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## **PROPERTIES OF CLAY PLASTER FOR THE FIRE DESIGN OF TIMBER STRUCTURES**

*Research project of Johanna Liblik is dealing with fire technical properties of clay plasters. Johanna is a master student at Tallinn University of Technology and a guest researcher at SP Wood Technology.*

### **Background**

Sustainable and energy conscious buildings with healthy and recyclable materials are experiencing a renaissance. Clay, being of the oldest building materials on earth, has excellent vapour permeability and good hygroscopic qualities which regulate the indoor climate. Clay plaster exhibits high capillary conductivity and works perfectly with timber buildings. For designers and architects clay plasters are very flexible and attractive materials.

Clay plasters are often overlooked or even purposely ignored in the repair and conservation of historic buildings. The reasons for this are partly a lack of understanding about the technical qualities of clay including fire properties. It is vital for both the technical performance and the integrity and character of historic buildings that clay plasters and renders are respected, preserved appropriately and repaired where necessary with authentic materials. It is to be hoped that, in the not-too-distant future, clay technology will, once again, become a major part of the preservation of our historic building heritage.

### **Clay plaster**

The described project deals with determination of fire properties of clay plaster as protection provided for timber structures.

Clay plaster consists of clay, sand, silt, additives and water. Properties of plaster are influenced by the different ratios of components, type of clay, the grain size distribution of sand, water content, additives and method of preparation.

Installation of clay plasters is done step by step using 10mm thickness of layer at a time. Every following layer is installed after previous layer has dried.

Failure time of the plaster depends mostly on material and build-up of substrate. See Figure 1.



Figure 1. Example of layers of clay plaster on wooden wall.

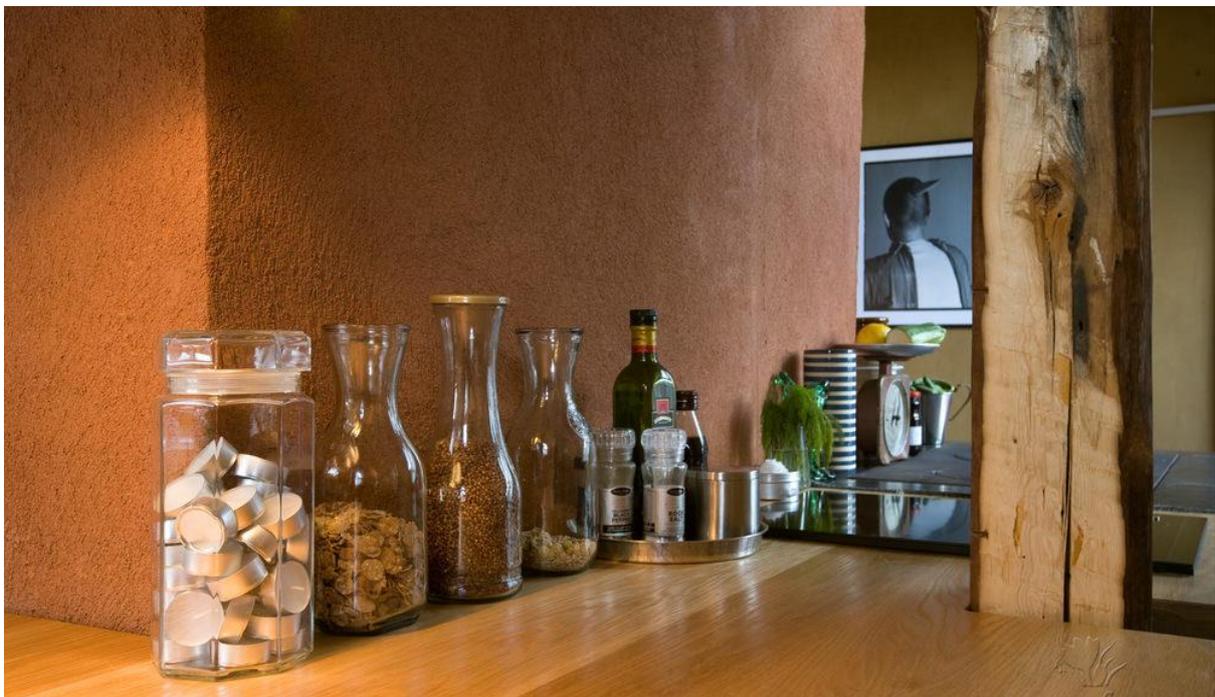


Figure 2. Interior with clay plaster. (photo by Safran)

