

Wood Corrosion in Historic Roof Constructions: Developing and Assessing of Methods to reduce and prevent Damages

Concise Version of the Report

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1. Goals and scope of the project

Since 1942 nearly all wooden roof constructions of churches and palaces and other large buildings in the „German Reich“ were treated with flame retardants based on salts. Many constructions were treated with flame retardants and/ or wood preservatives later on, too. About two thirds of these constructions are affected by acute or latent damages caused by these salt treatments.

During the last 25 years numerous buildings were refurbished but the effectiveness of different chemical methods to baulk the wood corrosion has not been proofed.

Background of the project have been the results of the research „Wood Corrosion in Historical Roof Constructions. Ascertaining and Cassifying the Extent of Damage in Saxony-Anhalt. Developing and Assessing a Rapid Test Procedure (MATE)“, finished in 2010. Now existing methods of supressing the wood corrosion (e. g. masking, neutralisation) were comparatively evaluated. New methods were developed and tested.

Starting point have been the physical and chemical processes which are affecting the surface of the wood. The salts which were employed as flame retardants, ammonium phosphate, fluoride, sulphate and natrium, are hygroscopic. On the one hand the damages are caused by the crystallisation pressure, when the (natrium) salt takes a lot of water from the surrounding air, on the other hand especially ammonium sulphate combines with the water to sulphuric acid.

Laboratory and on-site tests considered the different kinds of wood, the age of the wood, the surrounding climate and the different salts. From all objects samples were taken and tested to flame retardants and wood preservatives.

2. Selecting objects

17 objects in Germany, churches, palaces and town halls, were investigated. Since 1990 most of them had been refurbished by using different methods of baulking the wood corrosion. On-site the building situation was documented, samples from the wood surfaces were taken, climatic data were collected and evaluated. The wood samples were analysed to flame retardant salts and wood preservatives.

3. Laboratory analysis and tests

It was tried to reproduce the damage processes in the laboratory which was only partly successful because the chemical reactions are running very slowly and need a lot of time. Therefore it is understandable that the problem of wood corrosion induced by flame retardant salts applied 70 years ago became visible during the last 20 years and not earlier.

It is to consider that sulphate and natrium are more dangerous than phosphate and fluorid. Flame retardants based on sulphate and natrium seem to have been used as substitutes when phosphate and fluorid were not available. If the surrounding climate offers a high humidity the damages are more heavy than in dryer surroundings. Therefore it is necessary to know the salts in the wood and the climate in the roof in order to forecast the development of the damages.

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4. Evaluation of different methods of baulking the wood corrosion

The results of tests of cleaning and coating the wood surface and buffering the humidity on the surface were documented and evaluated. New methods of damage removal were developed.

Usefull are methods of dry cleaning by vacuum cleaner and by special brush grinding machines.

Washing methods worked quite well but should only be used if further steps are possible.

Otherwise the water could mobilise the salts from deeper layers in the wood. Constructions with acute damages which only had been cleaned showed ten years after new damages.

Good results showed constructions where after cleaning the surface was coated with compounds based on polyacrylate. Buffer agents which were applied in order to stabilise the humidity on the wood surface did not work longer than about 10 years.

A new approach is to change the salts into inert compounds using barium acetate.

Very well worked tests with compresses to put out the salt from the wood, a method which is used in the field of stone preservation since a longer time. Both new methods are to be tested in a large scale.

5. Recommendations for the treatment of roof constructions affected by wood corrosion

With the experiences of the on-site tests it is possible to derive some general recommendations for the treatment of roof constructions which are affected by wood corrosion. First it is necessary to take a mixed sample from the surface of the wood construction and to detect flame retardant salts (sulphate, phosphate, fluorid, natrium) and wood preservatives. It is recommended to collect climate data for one year or more before planning further steps. If other measures (repair) are planned it is recommended to clean constructions with latent damages before starting work to avoid dust contaminated with salts and wood preservatives. Acute damaged constructions should be cleaned; the surfaces can be coated with substances based on polyacrylate (conserving method) or with barium acetate in order to change the salts into inert compounds, or the salts are removed using compresses which is upto now the only real curative method.