and provide access to the roof structure. The interior of the church was given a uniform design in Romantic-Gothic style. Above the

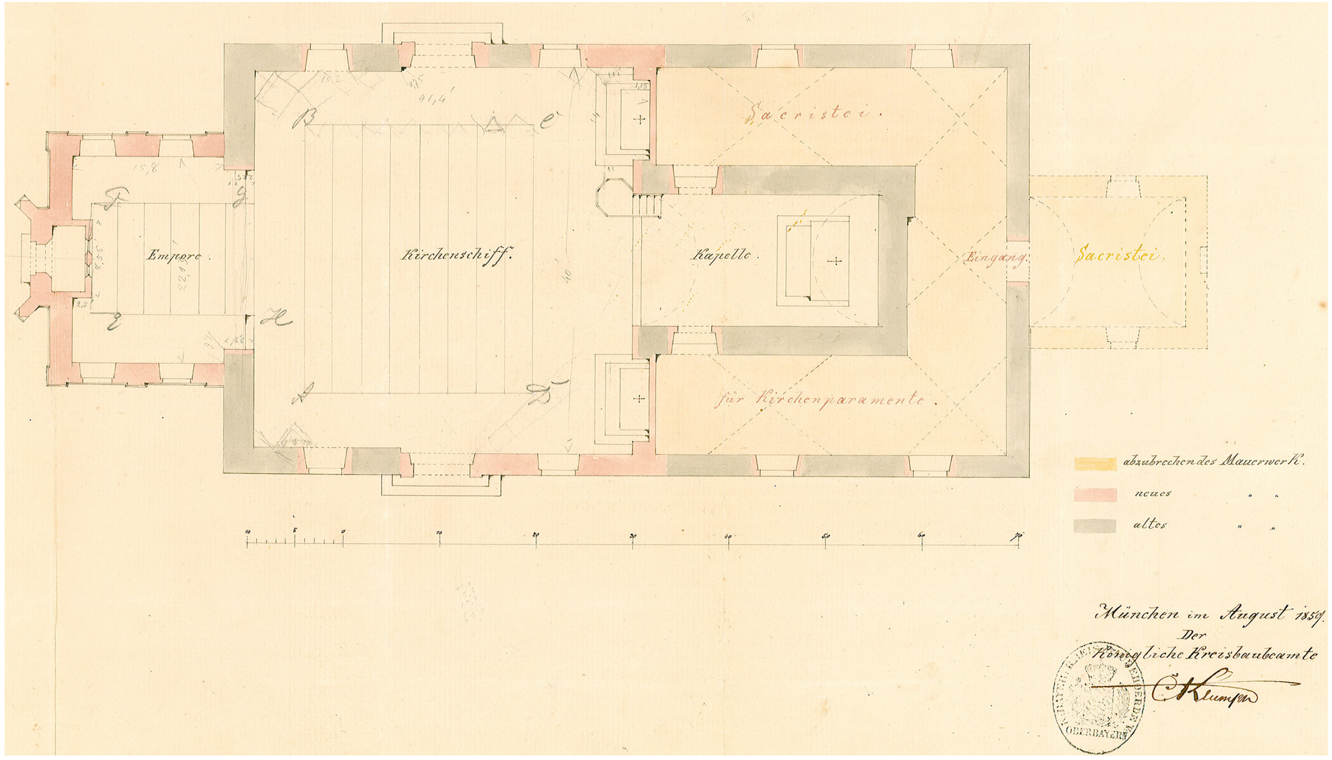

Fig. 3: Floor plan 1859, Ramsau (Archiv Staatliches Bauamt Rosenheim)

new central space of the nave, a layer of beams overlaid in a tight grid and the lower chords of the dome construction were formed as visible parts of a coffered, wooden, flat ceiling. The highlighted main axes of this coffered ceiling accommodated the square dome opening and were tectonically emphasized by corbels that descended to a perimeter cornice (Fig. 04 photo Gothic condition). The neo-Gothic furnishings were in some ways at odds with the overall Baroque design of the existing spatial concept, which was composed of basic geometric forms such as the barrel and cube.

These added features were removed in the 1950s and 1970s and replaced by partly original baroque features from the former chapel. Overall, the densely furnished interior space was thereby significantly simplified in appearance and baroquized in accordance with the taste of the time. The strongly articulated coffered ceiling and the inner sides of the dome were clad in simple forms with relatively flat surfaces, and the colour scheme was also redefined with pastel tones. In the process, the considerable deformations resulting from the dome construction, which had already become defective shortly after the reconstruction of 1859, were concealed.

Fig. 4: Interior view after 1859, Ramsau (Archiv Staatliches Bauamt Rosenheim)

2.2 Pilgrimage Church of Maria Birnbaum, Sielenbach

The church was erected 1661-68 by the Teutonic Order and is situated some 40 km north west of Munich. Its starting point was a pear-tree and a wooden statue of the Virgin Maria. The astonishing architecture was inspired by the Counter-Reformation.

