Measurement of responses in archaeological wood to ambient temperature and relative humidity

case study - the Oseberg ship

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A case study - The Oseberg ship

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INTRODUCTION

Recommendations for temperature and relative humidity are suggested for museum objects to ensure minimal physical damage, but recommendations do not distinguish archaeological wood from wood which has undergone natural aging without burial [1]. This study aims to measure the response of oak wood from the Oseberg ship, subjected to seasonal variations in the ambient climate in an attempt to understand its effect on the dimensional changes in the wood, and the potential stresses involved. As of today we have not seen any signs of damage that can be ascribed to fluctuations in RH, but this is difficult to ascertain in an object with variable condition. A long-term goal of this project is to establish an allowable range of climate conditions, to ensure future preservation of the ship.

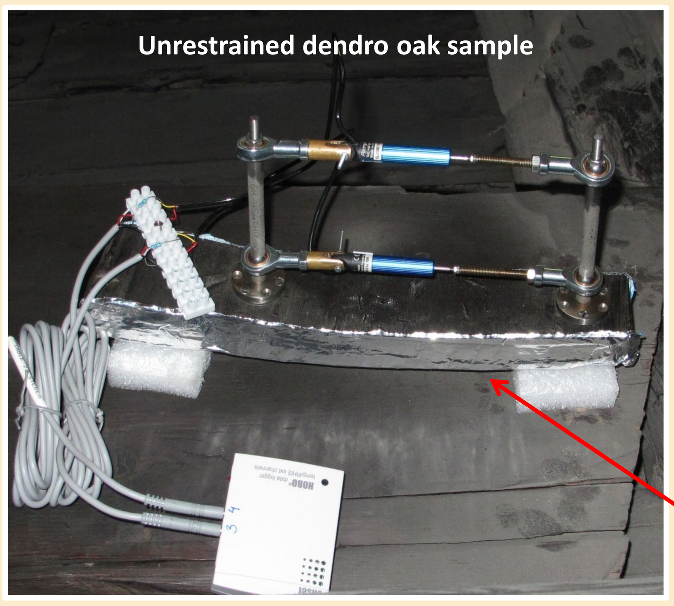
Excavated in 1904, the Oseberg ship, dated from 800 AD, is one of the most important discoveries of the Viking age period in Norway. The fact that the ship consists of 90 % original material makes it a unique find with no comparison elsewhere in the world. The ship is 24 meters long, built with radially cut, 3 cm thick oak planks and is 5 meters at its widest. In 1907 the waterlogged wood was conserved with linseed oil and creosote and the surface exterior was then lacquered. Over 2000 pieces were used for the reconstruction of the ship with the use of both original nails and modern screws together with adhesive.

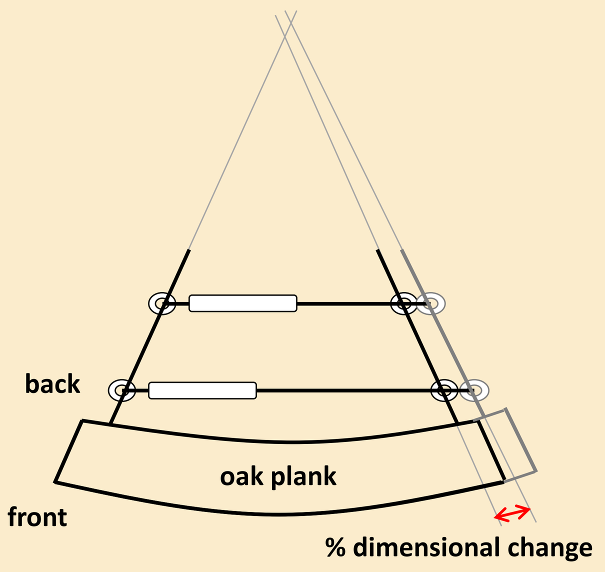
The Oseberg ship, displayed at the Viking Ship Museum in Oslo, has been subjected to an uncontrolled climate since 1926, with only heating in winter. The display area is therefore influenced by seasonal changes in relative humidity, which rises above values of 70% RH in summer, and drops below 30% RH in winter. Rapid changes over the course of a few hours have also been recorded.

MATERIALS AND METHODS:

This project is a collaboration between the conservation staff at the Museum of Cultural History and Dr. Paolo Dionisi Vici, wood scientist, who was at the time employed as a researcher at IVALSA-CNR Tree and Timber Institute. The method and setup used in this study was originally developed to measure deformations of panel paintings [2].

Each measuring system consists of two transducers, which convert small mechanical displacements in the wood into an electrical signal (volt). Voltage can be converted to mm by a simple calibration step. The transducers are arranged parallel to each other, at pre-set distances. The distance above the wood surface is also pre-set. The transducers are connected to a datalogger with four external channels, which is capable of recording the electrical signals from the transducers as well as the ambient T and RH at chosen intervals. This setup measures swelling and shrinkage of the wood, due to its dynamic response to changes in the ambient T and RH.





