AFGROW Workshop 2017

Round-Robin Life Prediction Invitation

for

Centered & Offset Holes with a Single Corner Crack

Purpose

The purpose of this round robin exercise is to determine the variability of users, given the same loading spectrum, material data, and Initial Flaw Size (IFS) to predict the evolution of the crack front shape and the total life of a given geometry using the AFGROW framework as the life prediction tool. As noted below, certain aspects of the AFGROW framework will be provided for common use by each participant, and others will be left to the user's discretion. It is important that each participant follow this guidance so that variability in the predictions is limited to the aspects left to user discretion. Test data from this Round Robin will be presented at the 2017 AFGROW Workshop along with predictions made by each participant. Each participant is invited to give a short presentation (10 minutes) outlining the pertinent details of their analyses. A group discussion will follow to help identify which analysis options worked best for this study, and what improvements to AFGROW may be helpful in the future. The results will be published on the AFGROW Web Page following the Workshop in a manner that will not identify who performed each prediction, but individuals will be provided with a key to know their results as they compare to the group.

Introduction

During the 2016 Workshop, it was suggested that a round-robin type prediction effort be conducted where interested individuals are provided specific inputs related to a series of crack growth tests and invited to make blind predictions of the evolution of crack shape, predicted cycles to through crack transition, and total life before failure. Ideally, each participant will give a short (10 minute) presentation explaining the details of their analyses methods and assumptions at the 2017 AFGROW Workshop (Sep 19-20, Layton, UT). The actual test results are being held in confidence by those who were involved in the testing/data reduction and will be revealed at the Workshop. We hope to have a very productive discussion once the results are compared to the analyses.

One of the recurring areas of interest at the annual AFGROW Workshop in Layton, UT has been the ability to accurately predict the life and natural crack shape progression of an initial corner crack as it grows through-the-thickness of a plate. There are many challenges involved in this type of analysis, including:

- How many points along the crack front are used to make these predictions?
- Where should these points be located along the crack front?
- Should we attempt to account for lack of constraint at free surfaces?
- Do the marker cycles create a load interaction effect?

With these challenges in mind, participants have discretion regarding the K-solution used in their predictions. This includes the use of Classic Models, Advanced Models, or other external K-solvers to

interface with the AFGROW analysis engine. We cannot expect to be able to validate any of the K-solutions used to make the predictions, but we will be able to note how different solutions affect the various predictions. The use of a load interaction model is also at the discretion of each participant, but certain models will have no effect since crack growth rate data are provided for a single stress ratio (R=0.1). Users also have discretion in the preferences used for their predictions in the AFGROW, Predict Preferences menu.

The information in the following sections will be used as provided by all participants as input data for each prediction.

Test Specimen Geometry

The attached Excel spreadsheet provides the geometry data for each test coupon, six in total. Three of these coupons have an initial corner crack at a centered hole, and the remaining three have an initial corner crack at an offset hole.

Initial Flaw Size

The fatigue tests were started via an EDM notch cut at one corner of the hole. The typical notch size is 0.02 x 0.02 in. The loading spectrum was applied that included marker cycles. After each test was completed (to failure), the fracture surface was examined using optical microscopy to obtain the crack front shape based on marker bands on the fracture surface. The initial crack lengths along the surface (c-dimension) and along the hole bore (a-dimension) were determined based on the first continuous crack front marker band identified beyond the starter notch that extended > 0.03 inches from the corner of the hole in each direction. Continuous in this context means the crack front intersected both the plate surface and hole bore.

Loading Spectrum

The normalized loading spectrum (R = 0.1) is provided in the standard AFGROW format, see attached AFGROW spectrum files.

Material

The material used for this effort is 7075-T651 Aluminum.

Crack Growth Rate Data

Crack growth rate data for the lot of material was derived from various groups of experiments with part-through crack geometries. The tabular crack growth rate data to be used for all predictions is given below for R = 0.1:

da/dN	DK
4.50E-07	4.236
2.20E-06	6.281
9.00E-06	10.148
1.70E-05	12.900
2.40E-05	15.000
3.25E-05	18.000
4.25E-05	20.500

6.00E-05	23.500
1.00E-04	26.600
2.00E-04	29.500
4.00E-04	32.750
1.00E-03	37.500
2.00E-03	40.250
1.00E-02	45.000
2.00E-02	46.500
1.00E-01	48.500

Required Input

Participants are required to use the following input data:

1. Specimen geometry as provided
2. Initial crack sizes as provided
3. Load spectra as provided
4. Tabular material crack growth rate model (R = 0.1) as provided.

Requested Prediction Results

Please summarize your results for each case including:

1. a-dimension vs. Cycles
2. c-dimension vs. Cycles
3. Crack Shape (a/c) vs. Cycles
4. Crack Growth Rate (dc/dN) vs ΔK for the 6 predictions

Please use the coupon name, as provided in the attachment for each of your analyses. This will allow the data processor the ability to link each prediction back to the test results for comparison. Also, include all pertinent details of the input data and assumptions used in the analyses. Include enough information so the processor can properly summarize your approach at the Workshop.

If you have any questions/comments, please e-mail: support@afgrow.net

Thank-you very much for your participation, and we hope to have a very good discussion at the Workshop!

We would also like to express our sincere appreciation and gratitude to:

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