The pilgrimage church Maria Birnbaum is thus one of the first sacred buildings of the Baroque period after the Thirty Years' War in which the central space idea was adopted. The interior is a spatial continuum and consists of three parts. It is formed by composite cylindrical structures, which, except for the central space, are cut and merge into one another, each ending with a dome. Above the main central space, with a clear diameter of about 17 m, there rises beyond the dome a round, windowed tambour with a diameter of about 7 m, the so-called Apostle's Tower. The church has one tower each in the north, east and south, two of which were added to the central space later. The rich stucco decoration goes back to the Wessobrunn school and was made by Matthias Schmuzer. After secularization, the church was initially bought by the parish of Sielenbach, and in 1999 it returned into the hands of the Teutonic Order, which established a novitiate in the monastery there (Fig. 05 photo exterior view).

The main timber construction over the central space with a free span of 15 m was erected as a dome pierced by a cylinder, the „Aposteltum". The Apostelturm with 6 m diameter is visible from below through the oculus in the brick dome and fully supported by the roof-construction (Fig 06 longitudinal section). Understanding the conception of the timber structure was challenging. The original structure combines a compression ring on the top and a tension ring at the bottom of the cylinder. The loads of the tower should be carried by twelve struts and transferred to the outer walls. The horizontal loads should have been carried by beams linked to the lower tension ring. Posts and beams are connected by mortise and tenon. The beams of the tension ring are linked by wrought-iron ferrules.

The respective central spaces of the two church buildings are the focus of attention in this paper. Despite the fact that span of Maria Birnbaum is about 40% larger than that of Maria Loreto, the basic arrangement of the structural and constructional solutions are very similar.

Fig. 5: Exterior view, Sielenbach

3. Damage and maintenance history

It is known that the timber dome structures of both churches showed first signs of damage soon after they were put into use. In the case of Maria Loreto, the archival records indicate that plans for a complete dismantling of the dome were already underway a few decades after completion. Not least because of the progressive sinking of the timber structure, the truss system under the dome was strengthened during the interior renovation in 1954-55 and the ceiling above the nave was fundamentally altered. The interior was designed according to the taste of the time in simple baroque forms and painted in muted pink tones. The aforementioned neo-Gothic consoles from 1859 were removed.

In the case of Maria Loreto, it was a routine static inspection commissioned in 2011 by the Rosenheim State Building Authority on behalf of the Munich-Freising Archbishop's Office that revealed considerable defects and damage to the dome structure. Both the dome and the associated coffered ceiling showed considerable deformation. The dome was slightly tilted. Findings on the ceiling cladding from the 1950s revealed even greater deformations of the remaining structure from 1859. Load-bearing elements were defective due to overloading, connections had become loose or were ineffective. Immediate emergency action was taken in the form of four massive timber supports under the corners of the dome. In the process, the friction connection to the actual dome structure had to be ensured two days before Christmas Eve. The emergency structure also served to safeguard the structural stability during the repair work. (Fig. 07 photo emergency backup).

Significant damage in the form of cracks and deformations also became apparent in the dome supporting structures of the pilgrimage church of Maria Birnbaum soon after completion. In 1793 the church was in dire need of repair. The masonry of the outer walls showed cracks, the roof-construction was lowered down to the massive dome-construction, which now had to bear parts of the

