

**University of West Hungary**

**Theses of the PhD dissertation**

**RENOVATION, REHABILITATION  
OF CHURCH TOWERS**

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Sopron

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# **RENOVATION, REHABILITATION OF CHURCH TOWERS**

## **I. Preliminaries and a short summary of the research task:**

In the second half of the past century on major part of the churches in Hungary absolutely no renovation work was done due to which the technical state of many churches deteriorated. Fast aging of the structures of church towers is especially obvious. After World War II some parts of the structures of the damaged churches were renovated unprofessionally during which valuable details perished and at some places even the shape of the wind-cap of the church tower was harshly changed. The renovation of church buildings cannot be put off for long the renovation of the churches of the strengthening Hungarian religions can be expected in great numbers in the near future. Even within the frame of the above the restoring of church towers belongs to the most compelling tasks.

In the course of the planning of the renovation besides the building structural, static and wood-protection requirements the regulations of preserving of monuments must almost always be adhered to. But the renovation of church towers is a very special area of monument-renovations which cannot be always solved with the research and planning methods and building procedures experienced in the preservation of monuments. The first task of the conservation of the tower is the renovation of the wind-cap. Professional literature on the special questions of the renovation of church towers is not available. Planning and carrying out the renovation of church towers according to the expectations of the state-of-the-art preservation of monuments and at the same time at the technical level of today can only be done by knowing the history of styles of tower wind-caps, the cap-forms and the morphological relationships of composite cap-types and their structural attachments. Moreover it is indispensable to explore the relationships between the structural formation of steepe types, the load-bearing structures and additional structures, the elaboration of the special methods of monument-renovation of church tower wind-caps and to suit its practice to the building technology of renovation and implementation.

The thesis shall survey the architectural historical connections of the formation and the development of church towers and wind-caps with a special highlight on Hungarian characteristics. It shall define the principles of typological classification of national helm roof types and shall make a classification. Besides outlining steepe structures it shall survey the dynamic relationships of the formation of helm roofs of wood structure and shall analyze the formal, structural and functional relations of these structures.

The thesis shall elaborate on the methods of preserving, reconstructing and rehabilitating the church steepes built of wood bearing structures - according to the regulations and practice of the Hungarian preservation of monuments. Finally it shall present their practical importance through realized examples and shall make the most important conclusions which also prove the importance of the above points.

By the formal and structural-operational analysis of the introduced examples on the basis of the classification of steepes by the bracing the structural categories: cupola and cap roofs, traditional roof structures, rhomboid roofs, angled strutted helm roofs, multi-storey helm roofs with braced skeleton-structure by the storeys, central towers and ridge turrets give the definition and interpretation of church tower structures.

The basic aim of the thesis is to contribute to the increase of the effectiveness of building diagnostics and planning activities (from surveying through approval as far as preparing working drawings) in connection with the renovation of church helm roofs made of wood and to increase the successfulness based on scientific knowledge and methods, and to broaden the theoretical bases of the construction works of the renovation.

In the course of the survey a morphological analysis was done based on my own on-site survey and photographical documentation and a later drawing illustration on the topic of the typology of church helm roofs in Hungary. Classification was done by utilizing 61 pictures of my own survey and a further 13 from referred literature. Out of the 25 actual helm roof structures of the ones introduced for the definition of structure categories 11 are my own survey plans prepared for church helm roof renovations during my expert work. The closing chapter introduces the lessons of case-studies of 14 church helm roof rehabilitations and the conclusions drawn from them justify the usability of the results of the examinations and methods.

## **II. The methods of the examinations:**

The survey was conducted by the examination of the European and Hungarian history of the formation and development of church towers, the revelation of specific facts, the collection, organisation and evaluating analysis of the national and international scientific and professional literature. Comparative morphological analysis in the course of the typological classification of Hungarian church helm roofs. Structure-operation analysis, functional survey of the building and support structures,

complexity examination, relation analysis of structural elements and their relationships in respect of the structures of the church helm roofs. The analysis of the terminology of reconstruction and the transposition of the known recommendations onto the renovation and reconstruction of church helm roofs - as a special case of monument renovations. The analysis of case-studies (the major part of which has been realised) taking into consideration utilization.

### **III. Theses:**

Thesis No. 1: The formation and development of church towers in the course of the change of its function

The tower of a church is a symbol first of all. In the course of its formation and development structural or functional points did not play such important role but it is rather the result of the expression of mysticism and materialistic representation as a formal means.

