Summary of the First and Second Global Sandia Fracture Challenges

Krishnaswamy Ravi-Chandar*

* The University of Texas at Austin
2617 Wichita Street, Mail Code: C0600, Austin, TX 78712
e-mail: ravi@utexas.edu

ABSTRACT

This presentation will discuss the highlights of the first and second global Sandia Fracture Challenges (SFC). The goal of these challenges was to benchmark the capabilities for the prediction of deformation and damage evolution associated with ductile tearing in structural metals, including physics models, computational methods, and numerical implementations currently available in the computational fracture community.

The first SFC was conducted in 2012, with the results summarized in Ref [1]. Researchers and engineers were invited to predict crack initiation and propagation in a simple but novel geometry fabricated from 15-5PH stainless steel, a common off-the-shelf commercial engineering alloy. Thirteen teams participated, reporting blind predictions for the outcome of the Challenge. The simulations and experiments were performed independently and kept confidential. The methods for fracture prediction taken by the thirteen teams ranged from very simple engineering calculations to complicated multiscale simulations. The wide variation in modeling results showed a striking lack of consistency across research groups in addressing problems of ductile fracture. While some methods were more successful than others, it is clear that the problem of ductile fracture prediction continues to be challenging.

The second SFC was conducted in 2014, with the results summarized in Ref [2]. This second SFC investigated the ductile rupture of a Ti–6Al–4V sheet under both quasi-static and modest-rate dynamic loading (failure in ∼0.1 s). Like the first challenge, the sheet had an unusual arrangement of notches and holes that added geometric complexity and fostered a competition between tensile- and shear-dominated failure modes. The teams were asked to predict the fracture path and quantitative far-field failure metrics such as the peak force and displacement to cause crack initiation. Fourteen teams contributed blind predictions, and the experimental outcomes were quantified in three independent test labs. Additional shortcomings were revealed in this second challenge such as inconsistency in the application of appropriate boundary conditions, need for a thermomechanical treatment of the heat generation in the dynamic loading condition, and further difficulties in model calibration based on limited real-world engineering data.

The presentation is aimed at providing background on these challenges as well as seeding discussions of strategies for modeling and simulation of ductile failure.

REFERENCES

[1] B.L. Boyce et al, “The Sandia Fracture Challenge: blind round robin predictions of ductile tearing”, *Int J Fract*, Vol. **186**, 5–68, (2014).

[2] B.L. Boyce et al, “The second Sandia Fracture Challenge: predictions of ductile failure under quasi-static and moderate-rate dynamic loading”, *Int J Fract*, Vol. **198**, 5–100, (2016).