§6. A New Test System of Axial Strain Controlled Fatigue Test with Miniature Specimen

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When the fatigue data of neuron irradiated samples under axial strain control is required, a miniature specimen is used to reduce the activated waste. Since the axial strain controlled fatigue test with the miniature specimen is not easy, hour-glass type specimens are adopted. In case of the specimen, the location of crack initiation is limited around the minimum cross sectional area. However, it is known that the hour glass specimens do not give the same data as the round bars which do not show the remarkable size effect of specimen. When the miniature round bar specimen with about 1 mm diameter is considered, the displacement measurement system must have an accuracy of sub-micrometer range. In 2009, a new laser displacement gage system with 1 nanometer accuracy was commercialized.

A new program to develop a new fatigue test system for the axial strain controlled fatigue with miniature specimens started in 2010. In this report, the trial test results using the new fatigue test system with the laser displacement gages are introduced.

The set up situation of the miniature specimen with two laser displacement gages is shown in Fig. 1. Support beams with reflecting plates are attached on the specimen surface pulled by a spring in horizontal direction. The distances between laser a head and a reflecting plate are measured independently and the specimen deformation was calculated by subtraction of the lower deformation from the upper one. The test material is JLF-1.

Figure 2 shows the stress – strain curves of specimen #6. Although the linear deformation is observed, the slope is not match with Young's modulus. Regarding the plastic strain component, the curve shows smaller plastic strain at the initial stage. The changes in the stress and strain during fatigue are shown in Fig. 3. The maximum and the minimum strains are kept constant under feedback control and the maximum and the minimum stresses are decreased gradually. The plastic strain components are shown in square symbols. The remarkable increase of the plastic strain is observed at the initial stage and such behavior was not seen in the case of standard specimens [1].

Figure 4 shows the results of low cycle fatigue of JLF-1. Square symbols show the results of hour glass specimens and round symbols show the results of round bars. The hour glass specimens give a steeper fatigue life curve than that of the round bars. Also, the miniature hour glass gives the shorter life than the standard one. The present results are shown in solid round marks and all data are plotted on the fatigue life curve obtained with the standard specimens. The results show the no effect of the specimen size in case of the round bar.

1) A. Nishimura et al., Journal of Nuclear Materials, 283-287 (2000) pp. 677-680.

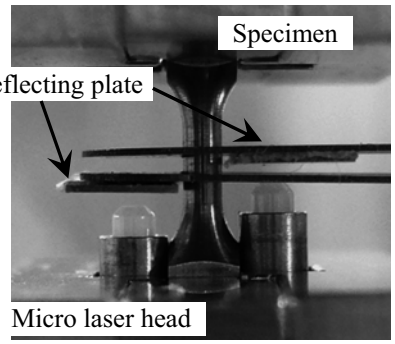

Fig. 1. Set up of specimen, reflecting plates and laser heads.

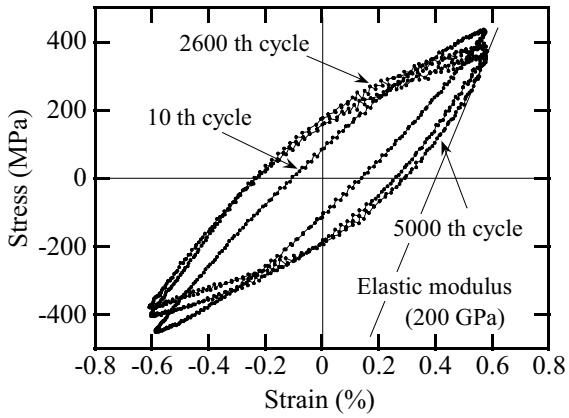

Fig. 2. Stress-strain curves of specimen #6.

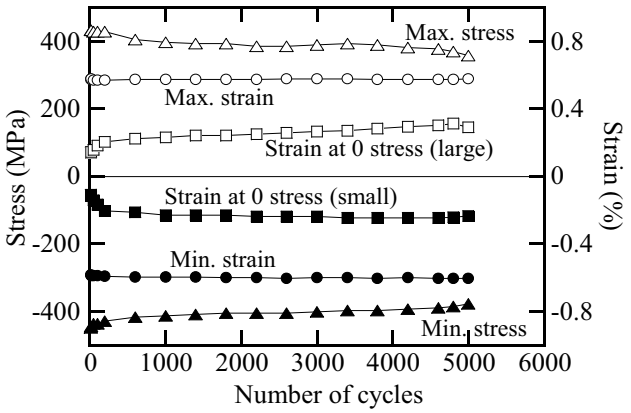

Fig. 3. Changes in stress and strain during fatigue of specimen #6.

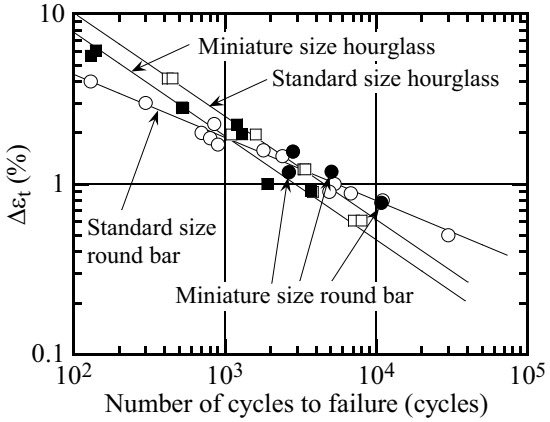

Fig. 4. Fatigue life curve of JLF-1.