A7050-RAM2 Fatigue

Product Information

Elementum 3D's A7050-RAM2 is an aerospace and specialty AM aluminum alloy that features a combination of high toughness, high strength, and good stress corrosion cracking resistance.

Introduction to Fatigue

Fatigue in metals and alloys can lead to the failure of a material at stresses well below the yield point of a material through a cyclic loading of the material in service. The fatigue life of a material is evaluated based on how many cycles it takes for a material to fail at a given stress below the yield strength of the material. To generate a full stress vs. fatigue life/cycles curve (S-N curve), multiple dog-bone samples of the material are tested at a variety of stresses.

Test results are reported as a maximum stress, however, fatigue samples are tested based on an amplitude and not simply just one stress value (i.e. the samples are pulled, typically in tension, to a max stress and then unloaded down to a maximum stress per cycle). Often the minimum stress is a compressive stress, so the sample is pulled in tension, unloaded, and then loaded under compression. This stress amplitude is defined by an R-ratio, which, given a maximum stress in an S-N curve, can be used to calculate the minimum stress. An R-ratio of -1 is fully reversible, i.e. the maximum stress is a tensile stress of a given value and the minimum stress is a compressive stress of the same magnitude as the maximum stress (e.g. a maximum stress of 30 ksi implies a minimum stress of -30 ksi, the negative referring to a compressive stress). Another common R-ratio is 0.1, where the minimum stress is 10% of the maximum stress (e.g. a maximum stress of 30 ksi would imply a minimum stress of 3 ksi). For tests performed at particularly low maximum stresses, run-out can occur, which is when a test is discontinued before the failure of material after a high number of cycles, such that reported here as 10^7.

Results

A7050-RAM2 fatigue results are shown by the green points in Figure 1. Expected values for 7050 wrought for comparison to A7050-RAM2 were taken from an MMPDS 7050 data set (provided in Figure 2), shown by the black points and black fit curve in Figure 1. Results were taken from samples tested with an R-ratio of -1. The A7050-RAM2 data shows similar results as those of the wrought MMPDS 7050 data set.

References

1. B. Reiling, G. Laird, "High-Cycle Fatigue Analysis: Stress-Life Made Easy," Endeavor Analysis, LLC, Predictive Engineering, Inc., 2022.

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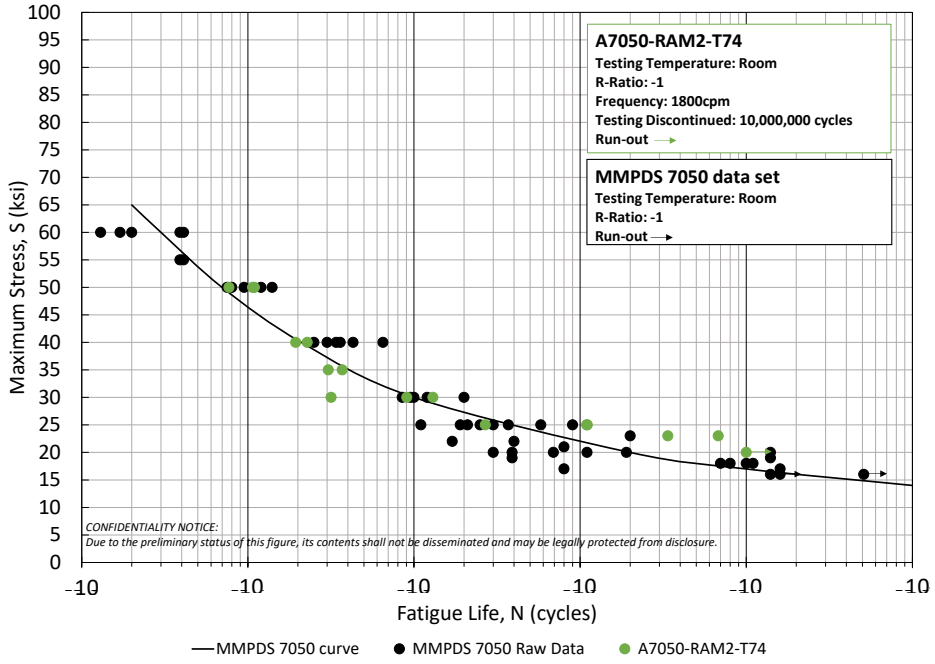

Figure 1: A7050-RAM2 fatigue data (green points) compared with MMPDS 7050 wrought data set (black points with curve fit given by black line), both tested with an R-ratio of -1. MMPDS 7050 wrought data set and fit curve were estimated from Figure 2.[1]

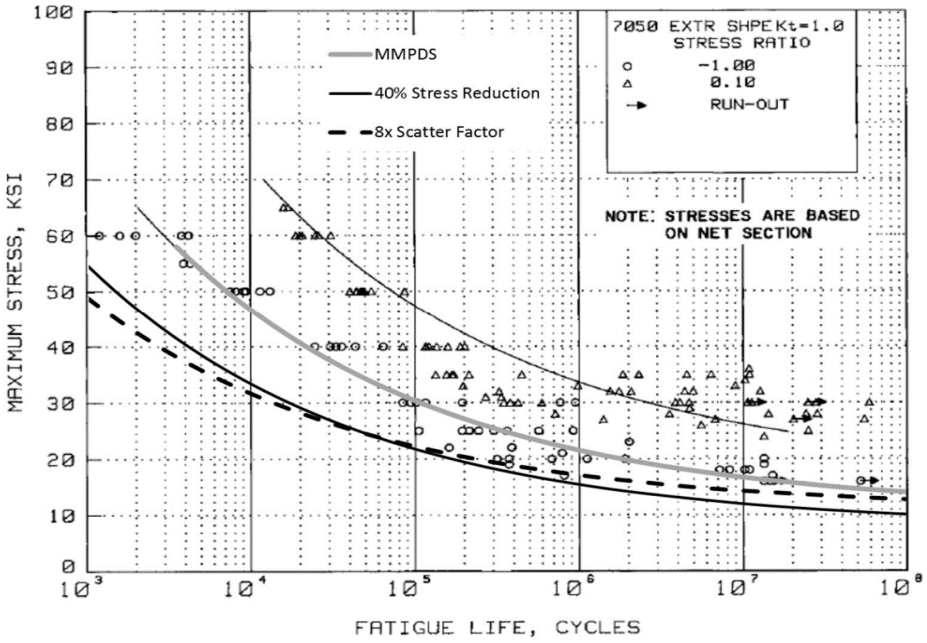

Figure 2: MMPDS wrought 7050 data set taken from literature, R-ratio -1.[1]