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THE VIENNA ROOF REGISTER – INVESTIGATING HISTORIC WOODEN ROOF STRUCTURES IN VIENNA'S CITY CENTRE

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ABSTRACT: The Vienna roof register illustrates the technical development of historic wooden construction on the basis of Vienna's roof structures. Timber roof frames appear to survive from six centuries in the inner city and are a store of knowledge about choice of materials/sourcing, planning/preparatory measurement, construction type/method of execution and organisation of the building site/erection procedure. The history of the development of roof frames is shaped by experiment and empirical evaluation. Today, the surviving stock can be investigated and evaluated systematically by scientific methods.

KEYWORDS: Historic roof structures, Vienna, inventory, buildings archaeology, preservation of historic monuments

1 INTRODUCTION

The Viennese roofscape conceals a hidden treasure of timber constructions hundreds of years old. The situation has changed a great deal in recent decades, however (Fig. 1, 2). A well-rounded historic texture has mutated into a heterogeneous, technoid-reshaped mixture.
The Austrian Federal Monuments Authority (BDA), the City of Vienna and the Federal Chancellor's Office have now launched a research project to gather information about and evaluate the historic roof structures in the city centre during the course of 2016. The register as planned will record the age, construction and state of development of the around 1,400 objects in the city centre. The inventory will be enhanced by the scientific

Figure 1: *Vienna's roofscape c. 1860. View from St. Stephen's eastwards towards the Old University (BDA Photo Archive)*

Figure 2: *The roofscape in 2007. View from St. Stephen's eastwards towards district around the Old University. In the foreground the façades of Wollzeile, in the centre of the picture the roofs of the old university with the Jesuit Church and in the background the buildings of the Ringstraße zone (BDA Neubauer-Pregl)*

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investigation of around 90 individual objects. The roof spaces of Vienna's burgher houses will be at the centre of the project, as they have been under enormous conversion pressure for several years now and are extremely threatened.

2 PROJECT

The roof register research project has four phases: 1. Establishment of the research base, 2. Object Survey, 3. Evaluation and 4. Publication.

In the first phase all roof structures were dated provisionally. This took place on the basis of monument inventories and BDA archive sources. Depictions of roof structures from more than 200 objects were retrieved from the plan archive. The photo archive contributed views of historic roofs, scale photos and war damage records. The general object archive provided information about construction and conversion work in the buildings concerned since the formation of the monuments service in 1850.

The second project phase consisted of the systematic survey, photographic documentation, technical description and dendrochronological analysis of individual objects. Ninety largely unchanged roof structures, representing a cross-section through the centuries, were selected on the basis of the initial roof survey. An average of two recorded sections are planned for each object, meaning that a total of 180 roof structures will be analysed. Recording will take place with the help of pre-printed forms, which determine the type of drawing used and structure the data gathered, thus assisting the systematic evaluation of the catalogue.

The initial survey and the detailed object records are the basis of the third phase of systematic evaluation, including typological classification of the timber roof frames and reconstruction of the development of roof structures. The knowledge gained about the roofs of secular and vernacular buildings will be placed against the background of the imperial and religious buildings.

Figure 3: *The Vienna City centre research area with the Ringstraße zone (outer area) and the historic centre (inner area)*

The roof constructions from the Hofburg, where research by the Technical University of Vienna began in 2010, are an important reference point [12]. At another level, an attempt will be made to discover innovation stages in the development of roof structures and Vienna's role in the transfer of technological knowledge. Results relevant to Vienna's economic area are also expected here.

Comprehensive dendrochronological analysis, headed by Michael Grabner from the University of Natural Resources and Life Sciences, will contribute to the buildings historical project, but also help to improve the dating of construction timber in Vienna and gain information about the geographic origin of the timber used [6].

In the fourth and final phase both the catalogue and the results of the evaluation will be published and thus help to close the gap in research into wooden roof frames in Central Europe. Some studies of the roof structures of religious buildings exist, but there are almost no urban inventories of profane buildings. Roof constructions have been published on a limited scale from Salzburg, Bamberg and Graz and, comprehensively, from Basle [5, 11, 10, 2].

3 PROJECT RESULTS

The first phase of the survey was completed in May 2016 after which the documentation of the individual objects began. First reliable results will be available by the WCTE conference in August 2016. Nevertheless, an introduction to the surviving roof structures and a general outline of the constructions found are possible here.

Vienna's 1st District is divided into the Ringstraße zone with roof structures from 1860 onwards and the historic centre in which roofs survive from many different centuries (Fig. 3). The map in Fig. 4 illustrates the number and distribution of building ages found in the historic centre.

