

# STANDARD REPAIR DETAILS FOR HISTORIC ROOF STRUCTURES ACCOUNTING SUPPORT DAMAGE AND MOUNTING SITUATION

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**ABSTRACT:** In literature, which deals with the rehabilitation of historic structures, historical wood structures and their damage are fully described. With regard to the amount of structural types and influencing factors it is subsequently specified that no general repair recommendations can be given. A systematic approach is missing and solutions are limited to repair-only connections, ignoring mounting situations with their fixed points. The essence of the presented work is a mapping table, which combines 11 types of damage and 8 mounting situations to 80 damage situations and assigns these to 51 standard repair details. Thus, the presented study supports the structural engineer in the systematic repair of supports. It helps with the targeted detection of damage situations and offers concrete solutions in the form of a standard repair catalog, rated in constructive, historic preservation and economic perspectives.

**KEY WORDS:** cultural heritage, timber constructions, historic roof structures, baroque, mounting situation

## 1 INTRODUCTION

The development of applicable standards in general for the structural repair in heritage conservation is not possible. The large number of different structures, building materials and geometries indicates the individual character of these buildings. In particular, this will protect them worth as representatives of past epochs. For example, the so-called “liegende Stuhlkonstruktionen” (lying chair constructions) with pentagonal joist, compression members, and mostly cast-iron fasteners will be a characteristic structure of the baroque period [1]. It enables architecture with ornate and therefore heavy plaster blankets over large spans, which frequently occur in southern Germany in religious buildings in the 17th and 18th centuries [2].

The high proportion of those baroque church roof structures with similar versions and damage symptoms was the intention, to develop a special standard repair catalog. Repair suggestions in handbooks etc. reflect today's point of view. Mostly, they cover only the pure

timber joint without considering the mounting situation. Therefore, the aim of this work was the development of catalog with standard repair details, taking into account the specific mounting situation (Figure 1). In addition to geometrical parameters, the high requirements on listed heritage buildings have been respected.

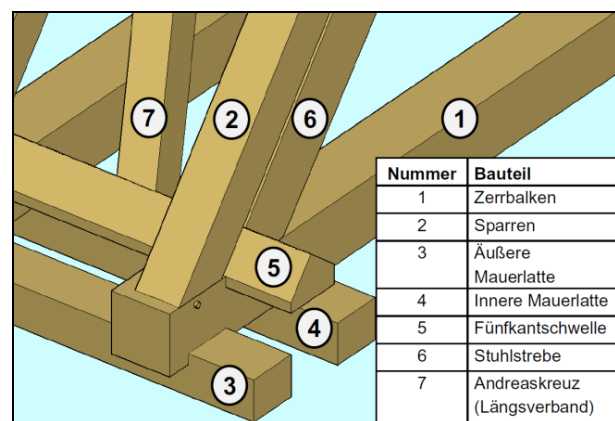


Figure 1: Schematic drawing of an investigated support

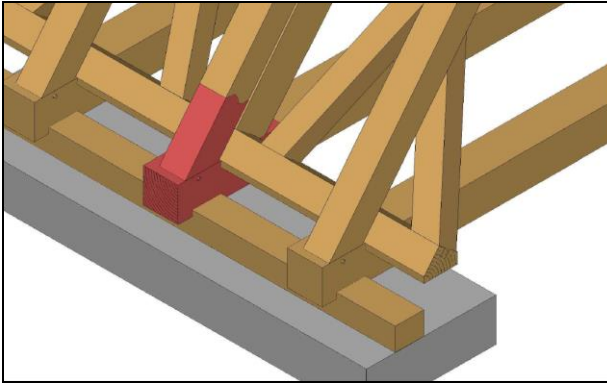
## 2 STANDARD REPAIR DETAILS

The definition of few damage areas on the components is sufficient to find a repair solution. Within these areas, the expansion of damage is irrelevant, because it has no effect on the procedure. The damage areas of the components can be classified into 11 frequent types of damage on the support of the roof structure (Figure 2).

