Specific Values for m and Q

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Abstract

Determine a specific *m* and Q value for a product

Question

How can I determine a specific *m* and Q value for a product for use in calculating the Fatigue Damage Spectrum (FDS)?

Answer

Vibration Research's Fatigue Damage Spectrum (FDS) software is a tool which utilizes weighted time history files representative of the end-use environment of a product to create a FDS. From the FDS a Random Power Spectral Density (PSD) can be calculated creating a random profile that is the damage equivalent to the end-use environment of the product. In order to accurately calculate the FDS the *m* and Q values of the device under test (DUT) must be entered. For analysis, or investigative purposes there are general values that can be entered (*m* = 6 to 8, Q = 10), but for a more in depth analysis, and more precise calculation an *m* and Q value can be determined for a product.

To determine a more specific value for Q, a simple sine sweep through the operating range of the DUT will provide the primary resonance. The Q value used for the FDS should be the Q of the primary resonance. The Q value has a much lesser effect on the FDS than *m*. A higher Q value will use narrower filters resulting in sharper peaks, while the lower Q will result in a wider filter, a smoother spectrum, but less detail.

The *m* value plays a more significant role in the FDS calculation, and the accuracy of the *m* value can significantly improve the accuracy of the FDS generated. The process to determine the *m* is more involved than that of determining Q. In order to accurately determine *m* the S-N graph (Stress to Number of Cycles) must be created (Wöhler, 1870). One method to determine the S-N graph is to repeatedly test a product to failure at varying G_{RMS} levels, recording the amount of time required to achieve failure. When enough failure runs have been recorded, it is possible to back calculate a strong approximation of the S-N curve by plotting the data points on a log-log graph, and then plot the power law model of the data. The slope of the power law model is equal to *b*. From *b* it is possible to calculate the value of *m*.

$$m = -\frac{1}{b} * SF$$

In the formula, SF is based on the recommendations of MIL-STD-810G:

> The value of "*m*" is strongly influenced by the material S-N curve, but fatigue life is also influenced by the surface finish, the treatment, the affect of mean stress correction, the contributions of elastic and plastic strain, the waveshape of the strain time history, etc. Therefore, the value of "*m*" is generally some proportion of the slope of the S-N curve, known as the fatigue strength exponent and designated as "*b*." Typical values of "*m*" are 80 percent of "b" for random waveshapes, and 60 percent of "*b*" for sinusoidal waveshapes. (MIL-STD-810G, 2008)

Vibration Research has a *m* calculation tool that will plot the G_{RMS} vs. time to failure data, determine the slope of the S-N curve, and calculate the *m* based on the input data available on our website: FDS Calculator

References

MIL-STD-810G. (2008, October 31). Method 514.6. *A Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests*. Retrieved September 15, 2015, from http://www.atec.army.mil/: http://www.atec.army.mil/publications/Mil-Std-810G/Mil-Std-810G.pdf

Wöhler, A. (1870). Über die Festigkeitsversuche mit Eisen und Stahl. *Zeitschrift für Bauwesen, 20*, 73-106.