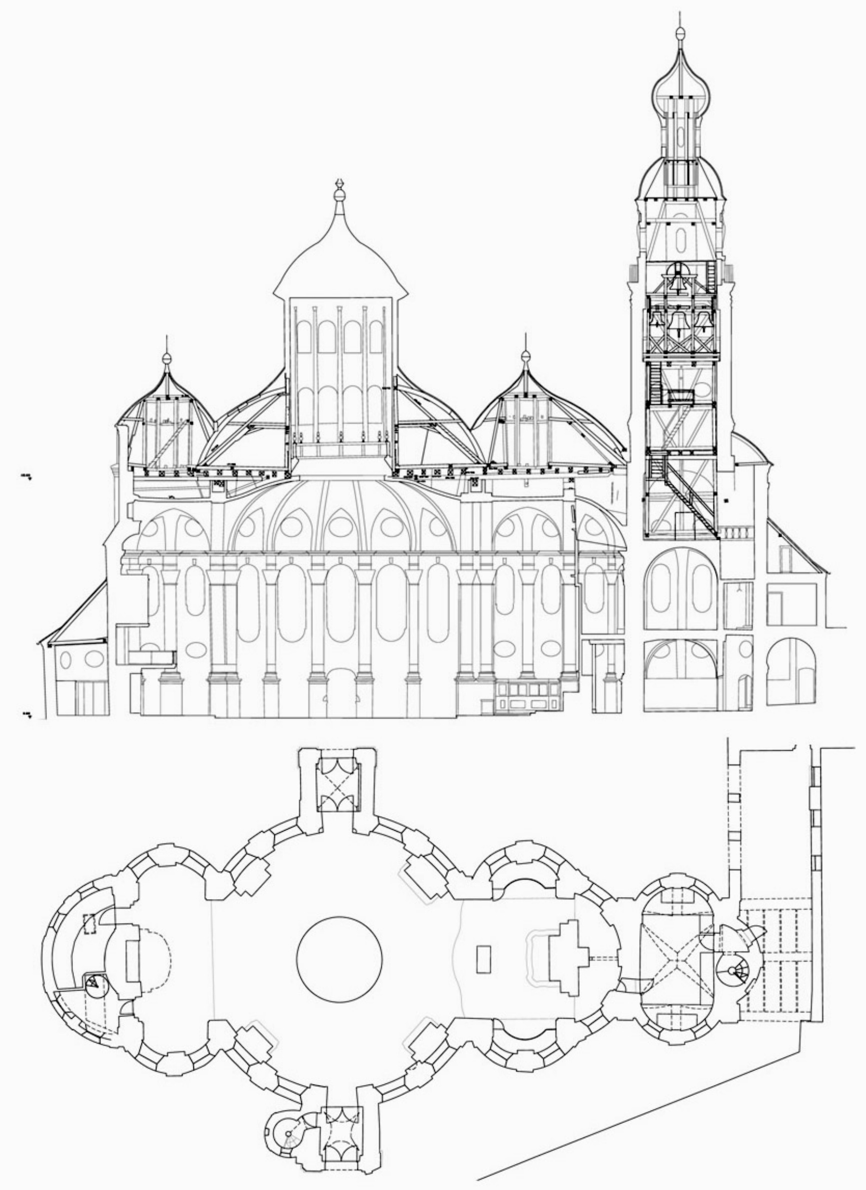

Fig. 6: Section and floor plan, Sielenbach (Kayser + Böttges, prev. Barthel + Maus)

timber-roof-construction. Reduction of the height of the tower, additional outer buttresses and the introduction of tie rods were some of the measures suggested. Finally, a low-budget solution was executed. Two major truss-constructions and two minor frames were added to the tower and connected to the tension ring in order to support both the roof- and the tower-construction. Tie rods were added above the triumphal arches and not visible from below. The height of the tower was reduced and the lantern removed.

As was the case at Maria Loreto, the ownership of Maria Birnbaum changed from the Teutonic Order to the Bavarian Kingdom in 1802. By 1865 the building was again in a bad state. In a private campaign the church was restored in 1895, but the works carried out were simple. Some rotted beams were exchanged and compression props were added between the roof-structure and the brick-dome. It is noteworthy that tie rods from the lower beams to the rafters, laid on the purlins of the truss units, were inserted in order to stop the sinking of the whole construction.

The last attempt to stop the continued spreading of the building's walls was made in the 1970s with the installation of two reinforced-concrete ring beams, above and below the porthole windows. On the other hand, no repairs were made to the timber structures of the roof.