The tower as a separated matter from the building of the church first appears in the 5<sup>th</sup> century above the antechamber (narthex) of basilicas built in Syria. In Europe during the Carolingian-age the tower first appears on the entrance structures of the western elevation of the churches, on the Westwerk, as a separate element of matter formation. By the decline of the multi-functionality of the Westwerk in the Roman age the towers gain a defined function their purpose become independent, their formation specialized. The tower-types are differentiated: the western tower, the tribune tower, the central tower, the staircase tower, the entrance tower and the steeple. In the Gothic art towers become an independent part of the church their aim is to increase verticality which is achieved by increasing the absolute height of the tower and the structural and plastic proportioning of the mass of the tower. During the Renaissance art the rules of constructing the composite steepe form are defined and by the French-Swiss cap steepe its classical proportions are formed. In case of Baroque churches the formation of the cap of the tower is subordinated to the formation of the elevation. Composite imperial domes and padded Baroque caps become the determinant part of the elevation of the churches due primarily to their unbelievably rich formal variety. From the 19<sup>th</sup> century church towers practically do not have any liturgical role. Their function - with the exception of the steeples - ceases, the tower becomes an inseparable symbol from the church.

## Thesis No. 2: Typology of church tower caps

### Thesis No. 2.a : Historical architectural analysis of the forms of church tower caps

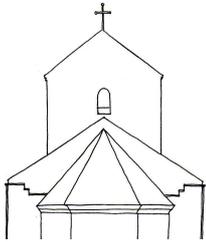
The development of the forms of tower caps - from the very simple forms to the multiple compound forms - is a more and more independent process from style ages. Simple breach roofs, steepes and conical roofs of the Roman and Gothic can definitely be attached to the style. The Renaissance besides the cupola and cap roofs often uses and further develops the steepe roofs of the Gothic (e.g. the four-pinnacle pinpointed steepes in Transylvania). The Baroque besides the padded caps wantonly changes the proportions of the French-Swiss roofs formed in the Renaissance and also makes the domes of the compound imperial domes more plastic and places volute scrolls on the lanterns. On the towers of neoclassical churches besides the steepes, cupola and cap roofs - just in Hungary and almost surely as the effect of the abolishment of the prohibition of tower building (1786) - more and more often multiple-compound imperial domes or French-Swiss cap roofs are built.

### Thesis No. 2.b: Formal-structural development history of church tower caps

The development of the forms of church towers was defined by the constructional component, constructional technology and building physical characteristics of the available shell-materials. The saddle roof, broach roof, steepe or conical form and steepness of the roofs of the simple caps limited by planes of the medieval (Roman and Gothic) towers was formed by tile, slate and shingle roofing. The roofing of the Renaissance cupola and cap roofs, even the French-Swiss caps became possible by the development of coppersmith craft and the improvement of manufacturing sheet tin. Zink sheets appearing in the beginning of the 1800s revolutionized tinning and made the formation of quite complex, three-dimensional curves possible. For the formation of load-bearing structures adjusting to the form several known roofing and steepe constructions were applicable.

## Forms of church towers

Saddle roof



Sárkeresztúr

Broach roof



Grábóc

Rhomboid roof



Hévíz

Steeple



Zsibrik

Conical roof



Szentbalázs

Cupola



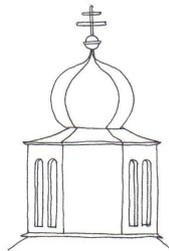
Dunakömlőd

Cap roof



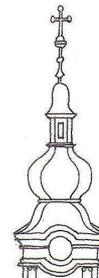
Kéthely

Imperial dome



Pápóc

French-Swiss cap roof



Bonyhádvarasd

Compound imperial dome



Nagydobsza

Padded Baroque wind cap



Ságvár

Classicizing wind cap



Tizsakécske

### Thesis No. 3: Structural terminology of the wind-caps of church towers

The tower of a church - which is a symbol primarily - is constructed on the basis of formal aspects. The load-bearing structure, the timberwork of the roof, the load-bearing framework supporting the given form and its different versions of the wind-cap are usually definitely form-specific but are never the result of a certain structure-development. Their bracing is defined by their sizes, proportions and forms that is why their classification is beneficial to be made on basis of the method of bracing - as the most essential characteristic of the structure.

Thesis No. 3.a: The cupola and cap roofs which are rigid and not too steep by themselves are erected by arch templates supporting each other. From the point of view of their formation they are simple roof structures not even tower roof structures.