The raw data is accessed through the datalogger software program where dimensional changes in the wood are plotted together with changes in RH and T. The geometrical setup of the transducers allows for the measured values to be analyzed using different formulas in a spreadsheet (ex. Gnumeric [3]). We have chosen to observe % dimensional change in the arc length [4]. A total of four separate transducer sets have been used to measure specific points of interest, which focus on restrained and unrestrained wood. The restrained wood consists of planks in the ship hull, held together with iron rivets on each edge ('upper ship' and 'lower ship'), which are also under gravitational loading [5]. Two unrestrained samples have been chosen as references to establish the behavior of wood when it can move freely.

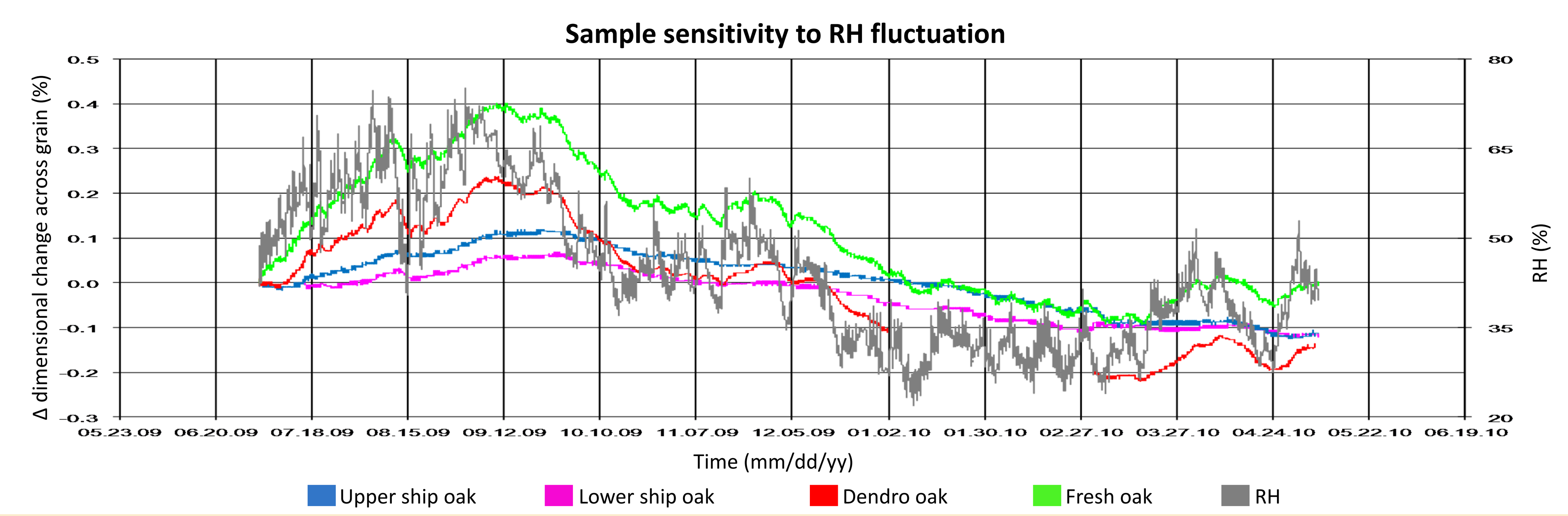
Fresh oak and a sample of the ship previously cut for dendrochronological dating ('dendro oak') are used as unrestrained 'references'.

All measurements are taken on radial sections, recording movement across the grain. The planks chosen do not, as far as possible, contain cracks or breaks. The end grain of the two unrestrained samples were sealed with aluminum foil such that only movement due to penetration of water across the grain is measured. The unrestrained samples are placed in the ship.

PRELIMINARY RESULTS

The unrestrained samples show greatest response to the variations in RH and T. Fresh oak reacts more rapidly and has slightly higher % dimensional change than the dendro sample. The dendro sample shows a delayed and lower response to moisture in relation to the modern sample even though it follows the same basic trend.

The restrained wood from the lower ship is the least responsive but still follows the general trend of variation with RH. The response of the upper plank to changes in climate is greater than that observed in the lower ship, likely because this area carries less weight.



CONCLUSION

Preliminary results show that the fresh wood is slightly more reactive to climate changes than the archaeological oak treated with linseed oil and creosote. Although all four measuring sites follow a general trend in the wood's dimensional response to changes in RH and T, we found a clear distinction between the unrestrained and restrained samples. The lowest dimensional response was recorded in the wood under greatest loading ('lower ship'). However the measurement site in the upper ship also had significantly lower dimensional response than in the unrestrained samples. This indicates the absorption of stresses in the restrained wood since they are prevented from moving. Further work should be done to evaluate whether the absorbed stresses are a source of damage.

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