BIOGRAPHICAL SKETCH

Former Research and Development Engineer in TTU's Center for Manufacturing Research, Mike is now the High Performance Computing Systems Administrator for TTU's Information Technology Services group.

EDUCATION

M.S., Mechanical Engineering

Tennessee Tech University, 1995–1998

College of Engineering

TENNESSEE TECH

The Department of

Mechanical Engineering

Announces the Dissertation Defense

of

Michael W. Renfro

In Partial Fulfillment of the Requirements

For the degree of

Doctor of Philosophy

November 2, 2018, 1:30 PM

Held in

Clement Hall 119

Tennessee Tech University

FIELD OF STUDY

Mechanical Engineering

DISSERTATION TOPIC

Analysis of Surface Cracks in Plates Loaded in Bending under Elastic-Plastic and Fully-Plastic Conditions

EXAMINING COMMITTEE

Dr. Christopher D. Wilson (Major Advisor)

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ABSTRACT

A review of both linear (elastic) and nonlinear (elastic-plastic) fracture mechanics is provided, including using finite element models to predict fracture parameters including linear stress intensity factor K and nonlinear strain energy release rate J. Established techniques for separating crack behavior into geometry-dependent and material- dependent components are examined. Methods of constructing failure assessment diagrams are reviewed, leading to predictions of the onset of stable crack growth.

Methods for verifying and validating both numerical and experimental results are reviewed, leading into the construction of a set of 600 elastic-plastic models of surface-cracked flat plates in bending covering a wide range of materials ($100 \le E/\sigma_{ys} \le 1000$, $3 \le n \le 20$) and geometries ($0.2 \le a/c \le 1.0$, $0.2 \le a/t \le 0.8$). Software algorithms and techniques for generating models in a consistent manner are developed through a series of tension and bending models, and are critical to maintaining the accuracy and reproducibility of this large a set of results. The results of the 600 models are reduced to a database of J variations around the crack front and measures of crack mouth opening displacement (CMOD).

A smaller series of finite element models is constructed to explore the applicability of the load separation technique to surface cracks in bending. Another series of models is based on previous Electric Power Research Institute (EPRI) methods for evaluating J. The final application of the database of bending model results is a modified version of the NASA Tool for Analysis of Surface Cracks program (TASC) suitable for use in both tension and bending, improving the ease of verifying compliance of experiments versus ASTM E2899, "Standard Test Method for Measurement of Initiation Toughness in Surface Cracks Under Tension and Bending."