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OPTICAL MEASUREMENT OF LOCAL STRAINS DEVELOPMENT IN FINGER-JOINTED WOOD SUBJECTED TO STATIC AND SUSTAINED LOADS

L. Muszyński[1], B. Clouet[2], R. Pommier[3]

[1] Dept of Wood Science & Engineering
Oregon State University (OSU)
Corvallis, Oregon 97331
U.S.A.
Lech.Muszynski@oregonstate.edu

[2] Department of Material Sciences
University of Technology in Troyes (UTT)
FRANCE
Boris.Clouet@utt.fr

[3] Unity of wood sciences and technology
University Bordeaux1
FRANCE
pommier@us2b.pierroton.inra.fr

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INTRODUCTION

In this study the full field optical measurement techniques based on the digital image correlation (DIC) were applied to investigate the local strains development in wet formed finger joints in French Maritime Pine logs.

Wood is a natural composite, characterized by fairly complex multi-level anisotropic, heterogeneous cellular structure, and high affinity to water. To various extents this nature is inherited by all wood-based composites. These materials when subjected to loads often reveal non-uniform deformation and strain patterns, and complex failure modes. About 50% of wood products present on the world markets today are manufactured as adhesive bonded or composites finished products with adhesive joints. Adhesive bonding is often used in order to obtain products of desired dimensions and geometries. It also provides an efficient way of utilizing low quality wood in value added products.

French Maritime Pine is an example of relatively abundant wood, which despite of favorable mechanical properties of clear material is generally considered unfit for structural applications due to presence of large number of knots and other undesirable features. One way of utilizing this secondary resource, which otherwise would become waste or fuel, is by removing the undesirable zones and re-constituting the relatively homogeneous clear wood sections into longer solid members by adhesive bonding. However cross-grained sections of wood do not bond easily. Currently finger jointing is considered the most efficient way of creating durable structural grade end joints in wood. Finger joints created in carefully conditioned dry wood are capable of retaining of up to 90% of the original tensile strength of the clear wood. However the micro-mechanics of finger joints in wood is not fully understood. Of particular interest is the load transfer at and around the finger tips, where the joint failure is typically initiated [1]. New promising technology of creating finger joints in wet wood developed at Laboratory of Wood Rheology in Bordeaux is expected to reduce the effect of strain concentrations around the finger tips and thus improve the overall strength of the bond [2].

In this study finger joints created in wet Maritime Pine logs according to European Standard EN385 using a new one-component polyurethane adhesive formula are investigated.

EXPERIMENTAL PROCEDURES

The general approach is to measure development of strain concentrations in wet formed finger joints subjected to static and sustained loads. Small specimens of finger jointed

sections (cross sections of 18 mm x 5 mm) are acquired from larger joint samples manufactured in wet Maritime Pine logs according to European Standard EN385 using a new one-component polyurethane adhesive formula. The specimens were then divided into two random groups. The first group was subjected to benchmark static tensile tests to failure. The second group has been subjected to a sustained load at 10% of the ultimate tensile load level (creep tests), after which the residual tensile strength in the joints will be determined in static tensile tests. The static tensile tests were performed in a regular universal testing machine. The creep tests are performed in a special static loading frame that allows testing four specimens at once in a way, which allows optical measurement of the deformations. Tests are performed in a controlled climate room at 23° C and 65% Relative humidity. In addition reference static tensile strength will be determined on specimens of clear Maritime Pine wood. Limited reference static and creep tests were also performed on traditional dry-formed finger joint specimens created in the same material.

The morphology of the joints is being examined in high resolution x-ray computed tomography (CT) scanner. This will allow morphology based modelling of the joint in the further stage of the project.

In tests with finger joints all deformations are measured with a full field optical measurement system VIC3D (by Correlated Solutions). Description of a 3-D measurement principles, calibration procedures, and sample applications may be found in [3, 4]. Development of local strain concentrations in, and around the adhesive bond was investigated. Preliminary results reveal severe strain concentrations indicating poor load transfer at the finger tips. Accuracy of the measurement is evaluated from initial images of undeformed scene.

This project is in progress. The results will be available in time of the conference.

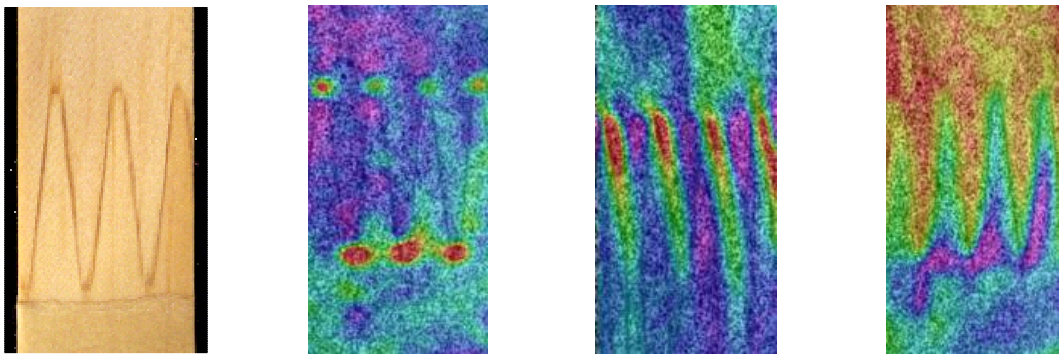

Figure 1- Specimen of a green formed finger joint and sample strain concentration maps: e_{yy}, e_{xx} and e_{xy}

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