Prior to the recent repair works,

Fig. 7: Emergency bachup, Raumsau

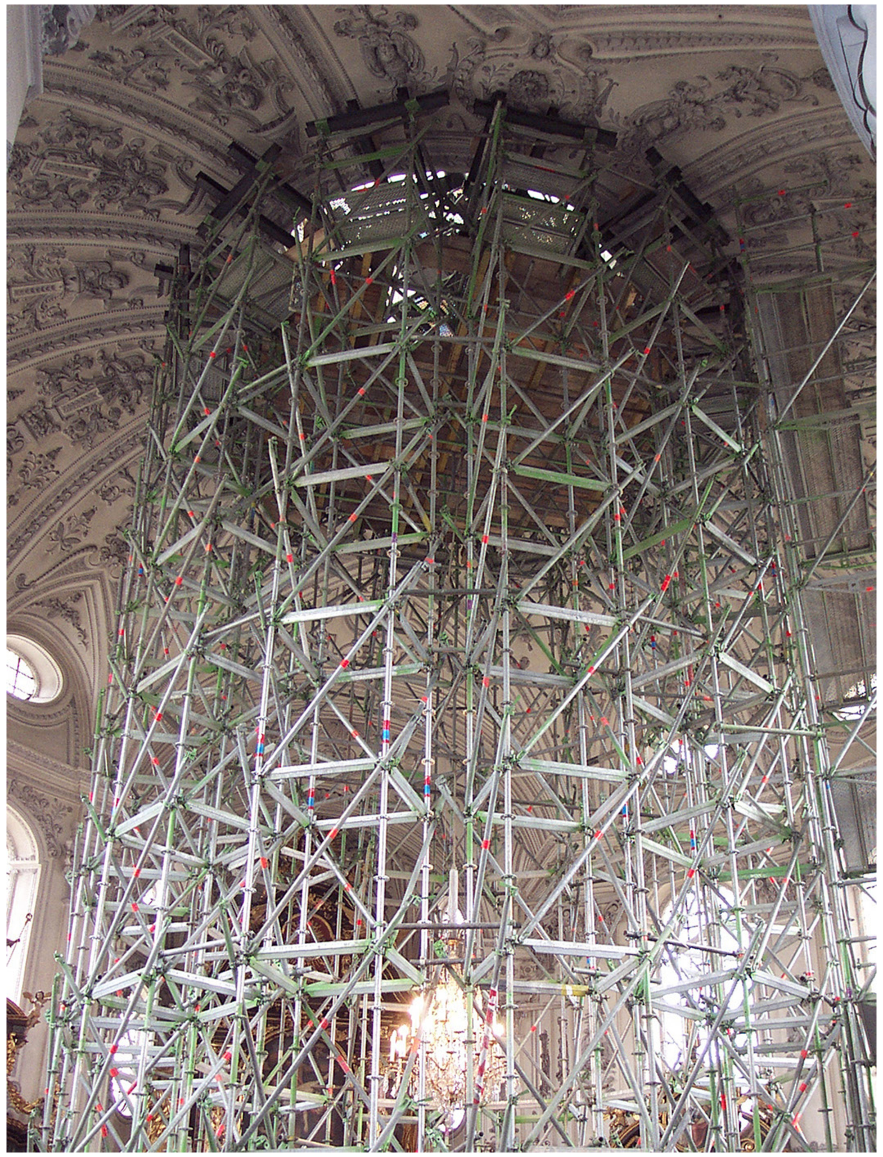

Fig. 8: Emergency bachup, Sielenbach (Christian Kayser)

there was again such considerable damage that the church had to be closed. The 15-metre-high tambour of the central building had sagged significantly. Cracks had appeared in the vault and in the outer walls. The shingle roof was leaking, and numerous timber sections had been damaged by rot. The dome had to be propped using emergency scaffolding placed beneath the tambour (Fig. 08 photo emergency backup). Here, too, there is a similarity to the emergency support in Ramsau, where four timber supports were sufficient, since the height was only about 7 m.

4. Statical and construction considerations

For Maria Loreto, it was planned at the time of construction to transfer the loads from the dome to the outer walls via the four-sided trusses. This was suggested by the detailing with iron components for the suspension structures. Whether the cast-iron corbels (comp. Fig. 3) installed on the underside in 1859, which ran from the corners of the dome to the outer walls, were intended to have a load-bearing function can therefore at least be questioned.

Rough statical calculations showed that even with intact connections, the working stresses in the elements of the truss structures were very high. Prior to the repair measures now carried out, the upper chord of the truss structures had to transfer the loads from the dome via bending up to the tension members. This unfavourable circumstance resulted from the fact that the octagonal floor plan of the dome was inscribed in the square floor plan formed by the truss constructions. Thus, the tension members of the trusses were spatially separated from the statically effective frames in the corners of the octagonal tambour. Moreover, the diagonal struts were severely overstressed. Connections had loosened and there were significant gaps in the connections. This resulted in clearly visible crushing of the timber fibres, as well as stress cracks and large deflections. The repair measures carried out in the 1950s were limited to partial doubling up the top chords and installing cleats at the connections to the tensile members. This did not remedy the insufficient depth of the truss structures and the resulting overloading of the cross-sections.

Great respect was always paid to the high-quality interior of Maria Birnbaum. Interventions in the roof and dome support structures were therefore always and exclusively limited to measures within the roof space in order to avoid visual impairments in the interior. The causes of the deformations were to be found in the construction of the dome, which is pierced by the tambour. The timber structure that was built initially was never capable of bearing the dead loads of the structure, the wind forces or the shear forces of the supporting structure. Even the repair measures carried out in around 1794, during which truss structures were added to the roof space, were not sufficient, as the required structural depth could not be achieved in the low roof space. Thus, the sinking of the supporting structure could not be halted. The tie rods used above the triumphal arches were inserted too high to absorb the thrust from the roof structure. Only the reduction in the height of the lantern helped to some extent to reduce the impact of wind forces.

The plans from 1793 described above, which are documented in the archives, would have been more effective, but were ultimately not carried out, or only in a very reduced form. The earlier interventions at Sielenbach carried out during its life were similar to the measures carried out at the church in Ramsau. In both cases, a holistic, engineering approach was not taken; indeed, the actual causes of the damage seem to have been ignored. Repair work was carried out on the visible symptoms rather than based on an understanding of the causes of the damage; existing deformations were either ignored or covered up. Indeed, it is astonishing that both structures survived for such a long time.

5. Actual repair concepts

A reconstruction of the existing trusses at Maria Loreto by repairing the damage to the existing trusses was not practicable because they had been so overstressed from the start, that a purely carpentry-based repair would not have provided an adequate load-bearing structure. In order to ensure the long-term stability of the dome, the installation of a subsidiary structural system was therefore unavoidable for this dome structure. The addition or doubling of the truss structures within the roof area with the aid of steel mouldings would have been the preferred method from the point of view of historic preservation. However, it was ruled out due to the very cramped conditions and the extremely high level of damage resulting from an attack by house longhorn beetles in 1973.

In order to find solutions to the structural problems, a feasibility study investigated alternative strengthening measures that would have a visual impact in the church interior. Such a measure represented a rather unusual intervention from the point of view of preservation of a heritage monument and was therefore a challenge for the planners. The installation of a supporting structure, which would be clearly visible in the interior of the church, was quite easy to realize from a structural engineering point of view and corresponded to the temporary emergency structure already used. Another variant was to rebuild the neo-Gothic corbels. For this, however, it would have been necessary to insert tie rods at the level of the connection of the console in the brick outer wall in order to avoid bending on these walls.

