



Experimental investigation on the effect of tensile pre-strain on ratcheting behavior of 430 Stainless Steel under fully-reversed loading condition

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ABSTRACT

In this paper, the effect of the tensile pre-strain on ratcheting process in 430 Stainless Steel was examined by performing a series of fully tensile–compression cyclic loading tests on the tested material with three tensile pre-strain levels or no prior deformation. The experimental results indicate that a compressive cyclic creep occurs in all applied cases for the tested material without pre-strain. Clearly, the observation reflects that the tested material exists the an-isotropic in tension and compression. Furthermore, for the tested material with various value of pre-strain, cyclic creep can also be found and the direction of creep deformation is always opposite to that of the given pre-strain. From an experimental observation on the residue deformation produced by cyclic creep, it is found that the stable total compressive creep strain scaled with increasing tensile pre-strains at the same stress amplitude condition. The material with greater compressive creep strain responded to the same applied tensile pre-strain level with higher controlled stress amplitude. Exploring the effects of the tensile pre-strain on the stable stress–strain response, this paper has been focused on those items. They are the strain range, $\Delta\epsilon$, plastic strain range, $\Delta\epsilon_p$, and plastic strain energy density, ΔW_p at half-life. Experimental results show that the material with different tensile pre-strains or without pre-strain had a higher response when the applied stress amplitude range was increased. Those indicated material responses have increased at increasing tensile pre-strain. In observation the effects of tensile pre-strain on the fatigue, it is found that the effect of the tensile pre-strain is to reduce the cycles to failure. A decreasing fatigue life is observed with increasing the tensile pre-strain level. In the domain of high-cycle fatigue life (in the range of 10^5 – 10^7 cycles), the effect of tensile pre-strain on degrading fatigue life is obvious and the degree of reducing fatigue life is governed by the magnitude of the stress amplitude. Moreover, the damage parameter based on the total plastic strain energy, $W_f = \sum \Delta W_p$, can produce satisfactory life prediction results for 430 Stainless Steel with a tensile pre-strain effect under fully reversed tension–compression loading condition.

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