## Basic design method

Scenario of charring of initially protected timber elements are shown on Figure 3. The start of charring is delayed and the charring rate behind the protection is lower compared to initially unprotected wooden surfaces.

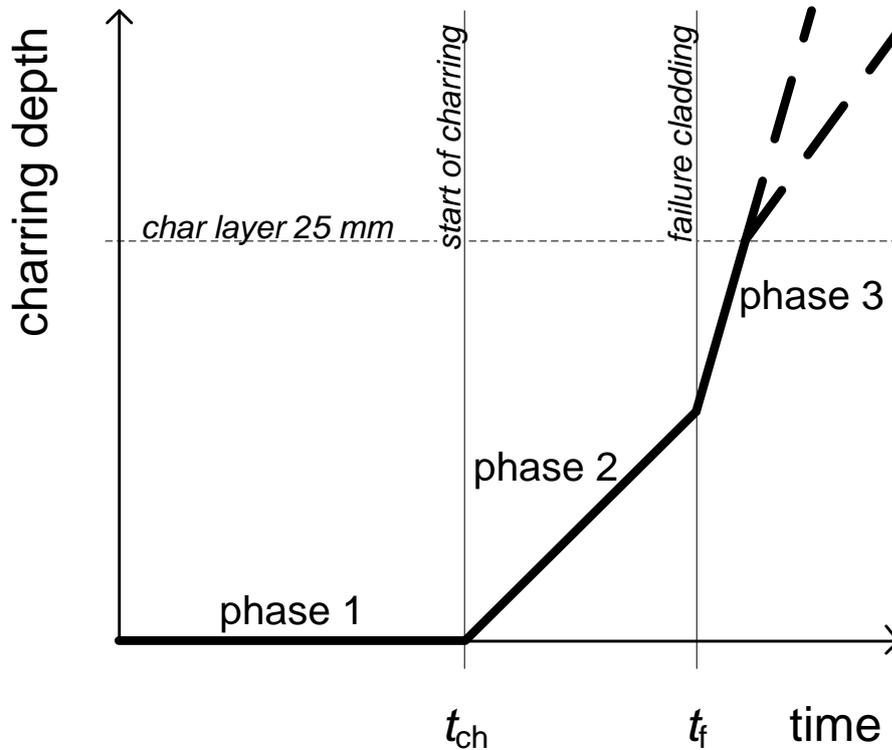


Figure 3. Phases of charring of timber element

European design method is given in Eurocode 5 Part 1-2 (EN 1995-1-2). There is no existing information concerning properties of plasters according to this design method. The purpose of the following research is to designate the firetechnical properties for clay plaster for the fire design of timber structures.

## Test specimens

Timber specimens of 100x100x100 mm were instrumented with thermocouples and covered by test clay coverings.

The tests included 3 different clay/sand ratios and different thicknesses (10-40 mm) of plasters with the same type of clay, sand, silt, additive (straw) and water content.

As clay plaster does not chemically react with the substrate a traditional reed mat was used to attach plaster to timber specimen.

