

Determining the elastic modulus of historic oil paintings

Citation for published version (APA):

Eumelen, G. J. A. M., Bosco, E., & Suiker, A. S. J. (2018). *Determining the elastic modulus of historic oil paintings*. Poster session presented at 21st Engineering Mechanics Symposium, Arnhem, Netherlands.

Document status and date:

Published: 23/10/2018

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

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Determining the elastic modulus of historic oil paintings

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View of Delft by J. Vermeer (1660-1661)
Obtained from [1].

Introduction

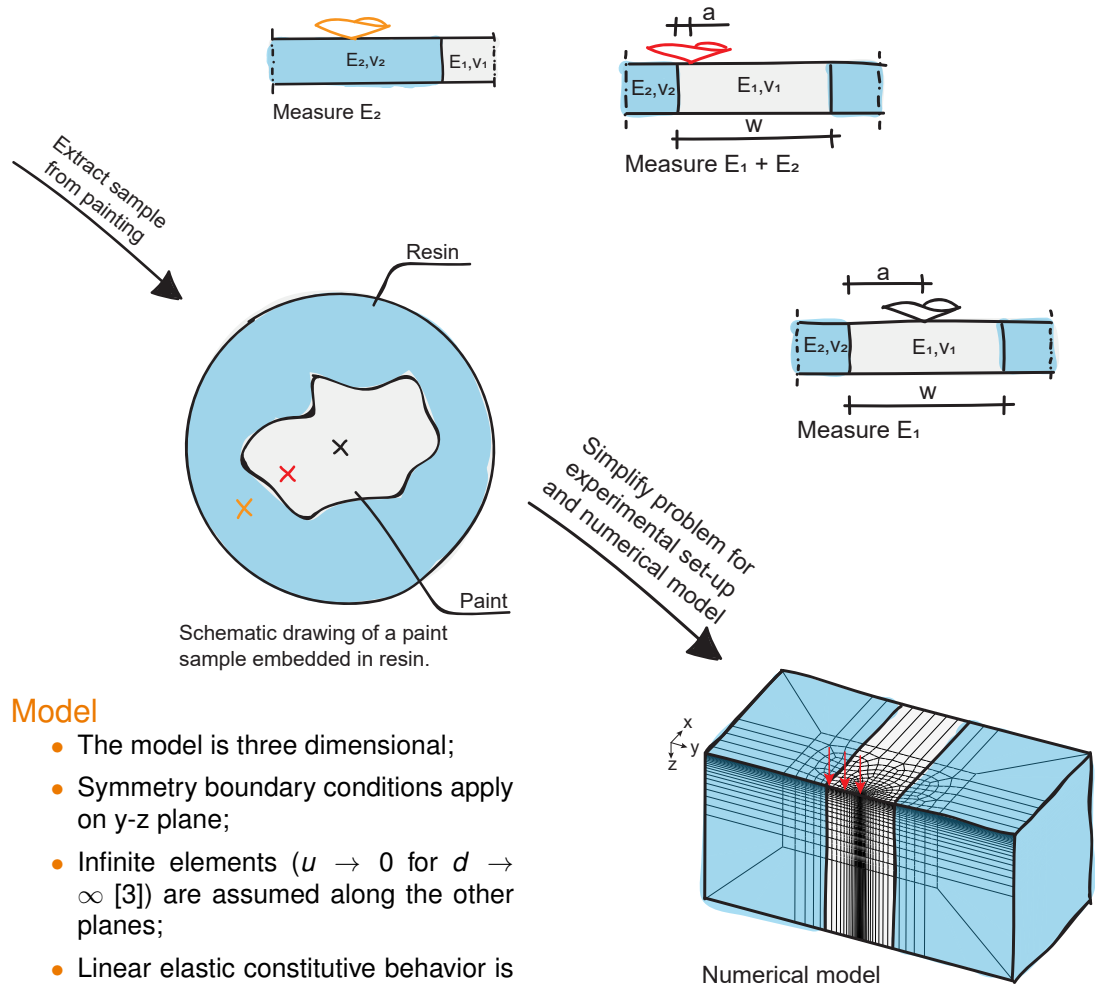
Nano-indentation is a technique that can be used to retrieve mechanical properties, such as the elastic modulus, at small scales. This technique is particularly advantageous when, for conservation purposes, material properties of historical oil paintings are required. In this way, measurements can be performed on small samples of actual historical paintings, allowing for more realistic values than if the properties were retrieved from artificially aged mock-ups. However, to perform the indentation tests, these samples need to be embedded in a resin. This influences the calculated stiffness [2].

Goal of the research

This research aims at understanding the effect of the embedding material on the material properties obtained from an indentation test, regardless of the position at which the indentation is performed.

Methodology

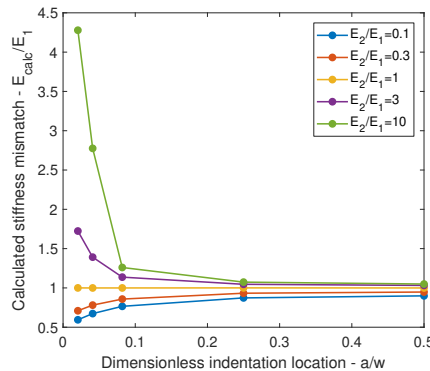
The work is based on a set of numerical simulations to be compared with experimental data from real paint samples.



Model

- The model is three dimensional;
- Symmetry boundary conditions apply on y-z plane;
- Infinite elements ($u \rightarrow 0$ for $d \rightarrow \infty$ [3]) are assumed along the other planes;
- Linear elastic constitutive behavior is assumed.

Results



Calculated stiffness normalized by the stiffness of the paint as a function of the indentation location, for a relative indentation depth of 2.5%.

Future work

- Include visco-plastic constitutive behavior;
- Validation with experiments performed by The Getty conservation Institute.

References

[1] <https://www.mauritshuis.nl/>
 [2] A. Freeman et al. Mechanical characterization of a cross-sectional TiO₂ acrylic-based paint by nano-indentation, Unpublished.
 [3] O.C. Zienkiewicz et al. A novel boundary infinite element, 1982.