

Fall 2014 FD&E Meeting Minutes – October 16, 2014

University of Wisconsin – Platteville

Opening Remarks – Chad Kerestes

- Noted that this is one of the higher-attendance meetings during his tenure
- Noted that this meeting would have a higher amount of philosophical content than typical, rather than only technical

8:30 – 8:45 – Welcome address: University of Wisconsin – Platteville – Casey Gales

- Nice introduction of U of W – Platteville, history of the school

8:45 – 10:00 - Total life Project – Testing & Analysis Update, Discussion

Eric Norton

- Introduced the specimen geometry and the weld test set up
- MTS, Somat EDAQ Lite
- Saw a video of weld specimen fatigue testing
- Saw time lapse video (pic every 5 sec) of fatigue test
- Steve Hague said that it would always break at the bolt hole, but Tom pointed out that a bar is clamped over the base, not bolts straight through. Charlie Sieck said St. Venant will take care of us.
- The group discussed accelerational forces – at 5.1 Hz and such a small mass, it should be small enough not to matter
- Shared how the SAE time history was created using RPC Pro
 - Made up of 3x transmission history, 1x bracket history, 2x suspension history
- Showed striations on the fracture surfaces

Matt Campbell

- Presented linear model
- Plane strain and plane stress gave same stress, different strain
- 3D showed higher stresses in center of thickness (~8% higher)
 - Shows that we need to use 3D model
 - Material in the middle is more constrained, higher stiffness in the middle so highest stress
- Sensitivity study to confirm adequate mesh density
 - 2nd order, 20-node elements
- Used a linear analysis to determine where to place the strain gage in a linear bending region
- Showed radius sensitivity of stress concentration factor
- Presented non-linear model
- Showed nonlinear material model, which included kinematic hardening to shift the yield surface
- Whole point of FEA – get stress through thickness of part
- Discussion about the weld toe radius and geometry
 - Previous work has been done here, likely needs to be performed for new batch of welded specimens

Tom Cordes

- We have backed off the weld samples and are working on the machined samples. If we can't handle the machined samples, we sure can't handle the weld
- Used recorded time history instead of assuming the load amplitude
- Local strain/strain-life approach – we're using it for initiation. Glinka has taken the same mathematics and extended it to crack growth
- Worse constant amplitude was a factor of 2 off
- Variable amplitude was worse at 2.5, but non-conservative
 - Culprit was the assumption that Miner's Rule summed to 1
 - Miner's rule sums to 1 for constant amplitude, but not for variable amplitude (See next-to-last publication edited by Socie for the curve)
 - Comment from the committee – perhaps mean stress is the reason for the change in the summation of Miner's rule – something to think about
 - The summation of Miner's Rule was a popular discussion. This should be a subject of follow-up discussions within the committee.
 - Varying mean stress the problem? -Steve Hague
- The committee seems very interested about how the mean stresses are being handled
 - Ayhan Ince and Steve Hague were particularly interested
- Tom made a call for people to get the data and show a better way to do it
 - Encouraged others to participate and try their own methods
- Showed striation counts from Stephen Horstemeyer (Mississippi State University) and Doug Hornbach (Lambda) and showed reasonable correlation with Glinka's crack growth prediction for depth and width
- Traditional method matches with total life method
 - Traditional method is saying that initiation happens at a crack 4 inches wide and 4 mm deep

Casey Gales

- Next step – welded specimens
- Residual stress subcommittee
 - Deere and Cat are going to do weld simulations
 - Going to get more measurements of the welded samples – Hill and Lambda

10:30 – 11:30 - Hayley Brown – FD&E Mission Discussion

- A small amount of historical perspective was presented, as well as the basic struggles of the current committee as a whole, as well as the steering committee
- Tom Cordes: there was once concern about Cat and Deere getting together.
- Presented that the committee was publishing ~10 yrs – we are well overdue
 - Dale Gallart: If you hold it to your chest, it will die with you, if you give it away, it will grow.
- Steve Haeg: Surface enhancement group completely separated in 2002/2003
- Ayhan: Can we use the data from projects for other things? Tom: Yes, but, please provide some feedback on your findings.
- We should now have a sub-committee on non-linear damage.
 - Next meeting should be non-linear damage, residual stress sup teams reporting
- Hayley – personal goal to have experimental details to be documented

