

# Fall Meeting 11/2/2022

Friday, November 4, 2022 3:20 PM

1. Impact of Columnar Grain Structure on Over-Stress Probe (OSP) Method for Fatigue Life Characterization in Aluminum Sand Castings [Rob Mackay]: OSP (overstress probe method) effective method to gauge fatigue durability of components and the impact of columnar grains on fatigue life (Nemak corporation research review)
  - a. Compliant samples are those that survive the target lifetime 10to7 power at a defined alternating stress ( $R=-1$ )
  - b. So this discussion is focused on the columnar grains in the material that affect the life of the part
  - c. 98hz cycle rate for fatigue samples, polished or as cast surface? Polished as the failure locations are the machined surfaces/tapped holes
  - d. This rate and cycle level makes sense from engine loading standpoint, lots of cycles in engines
2. Residual Stress Committee update [Casey Gales]
  - a. Residual stress measurement correlation
    - i. Working on improving measurement of A0 in order to improve Neutron measurements
  - b. Residual stress relaxation based on cycling, what is running in the structures lab, more samples to run
3. A Collection of Aluminum Cyclic Mean Stress Relaxation Data [Al Conle and RW Landgraf]
  - a. Aircraft industry is very focused on this for aluminums, hole stretching compressive residual stress for rivet holes for example
    - i. <https://fde.uwaterloo.ca/Fde/Articles/relaxAlumPres-Nov2022-4web.pdf>
  - b. The hysteresis loops need to be understood to appropriately relax residual stresses by cyclical loading. If you don't taper the load cycles then you will incur a load based residual stress that will not be an effect of non-load based residuals.
    - i. <https://fde.uwaterloo.ca/Fde/TBar/TestResults/toTaperOrNot.pdf>
4. Effect of semi-product homogeneity and machining parameters on fatigue life of specimens from 42CrMo4+QT [Jan Papuga FABEST corporation]
  - a. Sample size effect study review
  - b. Roughness effect study review
  - c. Portion of the casting that samples are taken from effect
5. Fuchs Award - Fatigue Behavior of Additively Manufactured Materials, Challenges and Procedures [Pooriya Nezhadfar PhD., Auburn University]
  - a. Congratulations to Pooriya on his accomplishments in AM and winning of the Fuch's award!
  - b. Build direction is important: fatigue and crack growth response is dependent on build direction, build direction is significantly less durable than normal to build direction
  - c. Poor surface condition definitely a reduction in fatigue performance, across steel and aluminum alloys
6. QUANTIFICATION OF THE IMPACT OF THE CRACK SHAPE CONSTRAINT ASSUMPTION ONTO PREDICTED REMAINING USEFUL LIFE [Adrian Loghin Simmetrix Inc]
  - a. Elliptic crack front assumption - this a challenge to that assumption and constraints associated with it
  - b. This is simulation based: 3D FEA modeling using remeshing capability
  - c. Compare multi-degree of freedom crack advancement and two degree of freedom or enforcement of elliptic crack front
    - i. not much different result between them
7. Shot peening and super finishing optimization of gear peening [Dave Brewer - Curtiss Wright Surface Technologies]
  - a. 15-30% increase in fatigue endurance limit improvement in steel/steel alloy gear roots
  - b. Depth of compressive stress on hardened material is shallow, on order of 0.2mm and it is almost back to zero with a peak at 0.1mm at -150ksi
8. Some Thoughts on Application of Residual Stress in Fatigue Methods [Ric Leist]
  - a. Ric presented some considerations on how to handle residual stress in different examples
  - b. Please reach out to Ric if you have questions or want to discuss
9. SFSA Casting Project Update [Frank Peters] - Failure analysis of castings, casting surfaces
  - a. Original objective is to use NDE to evaluate fatigue lives or factors that go into fatigue life evaluation
  - b. Most sample failures are not related to surface condition
  - c. "Exposed shrinkage" is primary reason for failure, so the as cast surfaces are not failing, mostly the machined surfaces are failing due to the exposed porosity, which is not what was wanted for the study
10. Discussion on the next round of testing on the steel cast samples [Casey Gales]
  - a. Summary was given on what parts are available and intent was move on machining
  - b. The #2 sample (the one with the off-leg) may want to consider doing FEA of the sample with and without the leg - need to round up the shareholders for this discussion
    - i. Some group members have offered to help with the FEA if needed (Thanks!)
  - c. Also, we may want laser scanning of the samples for documentation of the geometry
    - i. Frank Peters offered ISU's assistance in this
    - ii. Need to determine the order of operations: Machine, Scan, Test (or another order?) - need to get shareholder alignment on this
  - d. Instrumentation needs to be determined for the testing
    - i. Strain gages may be useful, but need to be careful of modifying the location of failure
    - ii. Crack Opening Displacement gage might be good to get an idea of crack initiation and progression
11. WCFA22\_VFA\_Invitation [proposed by Jan Papuga] see the separate communication on this
12. ISU Tour [Frank Peters]
  1. Frank gave us an awesome tour of the following labs. We saw some really cool projects that his students are working on. Then we saw the huge civil engineering test lab and the biggest glue up of boards I have ever seen for a bridge deck test. Then we went to the CNDE labs and got to learn about some really cool methods for NDE. The capabilities of the NDE center were quite impressive. Many thanks to Frank for hosting and showing use some of the really advanced and exciting things they are doing at ISU.
    - 2:05 Arrive in Civil Engineering's Structural Engineering Research Lab
    - 2:15 move to Black Engineering Building
    - 2:25 Tour manufacturing labs in Industrial & Manufacturing Systems Engineering
    - 3:05 Drive to Center for Non Destructive Evaluation