



Non-Destructive In-Situ Assessment of the Vasa Warship: A Case Study*Thomas Lechner¹, Robert Kliger², Ingela Bjurhager³*

The Vasa warship is one of the most important national treasures of Sweden. In 1956, the beauty of the Swedish navy was located on the seabed, before the ship was raised in 1961.

In order to maintain the integrity of the Vasa warship, conservation treatment was carried out during a period of 17 years after salvage. This PEG (Poly Ethylene Glycol) treatment prevented the ship from serious shrinkage and distortion that would have caused collapse of the cell walls.

These degradation processes have diminishing effects on the strength and stiffness of the ship structure, such as decreasing bearing capacity, loss of cross sectional area and global deformations.

During the last 10 years, the focus was on the mechanical properties of Vasa oak and the influence of PEG penetration in oak, but no final decisions were made on whether to strengthen or how to support the structure.

A conversion of a three-dimensional ship model to model the real structural behaviour might raise difficulties due to the complexity of the material properties that are needed for input. Therefore, a global non-destructive assessment of the mechanical properties combined with semi-destructive tests to predict both strength and stiffness parameters of the Vasa oak as input information are of great importance.

Since density has a significant relationship with the mechanical properties of timber and the non-destructive parameters often relate to density, the main aim of the paper was to compare the applicability of property prediction through non-destructive and semi-destructive testing. Particularly, portable X-ray equipment was used in this study to achieve accurate density measurements on-site which are valuable for model updating purposes as well as to establish a relationship of the influence of stiffness parameters and PEG to the X-ray density.

It was possible to obtain accurate estimates and a strong correlation with the density of Vasa oak's structural components using X-rays in combination with digital image processing. The proposed procedure can be used in-situ with satisfactory results for the evaluation of timber properties. The negative influence of the PEG content resulted in slight overestimation of the density which is on the safe side for the evaluation of the load-carrying capacity. The correlation between the indicative stiffness and the density properties was weak, but good agreement of the density properties was reached through cross correlation between PEG and the density properties, and PEG and the indicative stiffness parameters.

Keywords: In-situ assessment, Vasa warship, timber structures, non-destructive testing, X-ray

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