Figure 4: *Provisional map of the roof structures in the historic city centre with building age (Blue - Gothic; Green - Renaissance; Red - Baroque; Orange - Classicist; Ochre – Gründerzeit; Yellow - 20th century)*

The oldest timbers known at the moment are from the roof of the tower of St. Rupert's church and date to 1160 [12]. Their place in the history of the building is unclear at the monument. The oldest roof structures can be found above religious buildings from around 1400 onwards, surviving roofs from secular buildings appear to begin at around 1500 (Fig. 5, 17).

For analytical purposes, however, not only the remaining examples but rather all roof structures are important. There are three groups:

Surviving roofs – structures handed down in their entirety, which can include different construction and renovation phases,

Transformed roofs – surviving structures, which have been partly or completely altered or covered over during attic conversions and are therefore no longer accessible,

Lost roofs – structures which were destroyed by new stories, war or demolition and are now only known from the archives.

Figure 5: *View through Griechengasse of the house complex Fleischmarkt 11, with what appears to be the oldest surviving roof structure in the historic centre, 2015 (BDA Liebich)*

Figure 6: *The badly damaged building Am Hof on 19 July 1946 (BDA Photo archive)*

4 TERMINOLOGY

A necessary precondition of the intensive analysis and the evaluation to come is the clarification of the technical terminology involved. The success of the project necessitates exact definitions at the beginning, whereby of course these depend on the state of research. A challenging factor in the case of research into historic roof structures are the very different terms and explanatory models traditionally used in different regions, which have to be brought together. A certain variety in synonyms and analytical models will unavoidably remain.

Unequivocal terms for constructive components, joints, construction types and roof forms (types) are necessary in the roof register. The present project has two aims in this regard: On the one hand, to work with the terminologies most recently employed, in order to guarantee the comparability of the results, and, on the other, their extension to include Austrian phenomena. Historic terminology is inescapably connected to regional building traditions and its discovery is part of the history of building technology. Meisel 2015 [9], which includes first synonyms for Eastern Austrian terms, is followed when naming individual construction parts. Joints and connections are portrayed in great detail in Eißing 2012 [4], which is a very good basis. Construction types also follow Meisel's basic system. Roof forms are named according to Koepf's "Bildwörterbuch der Architektur". Some terms for Viennese variations of roofs with digs ("Grabendächer") are taken from Friedl 1993 [5].

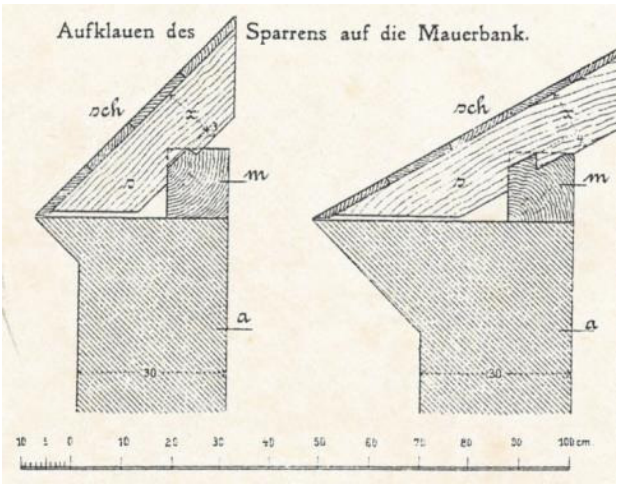

Figure 7: *Detailed drawing from Baudouin, Vienna 1906-1908, Tafel 10 / Reprint 1998, S.20 [1]*

5 ROOF COVERING

Roof form and roof covering play an important role, alongside construction type, in the study of roofs. There is a close relationship between form and function in every roof. Either the formal design or the intended introduction of technical innovations could play the leading role in an architectonic plan.

Knowledge about the original roof covering is important when interpreting the roof construction and the load for which it was built. Roof covering progresses historically from soft to hard coverings, that is from thatch through wood to tile and stone, sometimes to metal coverings, and finally to artificial materials such as fibre cement. Fireproof materials were compulsory as early as the 18th century in order to prevent city fires and are part of the origin of Viennese building regulations. No wooden roof coverings are known to have survived in the Vienna city centre to date, but they could survive under younger coverings, as an example from the 2nd district shows (Fig. 8). Archive photos of Naglergasse also illustrate the historical development of roof covering (Fig. 9). In them, Naglergasse 17 is still covered with wooden shingles everywhere apart from the edges of the roof, while the neighbouring building has a covering of tiles in the rectangular form known as the "Wiener Tasche".

Figure 8: *Detail of the tongue and groove wooden shingles, which have survived over a large area beneath a recent cement-asbestos covering. Haidgasse 6, 1020 Vienna, 2016 (BDA Liebich)*

Figure 9: *View of the roofscape of the buildings Naglergasse 15-21. In the centre of the picture is No. 17, scale photo 1940s (BDA Photo Archive)*

6 ROOF FORMS

In the historic centre of Vienna the surviving roof forms, themselves a product of the construction types used, can be divided into three basic types: saddleback, M-shaped and mansard roofs.