The option finally implemented was in the form of a trussed girder. This solution was achieved mainly by using tension members and strengthen the existing structure by tensioning the truss rods in the new trussed beams and so reversing the action of the existing truss structures. Only the tension members of the existing trusses had to be strengthened with new compression members. A double-T girder is used for the necessary compression member or bottom chord directly under the crossing girders, which were continuous from outer wall to outer wall and had previously been over-stressed. Overall, the effective depth of the structure supporting the dome was thus increased by the required amount (Fig 09 Ramsau Axonometry).

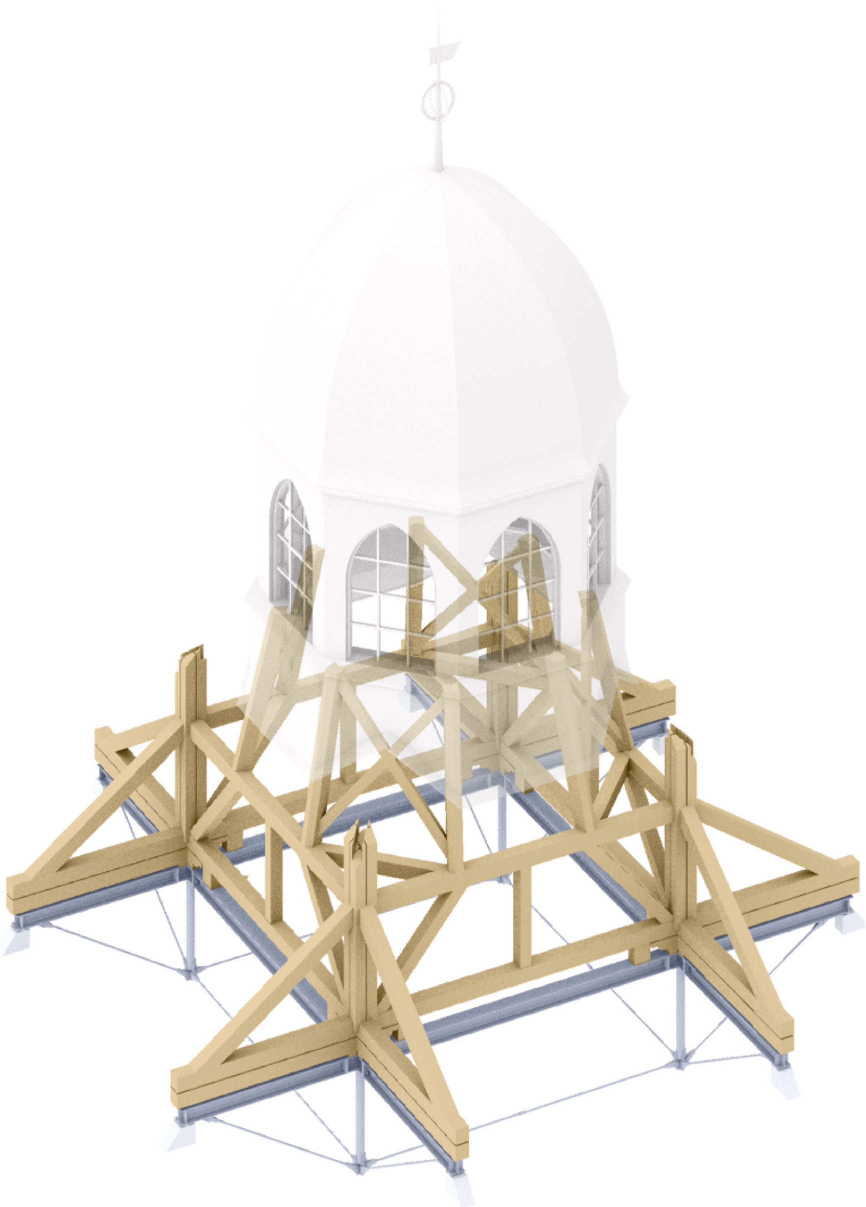

Fig. 9: Axonometry of the repair, Ramsau (Sebastian Nägele)

The new structural components added to the original, traditional structure at different stages of the building's history were each recognisable by their forms and styles which were characteristic of the different times when they were carried out. They created a new unity at each stage of the structural changes. The most recent necessary repairs to the structure of the dome were the latest addition to this historical sequence and, at once, a new intervention and also part of a traditional spatial whole.

