

New Random Vibration Fatigue Capability in fe-safe

Fatigue caused by forced vibration of a random nature is one of the major concerns in the automotive industry. The Power Spectrum Density (PSD) is the most concise and straightforward way of representing a random process in a frequency domain approach. Until now, commercial methodologies for fatigue analysis from PSDs have been limited to shaker table applications and have not fully addressed out-of-phase loadings from multiple channels. PSD is a function that describes the energy content distribution of a quantity over a frequency range.

The mean square value of the acceleration, for instance, can be evaluated by integrating the function with respect to the frequency. The random vibration approach in fatigue is important because:

- It concisely represents the dynamics of a system
- It substitutes the conventional rainflow counter by a probability density function (PDF)
- In FEA, a modal superposition steady state dynamic analysis (SSD) is much faster than a modal superposition transient and full transient analysis
- Random vibration fatigue algorithms are faster than equivalent time domain-based algorithms

fe-safe 6.5 (part of the Abaqus 6.14 release) includes the first release of an advanced and unique method for Random Vibration Fatigue. Key features include:

- Consideration of multiple input loadings in the (Figure 1) fatigue analysis. The user does not need to condense the loadings into a single input channel connected to a master point.
- Therefore, it is possible to study phasing between loading channels and scale and combine them using different factors, which is very convenient.
- Critical plane searching. Besides Von Mises, Normal, Shear, and Normal+Shear critical plane criteria are available.
- Speed of analysis. In order to assess the difference in speed, a comparison between the time and frequency domain was carried out. In this analysis of a go-kart frame, the acceleration time histories were equivalent to the acceleration PSDs. Spectral moments can always be used as parameters to assess the "equivalence" of input loadings.
- Probabilistic analysis is also a great advantage of the new approach in fe-safe. To achieve the same results in the time domain, the user needs to collect a few samples of transient results and perform a confidence interval

New in fe-safe 6.5

- New method for random vibration fatigue
- New method for critical distances
- Extended distributed processing

analysis to determine the range where the correct value (life) is supposed to be. This is far more complex than the new fe-safe method.

The stress histories and the output PSD results for the most damaging node of the analyzed go-kart frame are ultimately used by the fatigue algorithms in fe-safe to evaluate life, damage, and safety factors for time and frequency domain respectively.

The Findley multiaxial fatigue algorithm was used as the time domain algorithm, and Von Mises was used as the frequency domain algorithm. Findley uses the critical plane approach and is considerably slower than the new PSD method in fe-safe. The differences in terms of life and damage were less than 15%. Figure 2 shows the life distribution (log10 of life) for the entire go-kart frame.

The new method of fatigue of PSDs is available in fe-safe 6.5 at no additional cost.

For More Information
www.3ds.com/fe-safe

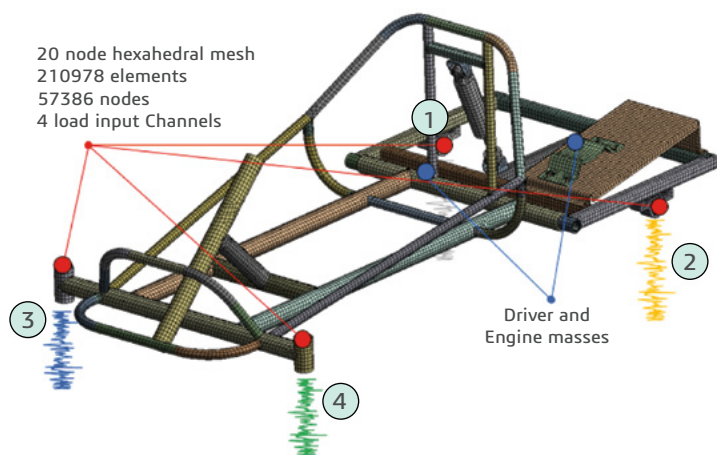


Figure 1. Four loading channels exciting the chassis.

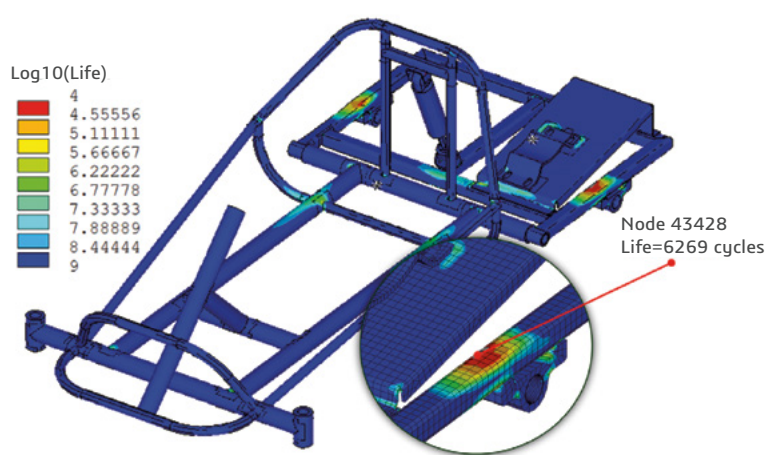


Figure 2. Most damaged node (43428) at the rear part of the go-kart frame, just above the second mounting point.