Modeling inhomogeneities of veneers with a grayscale mapping approach

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The formability of a veneer sheet on a given geometry depends on its individual macroscopic structure especially at critical areas, where large deformations occur. Hence, this local material behavior has to be taken into account for numerical predictions of the forming process of wood surfaces for automotive interior trim parts. A method is presented where grayscale values from images are mapped to material IDs on finite element meshes. This method provides an automatic discretization of visible macroscopic structures.

Images of sliced and burled ash wood veneers were chosen for the tests (Figure 1). The images were exported into the grayscale file format pgm (portable graymap) containing a grayscale value within the range of 0 to 255 for each pixel in ASCII format. Mapping has been performed with a recent development version of the mapping tool envyo® [1]. Based on the image size, a point cloud was created which contained all pixels and their assigned grayscale value. After alignment with the target finite element mesh, a nearest neighbor search was performed. Depending on the found grayscale value, material properties of early or late wood were assigned to shell elements in order to consider the different areas. The grayscale mapping method was applied to simulations of a Nakajima forming test (Figure 2). An orthotropic elastic material model was implemented in LS Dyna. Engineering constants of early and late wood were derived from tensile tests. Comparison of the simulation results to experimental tests of [2] showed a very good agreement in the major strain distribution (Figure 2b).The meshes generated by grayscale mapping showed the general behavior of the ash wood veneer sheets under 3D stress, induced by the sinking punch. Strain concentrated on the early wood zones due to the lower Young´s modulus in the direction transverse to the fiber axis (Figure 3).

With the presented method early and late wood areas as well as knots and other visible defects can be captured in numerical models always supposing that local testing data can be provided. A standard procedure for the configuration of grayscale ranges and element size must be further developed, to capture macroscopic structures properly according to the anatomical structure of wood. Additionally, the mapping of local fiber directions would improve forming predictions, especially for burled veneers.

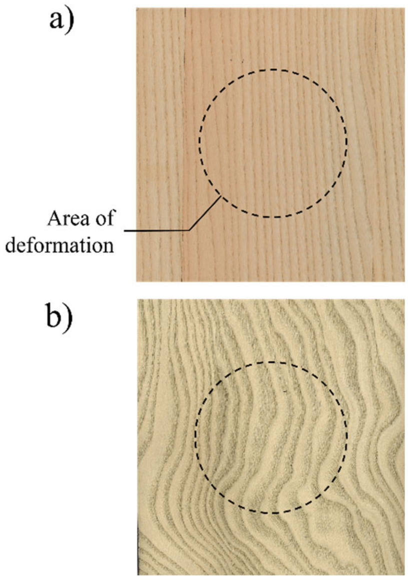

Figure 1: Images taken for mapping of a) sliced ash wood veneer sample and b) burled ash wood veneer sample

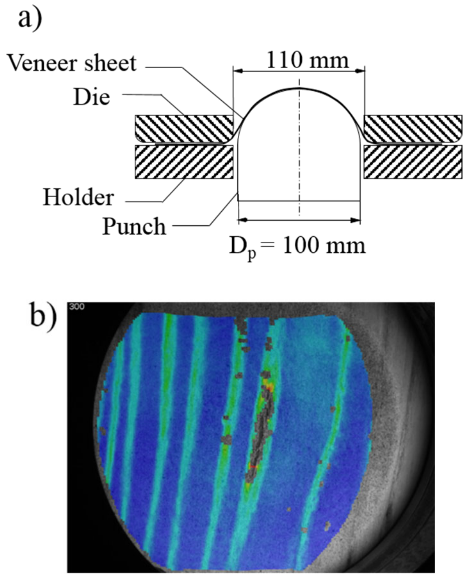

Figure 2: a) Nakajima test setup, b) Experimentally determined major strain distribution with crack of ash wood veneer

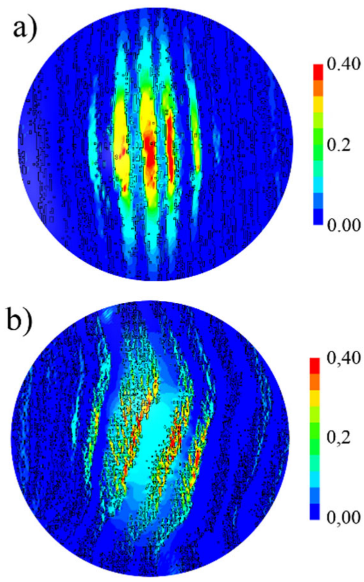

Figure 3: Simulation results (major strain) for meshes created from grayscale mapping for a) sliced and b) burled ash wood veneer

References

[1] DYNAmore GmbH: envyo® User's Manual (2019)

[2] D. Zerbst, E. Affronti, T. Gereke, B. Buchelt, S. Clauß, M. Merklein, C. Cherif: Analysis of the forming limit of ash wood veneers with nonwoven backings. *Wood Science and Technology* (Submitted for publication) (2019