Thesis No. 3.b: Traditional roof structures are the roof structures of the saddle roofs, broach roofs and steepes with relatively low steepness of the church towers. Purlins are supporting the rafting at about the middle which is supported by king posts. Neither tower caps are the traditional roof structures.

Thesis No. 3.c: Rhomboid roofs are special forms of the traditional roof structures (still not tower roofs). They are such lowered roof structures which lean on the four corners of the tower and on the points of the four verge-boardings. Due to the formation pointing sills and triangular shaped verge-boardings of the four sides are erected by the roof structure.

Thesis No. 3.d: Angled struttet helm roofs are such steep and high tower cap structures where the central post of the roof, the king post, is supported by angled struts. The height of the helm roof is limited by the rigidity depending on the support of the king post.

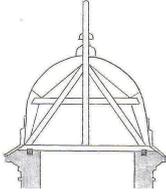
Thesis No. 3.e: The central body constructed by four or eight skeleton posts of the multi-storey helm roofs with braced skeleton-structure by the storeys are braced by a lower and an upper main beam cross in the horizontal plane or a beam grid or sometimes even an interior supporting cross. The skeleton-structure in its own plane is most often braced by diagonal braces or angled bars sometimes by filling beams built in horizontally.

Thesis No. 3.f: Tower structures of engineering character are quite grandiose in size these tower roofs can even be higher than 20 m formed by a rigid beam-structure in their own plane that is braced by beam-grids or beam crosses built-in every 3-5 meters in the horizontal plane. Their junctions are most often made by dimensioned engineering timber joints.

Thesis No. 3.g: Central towers and ridge turrets form a separate group due to their connection to the building of the church or to the roof of the church. Central towers lean on the crossing of the nave and the aisle, on the centre while ridge turrets are small towers situated on the ridge.

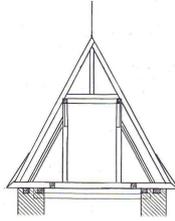
# Steepe structures

Cupola roof



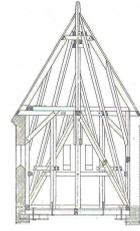
Darázs

Traditional roof structure



Mecseknádasd

Rhomboid roof



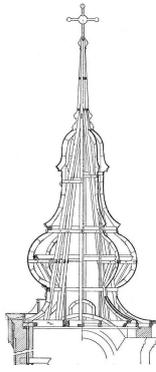
Kövegy

Angled strutted helm roof



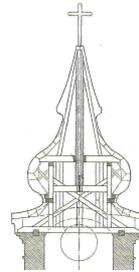
Kisharsány

Angled strutted helm roof



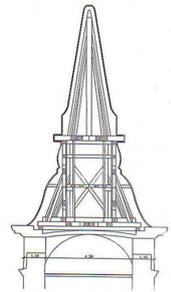
roof

Skeleton structured helm roof



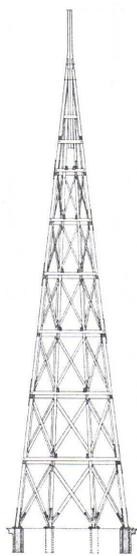
Mindszentgodisa

Skeleton structured helm roof

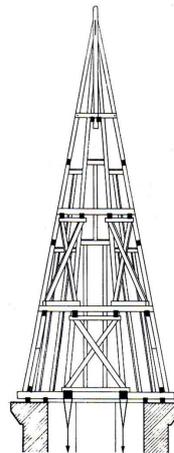


Kunszentmiklós

Steepe of Otzen-system



Steepe of Moller-system



Thesis No. 4: The constructional components, the outer shell (the roofing) and the load-bearing framework (the timber framework of the wind-cap) form an organic unit. Their obsolescence, defect and damage are a mutual chain of processes generating each other.

Thesis No. 4.a: The most critical parts of the steepe structure  
The thin structural elements, the boars of the shell and the supporting arch templates which do not suite bearing forces in case of putrefaction or damage by insects even by small degree (many times even by 1 cm). Structural elements directly being in connection with the brick tower that can only very slowly or cannot dry out at all due to the soaking-in of the eaves or to the connection with the soaked walls suffer serous putrefaction often spreading to the whole cross-section. Timber joints of roof structures made of timber framework. Infiltrating rainwater is collecting in the pin-holes, skew notches but even in the covered parts of the halving and the coggings and the joint starts to be destroyed from the inside.

