Using Weibull++ to Correlate Field Failures with Virtual Fatigue Results

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Agenda

- What is virtual fatigue analysis and what does it tell us?
- What is Weibull analysis and what does it tell us?
- What can Weibull tell us about our virtual fatigue analysis?
What is Virtual Fatigue?

- Step 1—Apply static loads in FEA to find stresses
- Step 2—Use DesignLife to simulate stress cycles
- Step 3—Use fatigue curve to find damage due to stress cycles

**ANSWER!**
Life = 610,238,729,421 repeats
What does the answer mean?

- What does 610.23872942 repeats mean?

What does a fatigue curve mean?

Stress Life without UTS correction

Stress Range (ps)

Life (cycles)
How is a fatigue curve created?

- Break multiple specimens under constant amplitude loading
- Plot the number of cycles to failure for each specimen versus the cyclic stress on a log-log plot
- Calculate a curve fit of stress and number of cycles to failure
How is a fatigue curve created?

- Typically the curve is a best fit through the data

50% of broken specimen are above curve

50% of broken specimen are below

- 50% Certainty of Survival
What is Weibull Analysis?

- The attempt to make predictions about the life of all products in a population by fitting a statistical distribution to life data from a representative sample of units

1. Gather life data from field or test lab
2. Select a distribution that will properly model life of the part
3. Estimate parameters that will fit the distribution to the data
4. Estimate life characteristics (e.g. reliability or mean life)
Estimating Life Characteristics

Median Life = 600
What is a “Representative Sample of Units”?

- Fatigue is statistical
- If DL calculates median life, we need to compare with median of field failures

**DesignLife**

**Real World**

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**ANSWER!**
Life = 610.2 repeats

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**ANSWER!**
Sample 1 Life = 274 repeats
Sample 2 Life = 974 repeats
Confidence Bounds

- How confident are we in the life characteristics we're calculating?

Median Life = 582
Confidence Bounds

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Confidence Bounds

- How confident are we in the life characteristics we’re calculating?

Probability - Weibull

Unreliability, F(t) = 100 - R(t) (%)

Time (t; Hr) Median Life = 582 890
What is a “Representative Sample of Units”?

- As population of failures increase, the confidence bounds squeeze closer together.
Do I Have Correlation?

- Does DesignLife prediction fall within this range?

Predicted Median Life = 610
Summary

• If we use DL to calculate median life, we need to compare with median of field failures

• One field failure doesn’t constitute a “representative sample of units”

• You can assign confidence bounds to statistically analyzed field failures

• Larger sample size allows us to more confidently assess correlation of analytical vs field failures
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