MOIRÉ ANALYSIS OF THE MODIFIED ARCANE SHEAR SPECIMEN

Douglas R. Rammer and Roland Hernandez

1.  INTRODUCTION

For development of the Arcan shear test as a standard test specimen for wood, a detailed knowledge of the strain and stress fields at the narrow cross section is required. Current ASTM D143 shear block tests have shown to have a non-uniform state of stress in the shear zone [1]. Previous research in high performance composites has identified that the Arcan specimen develops a near uniform state of shear at the narrow cross section, however, questions remain regarding its applicability to wood. This paper will investigate state of strain in the notch area by experimentally evaluating full-field strain patterns using moire interferometry.

2.  PROCEDURES

2.1 Moiré interferometry

Based on principles of geometric moiré, moiré interferometry (MI) possesses much higher resolutions for strain analysis. Typical geometric moire grids have line spacings of 2 to 80 lines/mm, whereas MI can have grid resolutions up to 4800 lines/mm. Thus, geometric moire has a theoretical displacement resolution of 0.0125 mm, whereas, MI has a resolution of 2.08x10^-4 mm. This increased strain resolution makes MI a useful tool for studying full-field strain behavior of wood.

From fringe patterns, shear strain values were calculated using the following:

\[ \gamma = \frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} = \frac{1}{f} \left( \frac{\Delta N_x}{\Delta x} + \frac{\Delta N_y}{\Delta y} \right) \]

where \( N_i \) is the fringe order in the \( i^{th} \) direction, and \( f \) is the grating frequency.

2.2 Arcan test setup

Arcan shear specimens were cut from Douglas-fir material conditioned to 12% moisture content. A 2400 lines/mm grating was applied 24 hours prior to testing. Figure 1 a shows the specimen prior to application of the grating. A tensile load was applied to the test jig at a rate of 30 N/min. Photographs of U- and V-field fringe patterns were taken at 90N increments until a maximum load of 280 N was reached, Figure 1b and 1c show the U- and V-field fringe patterns at 267N, respectively.

3.  RESULTS AND DISCUSSION

From the U- and V-field fringe patterns, shear strain was calculated using (1). Shear strain results (Figure 2) indicate that a nearly uniform level exists for approximately 80% of the 19.1-mm shear plane. Shear strain was also observed to approach zero at the notch boundaries.
V-field fringe pattern at 267N.

Figure 2 Shear strain distribution in the Arcan shear specimen.

For the 267 N load, the average uniform strain was 1.02x10^{-4} mm/mm. From these load and strain values, a shear modulus of 684 MPa for the longitudinal-tangential (L-T) plane was calculated.

This paper only presented the shear strain distribution in the L-T plane with the grain of the wood parallel to the shear zone. Other considerations for this type of specimen should include the longitudinal and transverse strains in the shear zone, placement of the earlywood-latewood bands within the shear plane for L-R specimen orientation, as well as the effect of varying grain angles.

4. REFERENCES

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