

## Study on the glued joints of historical glued laminated timber

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### 1. Introduction

At the beginning of the production of glued laminated timber in Germany in the early 20th century casein glue was mainly used for the glued joints. Since this glue (main components: casein and calcium hydroxide) has a limited resistance against moisture an alteration of the glued joints due to climatic and chemical exposure can appear.

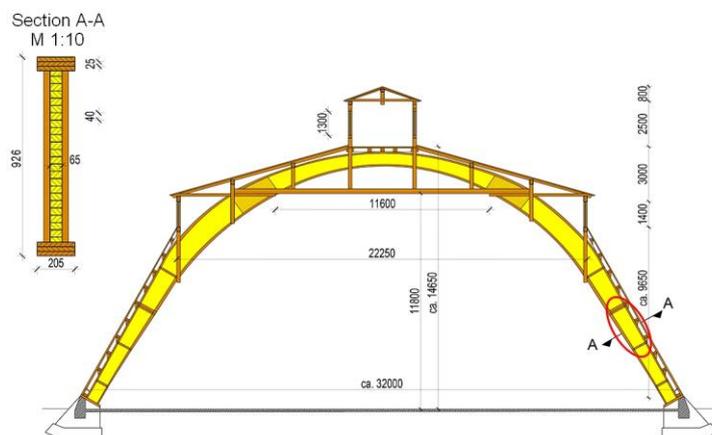
Warehouses for potassium salt are showing this problem in particular. The accumulated salt could diffuse into the wood structure due to variation of the climate and the wood moisture. There a chemical and mechanical destruction of the wooden structure takes place. This process is also called maceration.

### 2. Study on the glued joints

#### 2.1 Object and methods of the study

The studies have been carried out on specimen, which were taken from the timber structure of a warehouse for potassium salt (see Fig. 1). The warehouse was constructed in 1912 with the help of the Hetzer construction method. At the time of the studies the glued joints were nearly 100 years old (see [1]).

Preliminary surveys on the shear strength of the glued joints were carried out according to EN 392:1996 [2]. The determination of the remaining strength of the glued joints as well as the evaluation of the durability of the casein glue under long-term exposure to the potassium salt were the main objectives of this studies. For this purpose compression shear tests and the assessment of the fiber fracture ratio were executed.



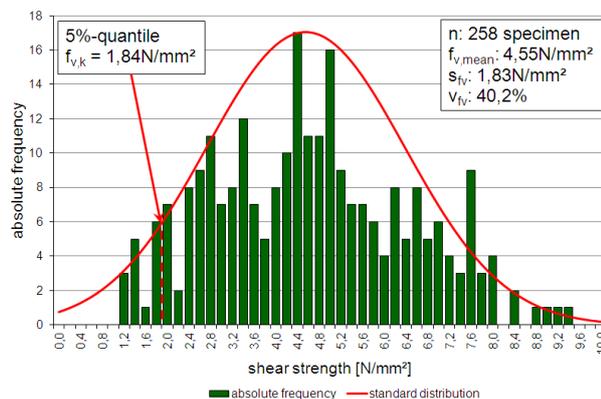
**Fig. 1:** View on the timber construction; the surveyed area is marked red

## 2.2 Results of the studies

The specimen showed clearly visible signs of maceration on their surface. This included amongst



**Fig. 2:** crystalline sediments in the glued joints



**Fig. 3:** distribution of the shear strength

others a greyish brown discoloration as well as the defibration of the wood structure near the surface. The glued joints on the chords were partially open and coated with crystalline sediments (see Fig. 2).

The shear strength of the glued joints varied between 1,1...9,4 N/mm<sup>2</sup>. The relatively large span width of 8,3 N/mm<sup>2</sup> is also confirmed by the variation coefficient with a value of 40,2%. The 5%-quantile of the shear strength measured 1,84 N/mm<sup>2</sup>.

The average shear strength was determined with a value of 4,3 N/mm<sup>2</sup> (chords) and 4,9 N/mm<sup>2</sup> (web). The average fiber fracture ratio measured 59%.

A comparison of the results with the data of directives of the use of casein glue in the production of wooden aircrafts of the 1930s and 1950s revealed, that the average shear strength of the specimen corresponds approximately with the listed minimum strength of (5,1...5,5) N/mm<sup>2</sup> (see [3] & [4])

applies also in the present case after nearly 100 years of exposure to moisture and potassium salt. Also, the directives for the construction of wooden aircrafts from the 1930s and 1950s (see [3] & [4]) are applicable for the assessment and evaluation of historical casein glue joints.

## 3. Conclusions

Further studies concerning the assessment and evaluation of historical glued laminated timber structures are planned. Studies on casein glue joints, which have been prepared under laboratory conditions have already proven that the efficiency of casein glue reaches that of modern adhesives.

The results of the study are showing clearly, that the casein glue joints of historical glued laminated timber are highly durable. This

## 4. References

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