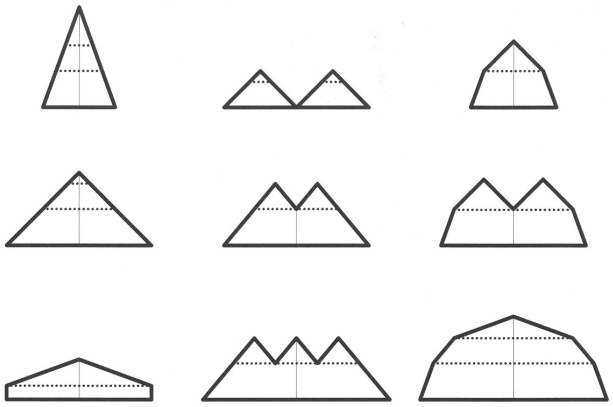

Figure 10: *Roof forms*

Left-hand column – saddleback roofs
Top: steep saddleback roofs, 50-70°
Centre: saddleback roofs, 40-50°
Bottom: flat saddleback roofs, 20-40°

Central column – dip roofs
Top: parallel roofs
Centre: simple M-shaped roof (Firstgrabendach)
Bottom: double M-shaped roof (Doppelfirstgrabendach)

Right-hand column – mansard roofs
Top: simple mansard roof
Centre: M-shaped mansard roof (Firstgrabenmansarddach)
Bottom: mansard roof with a triple slope

The simple saddleback roof is the most common type among the 1,400 objects surveyed. It crops up in all periods and can shelter very different constructions. Shed roofs can be seen as halved variants of this type.

In Vienna, as elsewhere, there is a basis reduction in roof pitch over time. The probably oldest roof includes angles of up to 70° (Fig. 17), while Baroque roofs have an average slope of 45°. Gründerzeit roofs with their purlin constructions can be pitched as little as 20°. Recent roof structures, which contribute to the restoration of the city's historic structure, are an exception. In such cases modern systems are employed to reconstruct the former roof shape. In a few rare cases, eclectic designs draw upon traditional steep roof forms.

The second group of roofs, with a "roof dip", is definitely not the same as the typical dip roofs (Grabendächer) of the burgher houses in the Inn-Salzach area (western Austria), which are always surrounded by a parapet and cannot be seen from street level [5]. The Viennese streetscape, by contrast, was marked by rows of narrow gable roofs, which then resembled dip roofs (Fig. 11, 12). Parallel roofs have almost completely disappeared today. They were destroyed during sieges or by fire or were replaced by new stories due to the court billeting system after 1563.

Two examples of this simple type are known at the moment. The house Naglergasse 21 has a parallel roof,

although the gables are hipped. The second example is Weihburggasse 16 with a parallel roof, which is in this case side-gabled. Here the two saddleback roofs are connected by a thin passageway, which includes a door enabling the maintenance of the roof dip. Dips parallel to the street also occur in the typically Viennese M-shaped roof (Fig. 10 central column, centre and bottom). M-shaped roofs can occur with a single dip or a pair of dips. The Old University is an example for such a double M-shaped roof with two dips (Fig. 2 on the far left). In most cases these roofs are hipped at the gable end.
The M-shaped mansard roof also belongs to the group of Viennese roofs with dips. In this case a M-shaped roof and a break of slope are combined. This was a type which appears to have been common in Vienna, but which is now only rarely preserved (Fig. 6).
The third group, that of mansard roofs, is not very common in Vienna's historic centre. It occurs in its simple form above very small buildings, in which case it was often historically living space. Larger objects often feature a dip in the upper part of the roof, which serves to reduce the interior space and the height of the ridge.
Only one example of a mansard roof with a triple slope (Fig. 10 right column, bottom) has been found to date, in the Herrengasse 9.

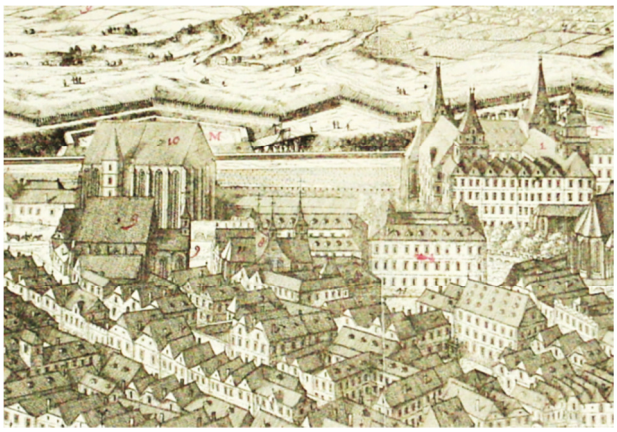

Figure 11: *The roofscape in the mid-17th century. View from St. Stephens westwards towards the Hofburg. Part of the bird's-eye view by Hoefnagel, in a version c. 1640*

