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STATIC AND DYNAMIC PHOTOELASTICITY AND CAUSTICS

RECENT DEVELOPMENTS

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PREFACE

Studies on the propagation of light waves in bodies that exhibit slight optical anisotropy and on the properties of laser radiation have contributed much to the revival of two- and three-dimensional photoelasticity. This coincided with advances in recording techniques, e.g., the multiple-spark camera, and in the field of data analysis.

The new photoelastic techniques associate three optical parameters at every point of a plane slice in a three dimensional medium. These parameters enable us to obtain the two classical mechanical parameters, namely the directions and difference of secondary principal stresses.

The first technique presented in this course is that of integrated photoelasticity which seems to be particularly adapted to the study of monocrystals, of shell structures of revolution and other bodies where the axisymmetrical stress-state is predominant.

The other techniques utilize the scattered-light phenomenon in the three-dimensional medium. Scattering, itself an inner polarizer or analyser, when combined with the new techniques it has the potential capacity for studying an important but complex class of three-dimensional problems in solid mechanics. These include the determination of the stress-state at the interior points of a turbine-blade root, or surface cracks under opening mode loading.

Two-dimensional dynamic photoelasticity studies using the high-speed multiple-spark camera will be presented with applications to stress waves propagation and dynamic fracture. The photoelastic coating technique is employed to allow the analysis of actual structural metallic elements with cracks. A new method for analyzing isochromatic fields will be discussed. It permits the determination of the characterizing parameters for a crack under mixed mode loading.

Specific methods using interferometry and holographic photoelasticity are developed for separating the principal stresses and a full field analysis is performed for projectile impact. A punctual method is presented which permits the observation of the dynamic development of principal stress at selected points. It is applied to a simulation of stress waves in a composite material.

Recent developments of the shadow optical method of caustics will be included. This method provides an opportunity for determination of the stress field around cracks in a plate under different types of fracture modes. The extension of the method so as to permit an analysis of elastoplastic material behaviour will be presented.

Alexis Lagarde

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