Instead of a hard break between old and new, an attempt was made to find sensitive detailing for a coherent transition. All structural elements in the ceiling were provided with a partial cladding that continues the existing structure and whose appearance is based on the profiles of the existing wooden ceiling. The soffits of the steel girders remained uncovered. The installation height of the steel structure had to be based on the lowest point of the deformed ceiling. Because of the considerable drop of around 15 cm, the distance to be bridged became considerable. To ensure that the effect of the girders was not too massive compared with the finely profiled coffered ceiling, the cladding recedes in steps into the web area of the steel girders; the resulting shadow gaps take on the scale of the existing structure. The multi-layered, overlapping cladding leads to a pleasant lightness of the overall impression due to the resulting profiling. By leaving the bottom chord visible, the structural disposition and materiality of the reinforcement

Fig. 10: Interior view in comparision before and after repair (Peter Kifinger)

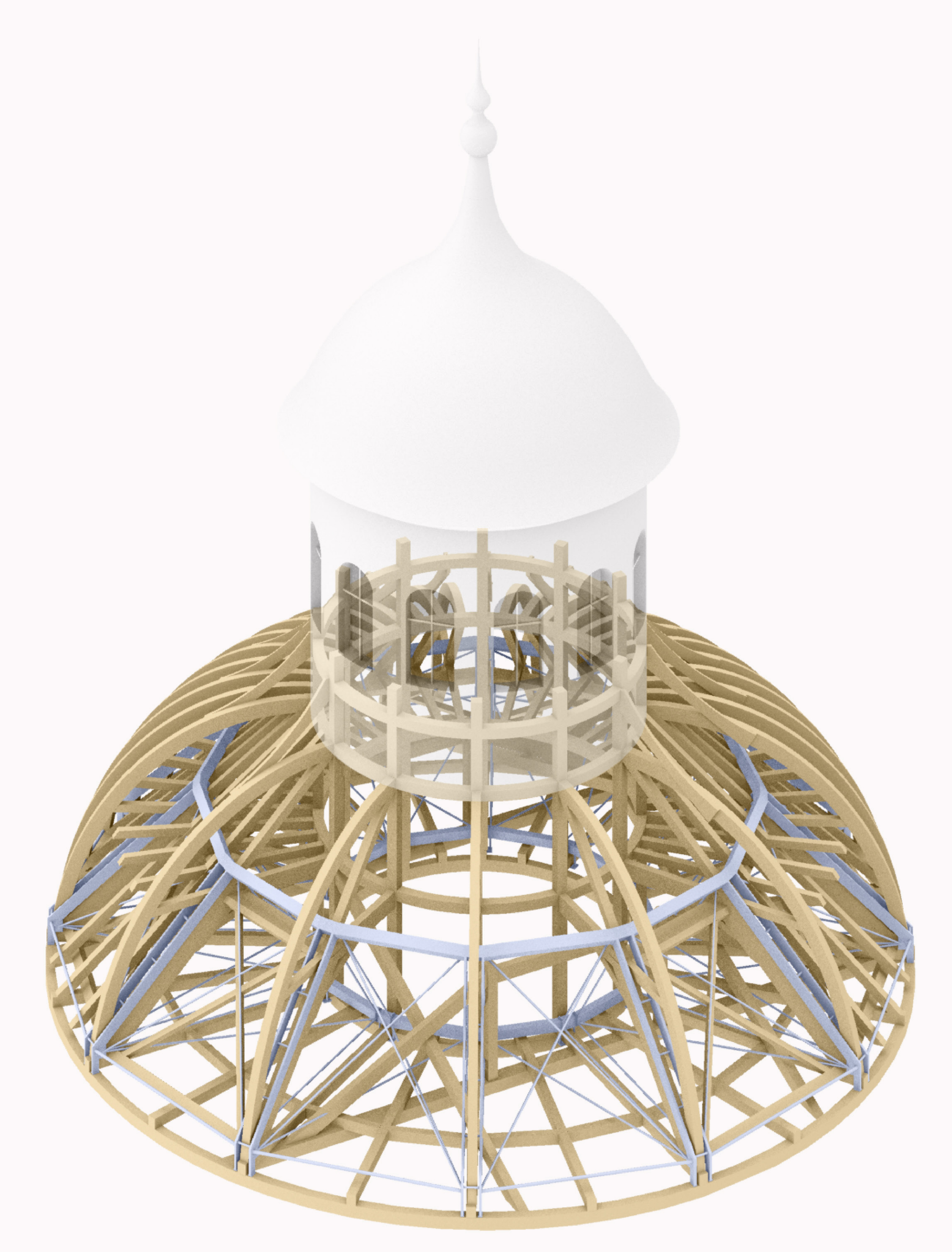

Fig. 11: Axonometry of the repair, Sielenbach (Sebastian Nägele)

can be read. The differentiated colour schemes are based on the existing structure. At the same time, shadow lines were used to emphasize ornamental elements such as the nodes or head plates.

In order to be able to reduce the height of the steel girder structure from the outset, the four corners of the dome were developed as cruciform nodes with compression struts, with the help of which the required overall depth of 1.7 m was achieved. The nodes connect the 12 girder sections with each other. In order to relieve the upper and lower chords of the timber truss structures, all compression connections in the existing structures in the roof space were also strengthened and detached connections were re-established.

Overall, the structural interventions take a back seat to the interior appearance due to the careful integration of the detail. At the same time, the new construction reinforces and reinterprets the tectonic effect of the dome, which has been impaired since the reconstruction of the 1950s. (Fig. 10 Ramsau Comparison before and after). The intervention measure at the parish church of Maria Loreto is thus clearly distinguished from the planning approach adopted at Maria Birnbaum.