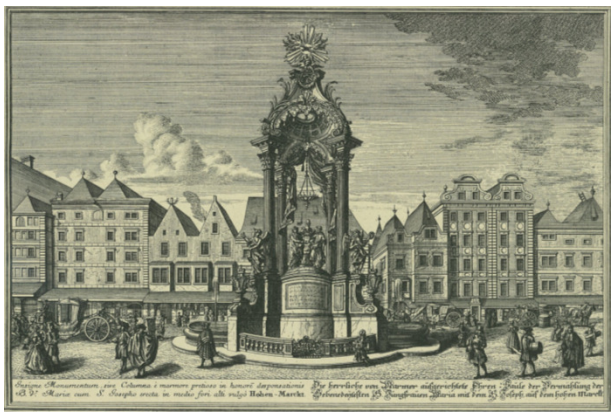

Figure 12: *House façades at Hoher Markt, engraving 1733, Salomon Kleiner: Das barocke Wien in Stichen 1700 - 1761, Reprint 1971*

7 CONSTRUCTION TYPES

A first overview of the construction types is possible with the help of the archive material gathered. The drawings shown here were prepared by different people, at different times and for different reasons. They will be exactly checked in the second project phase. Details of the joints are inadequately portrayed in almost all drawings, for example, despite the fact that these are an important part of the classification and dating of roof structures. The roofs shown have been chosen as typical examples in the history of building technology and include roofs, which have been preserved, as well as some which have been significantly changed or destroyed.
Four basic types of construction will be discussed initially here (7.1 – 7.4), in the knowledge that there are also many special and mixed forms.

7.1 RAFTER ROOFS WITHOUT TRUSS

Untrussed roofs, that is constructions without principal truss structures, occur above very small objects. These are likely to be the oldest constructions, as for example the buildings Am Gestade (Fig. 13, 14). Their state of preservation will be investigated soon, as they may have been completely replaced in the post-war period. The long sprockets / aisle rafters are worthy of note in both objects. They hint at later changes, such as roof extensions or new façades. Typical collar beam roofs covered the side wings of Kurrentgasse 6 (Fig. 15) and appear to include lap joints. These roofs could theoretically go back to the 17th century, but they were converted and partly demolished several years ago and can therefore no longer be re-examined. Another example of a large roof without a truss system is Löwelstraße 6 (Fig. 16), which dates somewhere between the High Baroque period and 1829.

7.2 RAFTER ROOFS WITH VERTICAL TRUSS

Standing roof trusses are very rare. They are some of the rare structures which survive form the period before the baroque building boom. To date, only one object is known with certainty. The steep roof at Fleischmarkt appears to have a single standing truss, each post having two braces connected to the tie beam. The row of king posts supports two longitudinal timbers. Carpentry joints are not shown in this drawing so that it is not possible to say how the roof actually worked. Long braces running parallel to the rafters are a typical indication of a very old roof structure. The roof is apparently still preserved and is clearly an important object in the current research phase. The very common double standing truss has only been found pre-dating the Baroque period so far. The example shown in Fig. 18 was chosen because lap joints appear to be visible. The construction history of Weihburggasse 16 as presently known points either to a date in the early 17th century or to 1822. An attic conversion thirty years ago also makes verification difficult, if not impossible, in this case. Double standing trusses experienced a brief return to popularity in the classicist period. They were built again or were still being built in early 19th century Vienna.

RAFTER ROOFS WITHOUT TRUSS

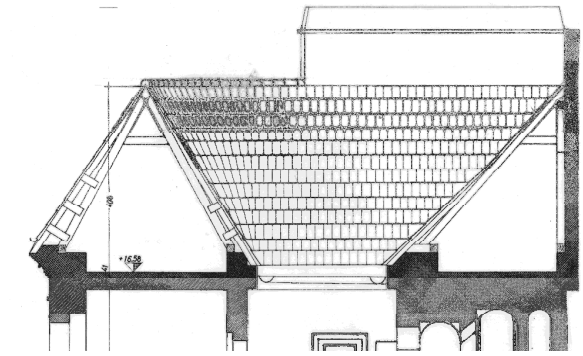

Figure 13: *Am Gestade 1, undated architectural drawing (BDA Plan archive, Inv.-Nr. 1535)*