Thesis No. 4. b: The damage of the wind-cap  
The steepe structure is soaking-in due to the damage of the shell → the soaked timber is attacked by fungus and insects → structural elements having higher moisture content than at air-dry state suffer permanent deformation in a greater degree than it is allowed → due to the change in the form the shell will close even less and as a consequence the degree of soaking-in will be even higher → as the effect of the biological pests the remaining undamaged cross-section is reduced on the permanently wet structural elements and the rigidity of the timber also decreases → the steepe structure starts to decay very quickly.

Thesis No. 5: Suggested solutions for the renovation of church tower wind-caps of monuments - illustrated by accomplished examples.

Thesis No. 5.a: The conservation of the wind-cap and the steepe by smaller repairs of the shell, the supplement of the damaged or defective elements and the terminating-preventing timber-protection of the still undamaged or slightly damaged timber of the steepe structure.

Thesis No. 5.b: The conservation of the timber framework of the wind-cap in good condition and the tower by the repair of the shell and perhaps by its change to equivalent of the original material and formation.

Thesis No. 5.c: The complete change of the totally defective shell and the seriously damaged steepe structure by an exact renovation which is identical

to the original and is based on the monument-survey of the still existing structures.

Thesis No. 5.d: Reconstruction of demolished, destroyed tower caps according to plans prepared on the basis of authentic documents that are justified to be identical in form and in structure to the original formation.

#### **IV. Utilization possibilities of the results of the thesis:**

The completed work is to serve the utilization of the theoretical knowledge in practice and the stress on the importance of the theoretical conclusions drawn from practical experiences. The main aim of the thesis is the utilization of the received results and the verification of them by their usefulness proved in practice.

To experts working in the area of the renovation of church towers

- the analysis of formal-structural development of Hungarian church towers and their different characteristics from those of Europe could invoke aid in their architectural historical research in the course of the renovation of tower caps;
- the typological classification of Hungarian church tower caps could be one of the basic data of monument exploration;
- the large number of constructions presented in the formal-structural classification of the tower-cap structures completed with detail-solutions could help the renovation of church towers in the course of the survey of its skeleton structure, static inspection and diagnostics. But at the same time it can give example to the complete reconstruction of demolished, destroyed tower caps or to the structural planning of the caps of new church buildings;
- presented case-studies and experiences learnt from them could help to understand the historical message of these structures and through this could aid their authentic preservation and could also help to save and to carry on the belief that was symbolically constantly delivered by church towers through the centuries.

## **V. Publications in the topic of the thesis:**

- Roof structures (a chapter of the working papers of the Constructional technical knowledge of the vocational training of constructional supervisors, Ministry of Agriculture and Regional Development, 2001)
- Tibor Bakó, Zoltán Lajtai: the renovation of the catholic church at Alsónána
- Tibor Bakó, Jenő Erb: the renovation of the evangelical church at Hidas
- Tibor Bakó: expert opinion on the renovation of the tower structure of the Calvinist church at Homokszentgyörgy
- Tibor Bakó, Jenő Erb, András Kis Bogdán, Attila Solymos: the renovation and strengthening of the tower structure and the circular balcony at bell-level of the Calvinist church at Kunszent-miklós
- Tibor Bakó, Attila Széll: the renovation of the tower and roof structure of the Roman Catholic church at Mindszentgodisa
- Tibor Bakó, Árpád Orosz: the renovation of the tower and the elevation of the Xavér Greek Catholic church at Pécs
- Tibor Bakó: expert opinion on the renovation of the tower and roof structure of the Calvinist church at Pécsvárad
- Tibor Bakó, Gábor Freivogel, Dr. András Meskó: the renovation of the Calvinist church at Túrony
- Tibor Bakó, Ildikó Mersits: the renovation of the roof structure of the evangelical church at Zsibrik
- Tibor Bakó: the renovation of the roof and the timbered ceiling of St. Stephan chapel at Mecseknádasd
- Tibor Bakó, Tibor Egyed: the renovation of the roof structure and the elevation of the Calvinist church at Ságvár
- Tibor Bakó: expert opinion on the renovation of the roof structure of the Roman Catholic church at Szentbalázs
- Tibor Bakó: expert opinion on the renovation of the tower of the Roman Catholic church at Bonyhádvarasd
- Tibor Bakó: expert opinion on the renovation of the roof structure of the Calvinist church at Nagypall
- Tibor Bakó, László Földes: the renovation of the roof structure of the evangelical church at Bátaapát
- Tibor Bakó: expert opinion on the renovation of the roof structure of the Calvinist church at Nagydobsza

