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Individual Stress Determination in Irregularly Perforated Unsymmetrically-loaded Structures from Temperature Data

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Abstract Topology optimization is an effective tool for high strength-to-weight ratio designs in automotive and aerospace engineering. However, such shape optimization techniques often result in non-traditional geometries and cutout shapes which complicate stress and fatigue analyses. Individual stress determination in an unsymmetrically-loaded finite-width isotropic structure containing an irregular cutout is presented. Stress analysis of such situations can be challenging as analytical solutions are rarely available for non-trivial geometries, and like computational methods, they require accurate knowledge of boundary conditions; often unavailable in practice. Recorded temperature information is processed here with a stress function while imposing traction-free conditions discretely on the edge of the cutout. Thermoelastic stress Analysis (TSA) stresses are separated and individual stresses are determined full-field. Technique is independent of external boundary conditions and does not require any differentiation of experimental data. Results are validated by those from finite element analysis predictions, strain gage measurements and load equilibrium calculations.

Keywords TSA, Stress Separation, Hybrid, Irregular Cutouts, Non-trivial Cutouts