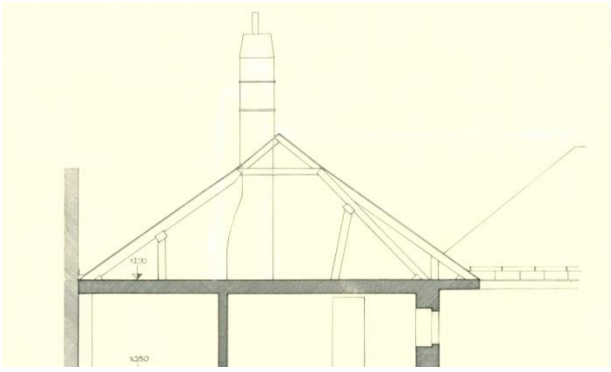

Figure 14: *Am Gestade 5, architectural drawing 1955 (BDA Plan archive, Inv.-Nr. 1352)*

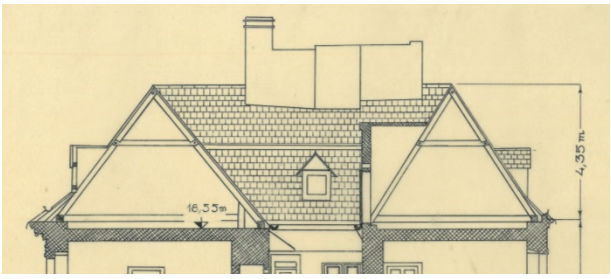

Figure 15: *Kurrentgasse 6, architectural drawing 1948 (BDA Plan archive, Inv.-Nr. 1663)*

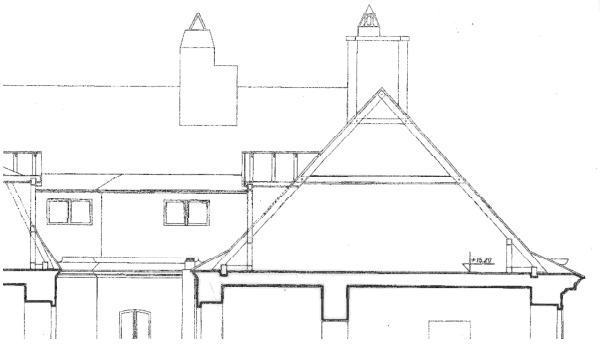

Figure 16: *Löwelstraße 6, undated architectural drawing prob. after 1960 (BDA Plan archive, Inv.-Nr. 2269)*

RAFTER ROOFS WITH VERTICAL TRUSS

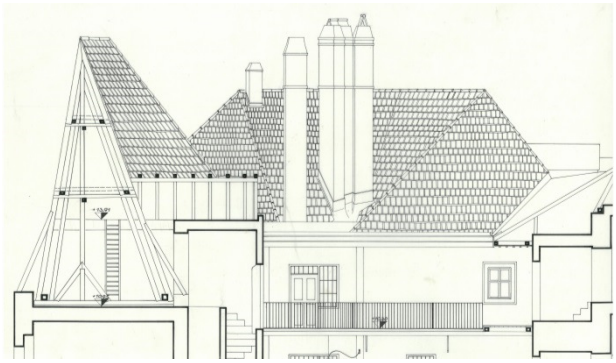

Figure 17: *Fleischmarkt 11, undated architectural drawing prob. after 1960 (BDA Plan archive, Inv.-Nr. 2581)*

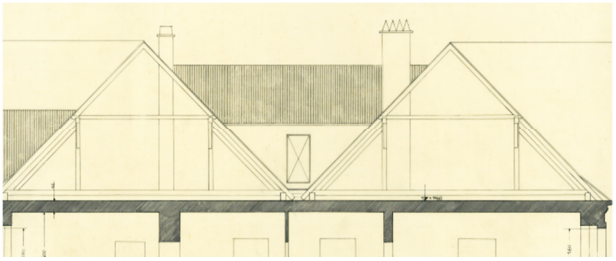

Figure 18: *Weihburggasse 16, architectural drawing 1953 (BDA Plan archive, Inv.-Nr. 2683)*

RAFTER ROOFS WITH INCLINED TRUSS

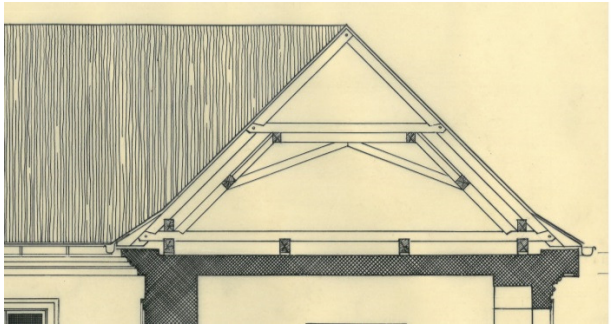

Figure 19: *Sonnenfelsgasse 17, architectural drawing 1952 (BDA Plan archive, Inv.-Nr. 1815)*