In preparation for the interior restoration works, the roof structure of Maria Birnbaum was investigated in 2005. All cracks and deformations were documented. The huge number of deficiencies led the engineers to conclude, that the building could collapse at any time. The church was closed and a scaffolding tower was erected under the tambour.

For the central dome of Maria Birnbaum, the installation of a steel compression ring around the existing tambour as high as possible was considered the most effective approach. In combination with a tension ring at the foot of the tambour and with struts and ties, this ring safely transferred the dead loads from the tower to the outer walls. When the structure was tensioned, it was also possible to raise the tambour slightly and finally detach it from the emergency scaffolding installed beneath. This primary structure was supplemented by a tension ring along the support above the outer walls so that the thrust from the supporting structure could be absorbed directly and not transferred into the reinforced-concrete ring anchors added in the 1970s, as had previously been the case. In order to secure the entire structure against wind loads, steel tension bands were inserted in the spaces between the struts, both at the level of the beams and at the level of the rafters. These also distribute asymmetrically applied loads evenly throughout the entire structure. These strengthening measures were actually carried out almost as had been planned in the original design. Nevertheless, it was only with the help of steel components that the structure could be made stable (Fig 11 Sielenbach Axonometry).

Fig. 12: Interior view, Sielenbach

6. Some concluding remarks on the preservation of monuments

The idea of a central space that was pursued in the Baroque period was based on the Counter-Reformation which attempted to establish a direct link to the early Christian church, i.e. sought a return to the ideals of the primitive church. The elongated, cruciform ground plan, which had previously dominated the layout of church buildings for many centuries and corresponded to the additive character of yoke-like Gothic sacred buildings, was thereby contracted into a Greek cross. The resulting central space was predestined to be elevated and especially emphasized by a dome. The dignified architectural form of the crossing dome was in turn familiar from numerous Romanesque church buildings. The liturgical approach of the central space, which was taken up again in the early Baroque period, entailed corresponding architectural ideas and presented the master builders of their time with great challenges. However, the early Baroque period was accompanied by a rupture in the art of building, which was largely caused by the Thirty Years' War. The building tradition broke off abruptly, at least in the areas of the church buildings examined here. Added to this is the fact that, until well into the modern era, structural connections that could be loaded in tension could only be made in limited circumstances within the current construction technology. The enormous design demands of Baroque builders put the inexperienced master builders to the test.

Vaulting domes, which are actually always converted from a square ground plan to an octagon or spherical dome, lead to complicated intersections. The timber domes considered here stand fully in this field of contention between design demands, the knowledge of the master builders and the technical possibilities of current construction. The baroque wanted to have the spatial shell freely at its disposal. The construction artifice had to remain hidden.

The solution in each of the cases presented in this paper was to erect a framework that transferred dead and live loads to the outer walls. In doing so, the engineers reverted to truss structures, which, when properly applied as a framework, were only intended to carry normal loads. Truss structures were born out of the idea of supporting rafter roofs with large spans or taking up the purlins of a purlin roof. This was intended to allow large spaces to be spanned without supports. The closed triangle of forces in a truss, consisting in principle of two compression struts, a strut required in the initial design, and a bottom chord subjected to tensile stress, represents a very stable structure if the struts are sufficiently steep. But if incorrectly designed it quickly reacts with deformations.

In the case of Maria Loreto, this was due to insufficient structural depth and the stressing of components of the truss in bending. In the case of Maria Birnbaum, the addition of half truss structures was chosen, arranged radially around a centrally placed tambour and without continuous bottom chords. The ring of timber members defining the inner wall of the lantern in the roof area was not suitable from the outset for transferring the vertical loads safely to the outer walls. The lowering of the overall structure subsequently also had an influence on the generally masonry exterior walls due to the horizontal load components. Exterior buttresses were rejected in the Baroque period for aesthetic reasons, as was the case at Maria Birnbaum. The

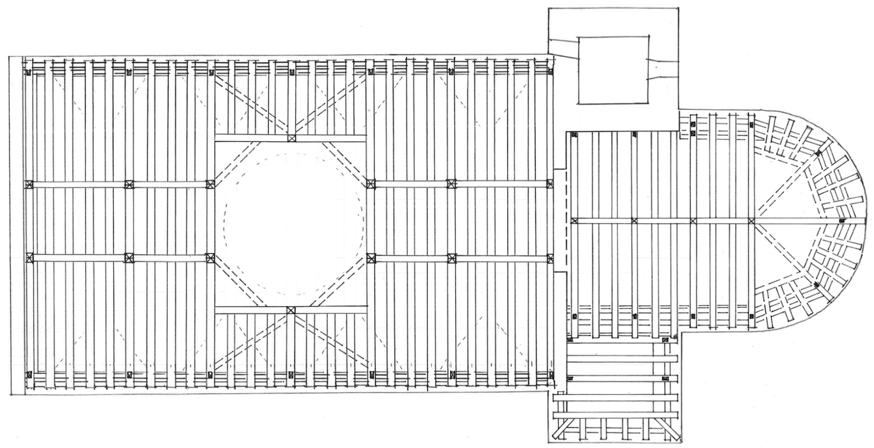

Fig. 13: Floor plan, parish church St. Martin, Pfaffenhofen a. d. Zusam (Kayser + Böttges, prev. Barthel + Maus)

deformations resulting from such a disturbed supporting structure from the outset can be seen in numerous buildings of this period. Also common in this type of structure are disruptions of rafter roofs where the tie beams were avoided in favour of dome or vault fixtures. The effect is the same. But the components of rafter roofs are also subjected to bending, if only in view of the roof loads; the components of truss structures were intended to support only direct forces. It is always crucial that a continuous bottom chord can absorb the shear stresses from the structure.