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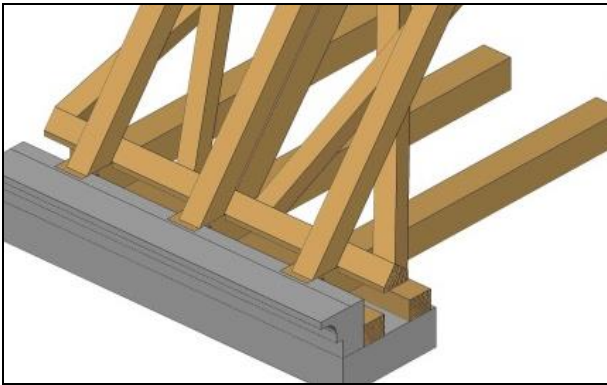
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**Figure 2:** Example of investigated damage types

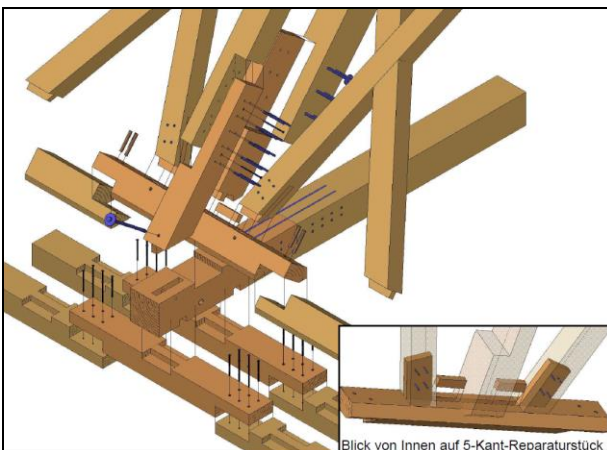
The mounting situation during the repair work is a very important parameter. For example, the existence of a mold is an essential criterion, how to repair a roof support (Figure 3). The investigated eleven damage types in eight mounting situations were combined into 80 damage situations and then analyzed one-by-one [3].



**Figure 3:** Drawing of a base point with a moulding

### 3 RESULTS

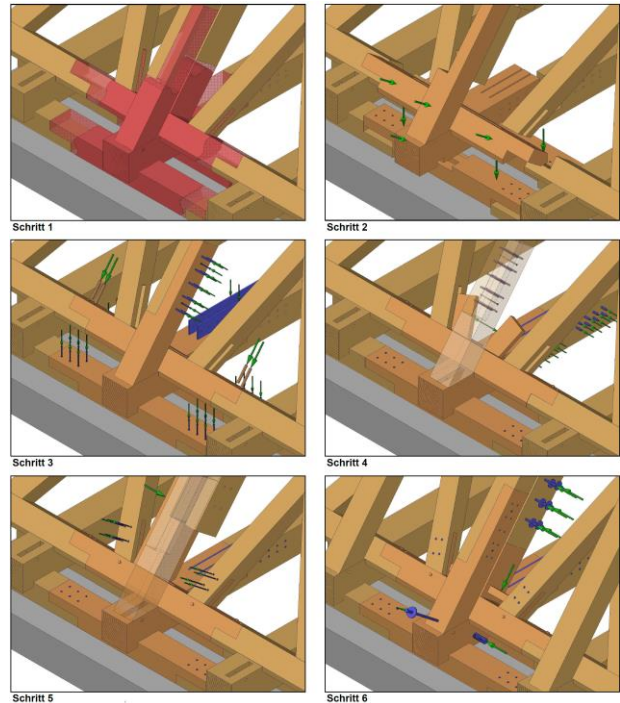
The catalog of standard repair details includes 51 different repair suggestions, dependent on the mounting situation and the type of damage encountered. An example is shown in Figure 4.



**Figure 4:** Drawing of a complex repair detail

For every repair detail, a visual guidance have been developed (Figure 5) to give the carpenters an advice, how to do it. For some situations, there are several

options to choose from and most of the suggestions are “backward compatible”. This means that - for example - the details for replacing the outer sole plate can also be applied for the replacement of the inner sole plate due to their better “reachability” and decreased difficulty level. Every repair detail was extensive planned and evaluated.



**Figure 5:** Visual “mounting guide” for one damaged support

### 4 CONCLUSIONS

In literature, the different roof constructions, the carpentry joints, timber damages and the possibilities for modeling of historical connections and structures are discussed in detail. However, with regard to repair suggestions, the authors make only general statements. Solving approaches are limited to a few repair examples. Thus, the present study supports the structural engineer in the systematic repair of roof supports. It is very helpful providing targeted damage identification and offers precise solutions in the form of a standard repair catalog, ranking decision aspects of construction, historic preservation and economic perspectives.

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