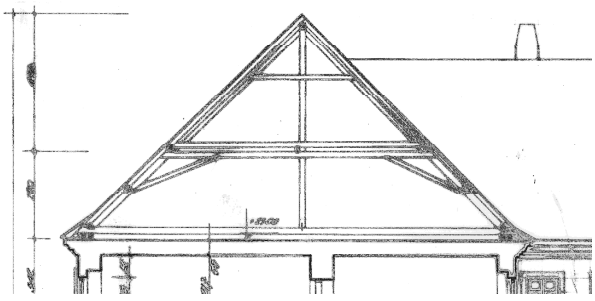

Figure 20: *Franziskanerplatz 5, Bauaufnahme 1959 (BDA Planarchiv, Inv.-Nr. 2552)*

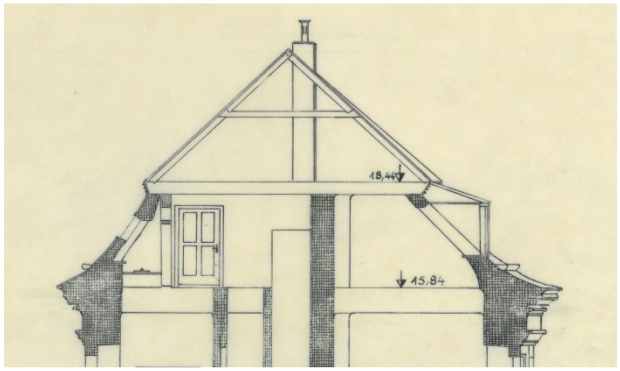

Figure 21: *Ledererhof 9, architectural drawing 1959 (BDA Plan archive, Inv.-Nr. 2552)*

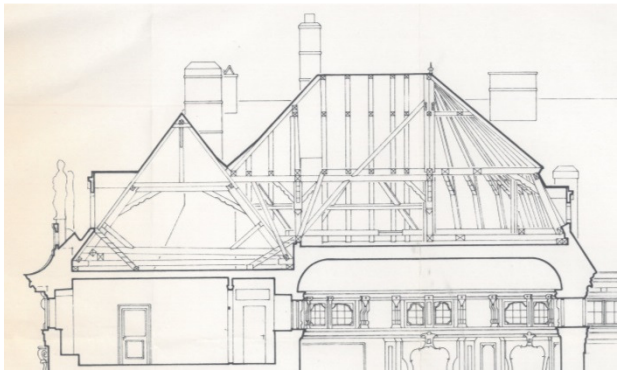

Figure 22: *Freyung 4, replacement plan 1987 (BDA Plan archive, Inv.-Nr. 11637)*

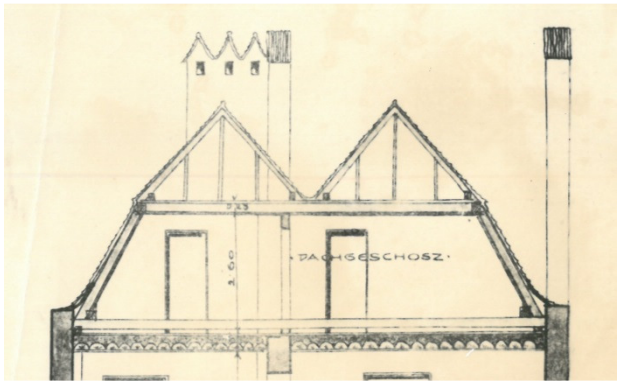

Figure 23: *Schönlaterngasse 6, application plan 1921(BDA Plan archive, Inv.-Nr. 3242)*

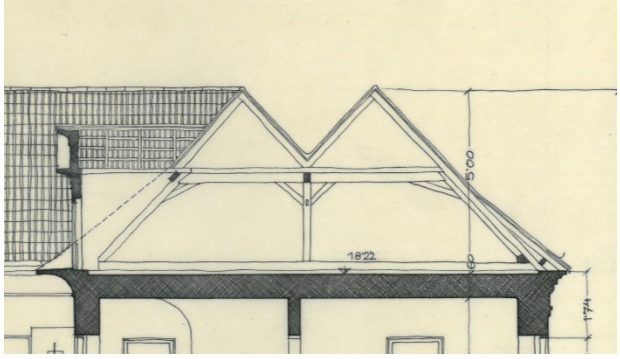

Figure 24: *Bäckerstraße 16, architectural drawing 1947(BDA Plan archive, Inv.-Nr. 1305)*

PURLIN ROOFS

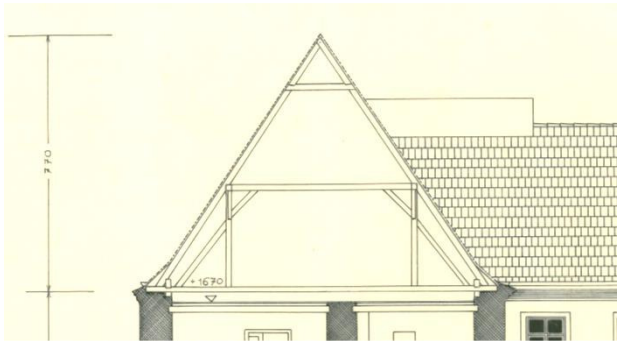

Figure 25: *Judengasse 11, architectural drawing 1949 (BDA Plan archive, Inv.-Nr. 2342)*

