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Recent Research and Applications of Advanced Photomechanics Techniques

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In this speech, two recent research and applications of advanced photomechanics techniques on glass and wood are reported.

To meet the strong demand of measurement capability of low-level stress and the stress in low birefringence materials (e.g. glass), the transmissivity extremities theory of photoelasticity (TEToP) was developed by integrating white light photoelasticity and spectrometry. In addition, based on the phase-shifting technique, the enhanced exposure theory of photoelasticity (EEToP) was developed by calculation of the intensified light intensity of the isochromatic fringe pattern. By combining the advanced reflection theory of photoelasticity (ARToP) and EEToP, reflection-type EEToP (R-EEToP) was introduced to measure the low-level stress in thin glass plates. R-EEToP can be used to measure the low-level stress of the thin glass plate with coatings or without coating on its rear surface. The applications of these advanced photoelastic techniques will also be presented.

In the second part of this speech, modulus of elasticity (MOE) of Japanese cedar was determined by three approaches. Laser speckle images of the wood surface of Japanese cedar were first collected by using the three-dimensional fiber orientation scanning (3D FOSS) system developed in the Photomechanics Laboratory at National Tsing Hua University (NTHU). The measured in-plane and out-of-plane fiber angles were then substituted into strain-stress relationships and global coordinate transformation equations to obtain the predicted MOE. Finite element (FE) method was then used to verify the predicted MOE. To construct a three-dimensional FE model, X-ray computed tomography (CT) images of the wood were employed to obtain internal features such as earlywood, latewood, and knots.

The predicted MOE and boundary conditions of the four-point bending experiments were used in the FEM simulation to calculate the displacement, stress, and strain of the wood under four-point bending. Furthermore, three-dimensional digital image correlation (3D-DIC) method was used in conjunction with the four-point bending experiment to obtain the experimental values of displacement, strain, and MOE. Both the FEM displacement and strain results are well matched with the experimental values.