- Phil – experimental method section helping
- There was a large amount of discussion on training
 - Tom Prucha – design engineers need to categorize material properties – have a lack of information on how to use the data parameters and how to categorize the varying material trying to link the design process on how material selections are made
 - Omer Yousif: Is the goal to provide training? (lots of discussion here, but goal is more than just training, but training could be part)
 - Matt Campbell: MTS hosted training last year. Tom, Steve, Dan provided
 - Omer: Course is valuable
 - Dan: Four days - short course is traditional for FD&E, makes it more valuable for the engineer. Traditional 2 day fracture mechanics short course from U of I does not go deep enough. This group can offer more than just a fundamentals course.
 - Believe that most companies could make an effort to have 1 or 2 people
 - Question asked: Could we have Education sub-group?
 - Tom: who here thinks they can get their management to pay for a fund to pay instructors?
 - Steve: there are a lot of ways to structure it. Need a product: knowledge, data, tools need a technical session (industry example) goals and milestones
 - Dave Nichols: Cummins: How do much do you need? (Manager question)
 - Steve: we all have industry examples
 - Steve: Need to develop more of a business model cost per seat, soliciting donations may not be as viable
 - Dave Nichols: Perspective of a manager: getting together with other engineers on characterizing uncertainty: is some tangible, valuable to his company
 - Charlie: Does anyone remember what happened: 9/11 and course got cancelled, seed money died. Been struggling ever since to get the contribution
 - Steve: have to present the value model for others to buy into it
 - Omer: solid mechanics, experimental, metallurgy – Need to have these connected to add value to the training.
 - One comment about the value of the class was regarding unique content
 - Most classes either have fundamentals (academic) or how to use a certain software to calculate fatigue life (software companies)
 - We can provide training on how to solve industry problems and relate the fundamentals and software capabilities to real-world problems
- Hayley: how do we keep this going?
 - Can we start small groups working
 - Kyle, MTS: what do you need help with on the web site?
 - Need a way of collaborating on line
 - We tried basecamp, what options
 - Wiki: set up something with the web site
 - Third box on website: help with an appropriate form of sharing

12:30 – 1:15 - Chad Kerestes - FD&E Industry Perspective Discussion

- What is industry perspective?
 - A practical, application-based design, analysis, or test & development challenge that has caused discrepancy in structural fatigue, and the problem remains unsolved or has not been optimally resolved.

- Short term, midterm, long term
- We need balance between academia and industry
- Steve Hague thinks that the definition of the industry perspective problem is important
 - Combine it into the mission statement
- Dan Lingenfelter says perhaps have everyone bring a slide that attends the meeting
 - Also suggested a form on the website to have input on what they would like to hear
- Doesn't have to be a formal presentation – make it easy or anonymous to ask for help, ask to present, ask for a topic to be discussed
- Tom says that the committee is polite and we never attack – needs to be a ground rule
- Steve Hague says that people don't come to the FD&E committee meetings to self-promote or sell a company, which is a good thing
- Chad wants to have at least one industry perspective presentation per meeting

1:15 – 2:00 - Bill Moser – Life Prediction Sensitivity Study on Residual Stress vs. Mean Stress Correction Method

- SAE4120 steel, notched specimen FEA ($k_t = 3$), FESAFE, strain-life with ultra-high cycle fatigue slope, SWT, Goodman, Modified Goodman, Morrow
- Ayhan Ince mentioned a paper he published on mean stress when Bill was talking about SWT having no damage in compression
- Goodman didn't follow the data very well for strain-life
- Probability – need distribution of material properties (but Bill left them as fixed in the current study)
- Wants to add Weibull parameters to total life data and look at the probabilistic approach
- Management judges us on failure rate – we should be calculating it and making a prediction on that
 - Showed failure rate sensitivity to % change in mean stress
- Residual stress can change fatigue life and the percent failure rate dramatically
- Mean stress correction method may vary fatigue life significantly when mean stress is in compression
- Comments about imparting compressive residual stress
 - Steve Hague commented that preloading is also a method of imparting compressive residual stresses
 - Ayhan Ince brought up ultrasonic peening as an additional method of imparting compressive residuals
- It's not that we have a clear path to do a better job of it, but we need to be aware of it and not ignore it
- More important in high cycle fatigue than in low cycle fatigue. Low cycle fatigue will relax some of these stresses.
- Even Weibull vs. normal can give massively different failure rates

2:30 – 3:30 - Facility/Eng Campus Tour: University of Wisconsin – Platteville

- Tour of the MEMS lab
 - Two scanning electron microscopes, an atomic force microscope
 - Methods for making MEMS
 - Masking machine
 - They have people from industry and other areas of the school that utilize their lab equipment

Thomas Prucha – American Foundry Society – Cast Steel Data for CADS (Casting Alloy Data Search Tool)

- Requesting data for cast steel for a web-based database
- Trying to decide whether to retest stuff done in the 80s because the compositions are tighter now than they were then – asking for input about that
- Asking for input on direction for future cast steel database
 - Strain-life? LCF or HCF? Wants to develop USEFUL data
- They want feedback on the data and specimens
- Want help procuring samples
 - Needs fatigue and monotonic specimens, with any processing, chemistry information possible
 - AFS will do testing?
- Charlie Sieck says that the real value in steel castings today is in LARGE castings
 - How do you degrade for casting size?
 - Big castings – big mistake
- tprucha@afsinc.org
 - Hayley will ask if he wants an email box on the webpage

Wrap up

- Final comments about immediate needs for the Total Life Project
- People that are interested in being on the residual stress subcommittee gave their email addresses to Casey Gales so that they might move quickly

Subgroups were created for the topics below with signup sheets at the back of the room. An email will be sent out to the full committee email roster to alert everyone of the opportunities. Also, signup boxes will be added to the website so that everyone has a chance to get hooked into anything of interest.

- Education
- Mean Stress
- Uncertainty

Respectfully submitted to the FD&E Committee,

Hayley Brown
Chad Kerestes