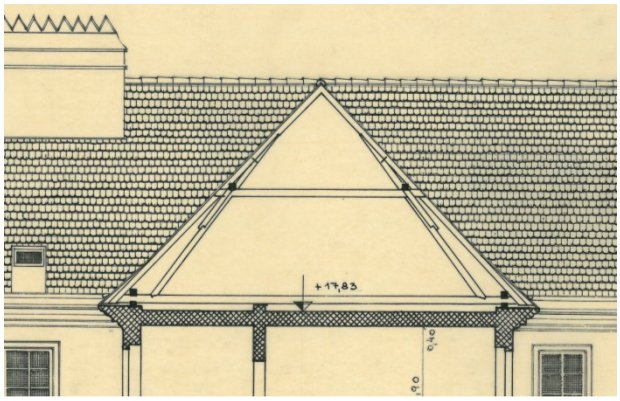

Figure 26: *Domgasse 4, architectural drawing 1953 (BDA Plan archive, Inv.-Nr. 2160)*

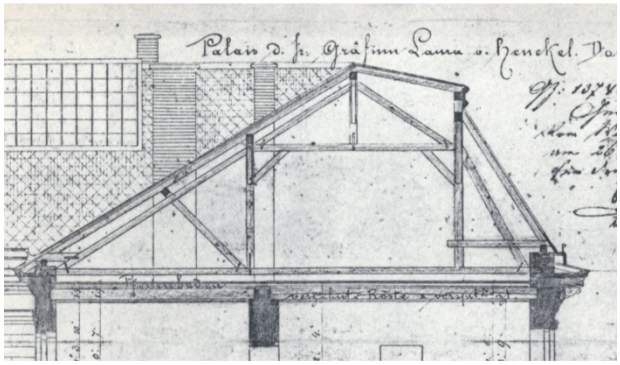

Figure 27: *Hegelgasse 1, undated plan prob. before 1918 (BDA Plan archive, Inv.-Nr. 2127)*

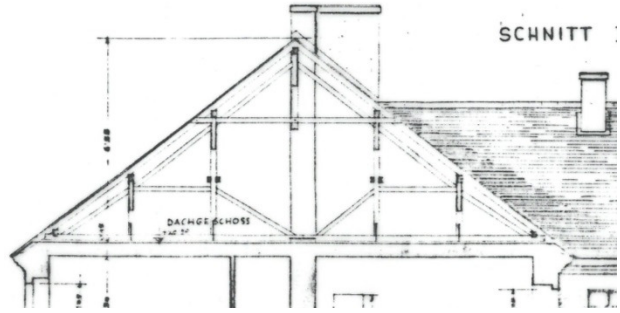

Figure 28: *Himmelpfortgasse 6 -8, survey plan 1949 (BDA Plan archive, Inv.-Nr. 27892)*

7.3 RAFTER ROOFS WITH INCLINED TRUSS

Roof structures with inclined trusses are very common in the historic city centre. They can be simple, but also very complex. When this construction began is a very important question, but the plan material gathered to date does not provide an answer. At Sonnenfelsgasse 17 this truss type appears to have been inserted into the roofs of the side wings secondarily (Fig. 19). The inclined truss is a considerable distance from the rafters. The apparently original simple collar rafter roof is connected to the collar and tie beams with lap joints and could therefore be much older. Present knowledge of the construction history cannot rule out a first phase at around 1600. The roofs have been subjected to conversion work since the 1980s, however.

The house Franziskanerplatz 5, on the other hand has a typically high rafter roof with inclined trusses in the lower part of the roof (Fig. 20). All three levels are connected by a central hanging post, which supports a ridge purlin. Structures of this type are common in the Baroque period and became increasingly sophisticated. The hanging posts were later erected in pairs in order to resist thrust and guarantee the symmetrical load transfer of the load. The position of the straining beam varies in the technical literature. It can anchor a central longitudinal timber or lie directly beneath the collar beam.

Mansard roofs also generally have inclined trusses in the lower part of the roof. Ledererhof 9 could also be seen as an untrussed roof with a break of slope, however, a constructive differentiation which is very new in Vienna (Fig. 21). Examples of characteristic simple mansard roofs are relatively infrequent. The roof structure at Freyung 4 is rare, but particularly representatively designed (Fig. 22).