It is rare to find an intelligent design solution in the early Baroque period. It was not until the beginning of the 18th century that master builders in southern Germany had again professionalized to such an extent that suitable solutions could be found to meet the increased aesthetic demands of the clients. One such solution can be found in the parish church of St. Martin in Pfaffenhofen an der Zusam, to the north of Augsburg, built in in 1722 (Fig. 12 floor plan draw bars PAF/ Zusam). Here, the timber dome, which intervenes centrally in the roof space, is set on a crown that rests on the beam plane of the multi-storey rafter roof. The thrust resulting from the cutting out of the ties in the dome is absorbed by two horizontal truss structures that transfer the forces to the next continuous draw bar. This is an exceptionally clever design that has been effective for over 300 years and will continue to function.

The listed churches of Ramsau and Sielenbach are buildings of special importance, on the one hand because of the early baroque and unique building shape, on the other hand because of the extraordinary roof constructions. These surviving roof and dome support structures have been repaired again and again over the centuries and contribute to the monument value of the buildings for technical reasons alone because of their unusual maintenance history. This maintenance history is very interesting for heritage monument research. Thus, together with the archival records to be found, the discrepancy between claim and reality can also be traced. It remains the wish of the conservationists to preserve as much of the original substance as possible and to keep the necessary renovations in the background as far as possible. On the other hand, a contrast must be consciously sought if subtle measures are not possible.

The two church buildings presented here and compared with regard to retrofitting, had a similar problem. Both churches are pilgrimage churches from the Baroque period, at least in the original sense. The dome of Maria Loreto, however, was not built until 1859, almost 200 years after Maria Birnbaum. However, the construction of the dome structure was no less problematic. As explained, very different concepts were offered for the restoration, which are closely related to the original conception of the construction and to the history of alteration itself. In both cases, reconstruction of the original was ruled out as a solution, since the structure as it was built was never suitable for the task assigned to it. None of the existing constructions was suitable for securely placing the dome on the rising walls.

The structural engineering possibilities and building materials available today provide the designer with excellent assistance in meeting the requirements of the conservation regulations. If it is not sufficient to reassemble historic components at the original location, individual components or parts of structures must be supplemented. These additions must be kept to a minimum and be clearly legible. The planning approach for the restoration of the dome of Maria Loreto goes beyond this approach in that the newly added parts were integrated into the existing structure in such a way that the eye of the beholder takes them for granted. The result is that what is in itself a very modern upgrade becomes a meaningful continuation of the history of change that goes back a long way. In addition to the courageous decision making the renovation visible to everyone in the sacred space, the visual integration into the existing structure was also intended, instead of seeking a contrast. The advantage of the measures implemented is that it was only necessary to intervene minimally in the existing structure,

a maxim of monument preservation.

In the case of Maria Birnbaum, it was possible to dispense with visually effective interventions completely and thus to comply fully with the always cherished wish of monument preservation to keep structural measures to a minimum (Fig 13 Sielenbach photo interior). Here, however, there were not the same spatial constraints as in the Maria Loreto church. Rather, it was possible to accommodate the retrofitting in the spaces remaining within the existing structure to supplement the primarily tensile-stressed steel components.

What makes dealing with existing buildings interesting and exciting is that individual approaches to design solutions can lead to ever new original retrofitting measures. It also shows that the exchange between the partners from historic preservation, architecture and engineering involved in the objects can be very fruitful and purposeful.

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Maria Birnbaum:
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State Office of Preservation: Dr. Markus Weis and Dipl.-Ing. Tobias Lange

Object planning: Landherr Architekten, Munich

Structural design: Barthel & Maus, Beratende Ingenieure GmbH, Munich (Prof. Dr.-Ing. Rainer Barthel, Dr.-Ing. Helmut Maus, Dr.-Ing. Christian Kayser and Dipl.-Ing. Michael Löffler)

Maria Loreto:
Client: Church administration of Gars am Inn, represented by the Archbishop‘s Office of Munich and Freising and the Rosenheim State Building Authority.

State Office of Preservation: Dr. Hildegard Sahler

Structural object design: Barthel & Maus, Beratende Ingenieure GmbH, Munich (Dr.-Ing. Jörg Rehm, Dipl.-Ing. Peter Kifinger, Dipl.-Ing. Mark Böttges and Dipl.-Ing. Erik Eberhard)

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