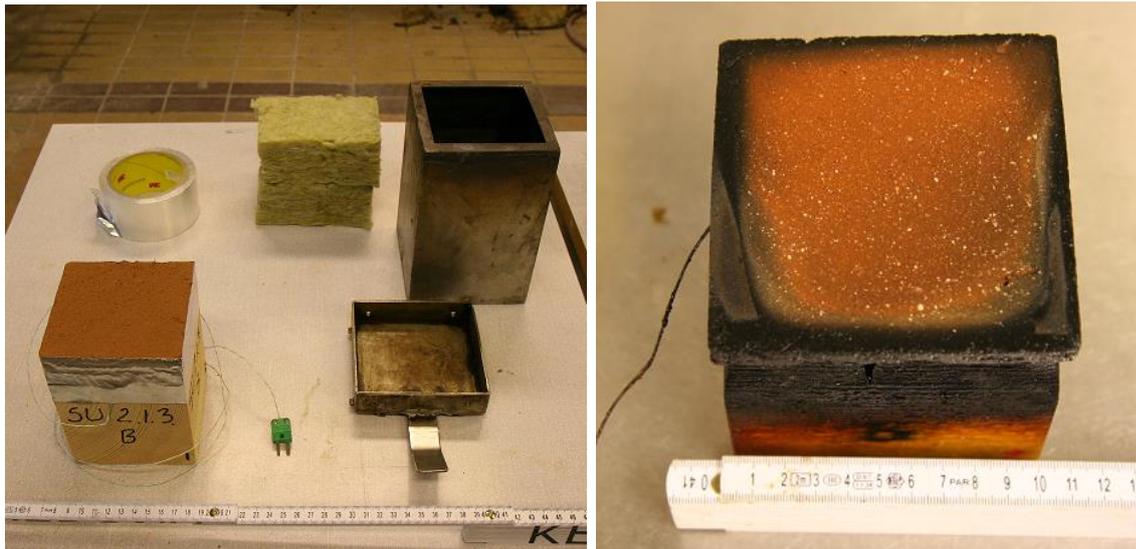


Figure 4. Test specimen before and after testing

## Testing

In order to determine the temperature profiles and charring of wooden specimens a cone calorimeter was used. Standard fire exposure (ISO 834) for 60 minutes was used.

Properties as the start of charring and charring rate behind the plaster were measured by thermocouples and also measuring the residual cross-section. Failure time of the plaster was not investigated in this research phase.

Totally 51 test specimens were tested at SP in Stockholm.

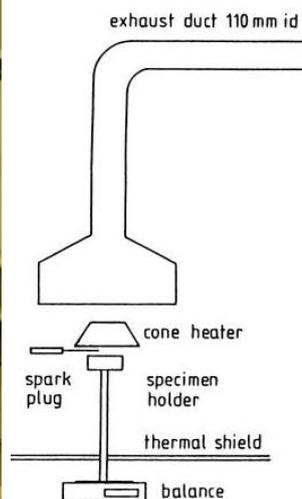


Figure 5. Testing with cone calorimeter

## Interim results

Interim results are presented on Figure 5 and 6. Plaster layers had no visual difference and no cracks during the tests. Different tested ratios of clay and sand as well as different densities did not show noticeable difference in start time of charring.

Although it is clearly recognized that the plaster thickness is an important factor considering the start of charring.

The start time of charring occurs earlier than of gypsum plasterboards. Charring itself behind the plaster is slower than behind the gypsum plasterboard.

Plaster layer was still anchored to many specimens after the testing. That leads to the need to continue research program to determine failure times in bigger scale.