The M-shaped mansard roof, which was already mentioned above, occurs in a few cases in Vienna, which are always side-gabled (Fig. 6). Only one example of a gable-ended roof of this type is known at the moment and it could in fact be an untrussed roof with a break of slope (Fig. 23). In this case, at Schönlaterngasse 6, the two upper rafter roofs are hipped. The history of the building tells us that the roof could date to before 1709 and that it was already subjected to conversion at the beginning of the 20th century. Yet the structure is largely preserved, as possibly the last of its type.

There are not only M-shaped mansard roofs with a break of slope, but, in a drawing of the house at Bäckerstraße 16, also a variant with continuous rafters at the same pitch. The outer form of the roof is disguised by the long sprockets, however. The roof presumably dates to the heightening of the building in 1712 and may remain unchanged.

7.4 PURLIN ROOFS

The exact definition of a purlin roof is a difficult matter in historical buildings research for three reasons: Firstly, because combined constructions have existed for a long time; secondly, because the plan material available often makes an exact classification very difficult; thirdly, because in building industry practice terms are often used in an undifferentiated fashion.

Purlin roof frames occur occasionally throughout the centuries. They can be combined with vertical (Fig. 25) or inclined trusses (Fig. 26). The two examples shown here probably date to the second half of the 18th century. Purlin roofs became the standard construction method in Vienna in the mid-19th century. They are the largest group of roof constructions in the 1st district. This is due above all to the Ringstraße project from 1860 onwards. At first construction methods were tested which aimed to save as much timber as possible, by resting the purlins on massive central and traverse walls, but this method did not catch on. Instead the use of complicated standing, hanging or strutted wooden trusses continued. In the historic centre these were often very steep, as they were expected to conform to the streetscape. In the Ringstraße zone, by contrast, there was a great deal of experimentation in form [7]. The visible side of the roof could be built in a pseudo-mansard form, for example, but with a straight slope at the rear side (Fig. 27). Despite the standardised construction activity employed then many variations of this type can still be found.

The research project covers roofs right into the 20th century i.e. it reaches for as long as wooden roof structures were built. The post-war period was another intensive construction phase (Fig. 28).

Figure 29: *Michaelerplatz 2, 2016 (BDA Liebich)*

Figure 30: *Michaelerplatz 4, 2016 (BDA Liebich)*

The normal erection of wooden roofs ended in the 1960s. From then on existing roofs were generally converted to full storeys or completely new rooftop storeys were added. Ultimately, the roof as an area of transition between outside and inside with all its technical and structural peculiarities comes to an end in urban architecture.

8 ROOF CONVERSIONS

The future use of roof areas is crucial in deciding whether or not the cultural heritage which wooden roof structures represent will have a future. The use of roof areas has always been an issue of course, but the extent of the transformation which this involves varies considerably (Fig. 29, 30). Historic pictures show roofs with many openings for light and transport purposes. They served storage areas or very simple living spaces, which had to submit to the special conditions roof areas brought with them. Modern conversions, on the other hand, transform a roof into a full storey, often on several levels. This is preceded by the demolition of the previous structure, thus amounting to a completely new roof. The arduous task of extending an existing roof is only undertaken if the object is listed. Then, a permeable roof covering resting on sloping timbers has to be transformed into a fully functional outer wall.

In past centuries the surface of the roof was intensively maintained. Old engravings repeatedly show ladders needed for this constant care (Fig. 12, right-hand side). These surfaces are still exposed to the elements today, but "intelligent" conversion systems aim to prevent damage in future. Ventilation, subsidiary layers, insulation, waterproofing, installations and fire protection material are installed below the skin of the roof. In historic roof structures this complicated series of layers is permeated by numerous constructive timbers and is only very rarely possible without damage at some point. Not only structural concerns but also statics, room height, circulation, wheelchair access, emergency exits, chimney cleaning, lighting and noise reduction all make demands of the substance, so that an up-to-date conversion compatible with conservation ultimately becomes impossible. The monuments service aims to hand on authentic roof structures to future generations. This involving upholding the exterior appearance of the object, preservation of the greater part of the roof structure in situ and of its living presence in the attic area, and also its actual purpose as a loadbearing construction.

Seventy per cent of roofs in the Vienna's city centre have now been subject to conversion. This has gone so far, that for certain periods only solitary roofs have survived unchanged. The work of classification now taking place means that many roof types are likely to be subdivided into further categories. Thus it is likely that some special constructions may have ceased to exist altogether.

That "continuous change" nevertheless has to respect the existing substance was an important part of the conference "The Charter of Venice – 50 Years on" [3]. The roof register now clearly shows that there is an urgent need for action.

9 CONCLUSIONS

The Vienna roof register is a milestone in research into historic buildings and will greatly improve our knowledge of Vienna's city centre.

For monuments professionals it will be an urgently needed basis for decisions aimed at developing a preservation strategy for roof structures.

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