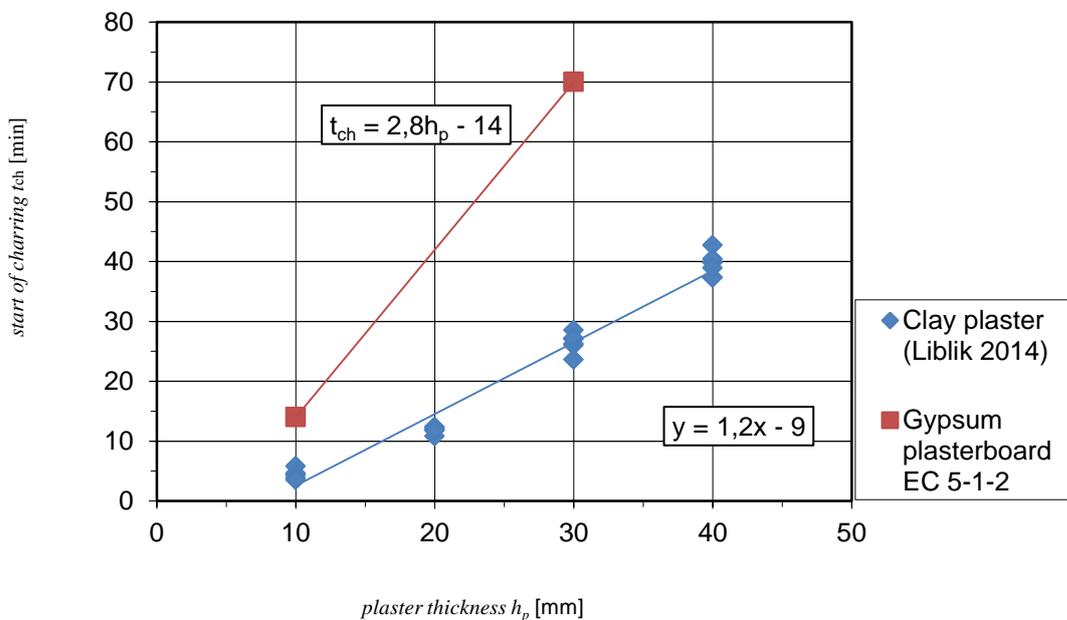


Figure 6. Start of charring. Comparison of clay plaster and gypsum plasterboard

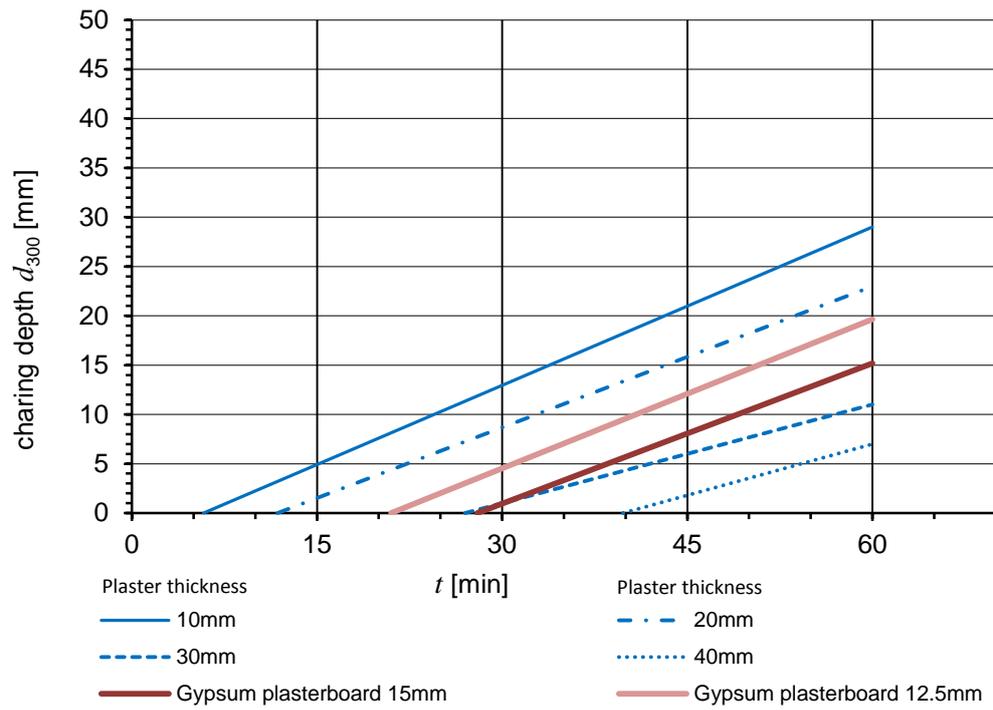


Figure 7. Charring rate in protected phase