論文の内容の要旨

氏　名　　AYE THANT HTOO

Fatigue problems are important issues for structural integrity and safety design of structures. Notches and holes are unavoidable in practical structures for their functions. Therefore, fatigue behavior of structures with notches or holes should be solely understood for safety design. It is well known that in low cycle fatigue region, the strain-life curves are identical regardless of the applied remote stress ratio in the high strain amplitude region. On the contrary, effect of stress ratio on the stress-life curve is significant in high cycle fatigue region and fatigue strength decreases with an increase in stress ratio. The transition behavior between these two typical fatigue regions is expected to be complicated. However, there has been almost no detail research on fatigue behavior in transition region. Moreover, the prediction of fatigue life in the transition region has been not always reported and clarified. In the present study, the notch fatigue behavior in transition region was investigated for two different materials of Ti-6Al-4V alloy and A2024-T4 alloy. Moreover, effect of local stress ratio variation at notch root on transition behavior was clarified and discussed. Fatigue life prediction was attempted in the wide range of low cycle fatigue to high cycle fatigue including transition region based on the combined finite element analysis and Smith Watson Topper (SWT) damage parameter taking into account the local stress ratio variation.

Chapter 1: Introduction — The background of fatigue and basic knowledge of notch effect on fatigue has been introduced and current status of notch research has been reviewed. The scope and objective of the present study have been also addressed.

Chapter 2: Notch fatigue behavior of Ti-6Al-4V alloy under load-controlled high cycle fatigue tests — Notch fatigue behavior of Ti-6Al-4V alloy has been investigated under load-controlled high cycle fatigue tests and elastic-plastic finite element analysis also carried out to investigate the effect of local stress ratio variation at notch root in the high cycle fatigue regime and in the transition region. The results indicated that the S-N curve was kinked in transition region at the critical nominal stress amplitude above which the local stress ratio becomes low due to the development of plastic deformation at notch root.

Chapter 3: Notch fatigue behavior of Ti-6Al-4V alloy under displacement-controlled low cycle fatigue tests — Wide range of notch fatigue behavior has been investigated by carrying out the displacement-controlled low cycle fatigue tests of the Ti-6Al-4V alloy notched specimen combined with the previous results of the load-controlled high cycle fatigue tests. The elastic-plastic stress and strain states and variation of local stress ratio at notch root have been investigated by carrying out the elastic-plastic finite element analysis. From the results, it was found that S-N curve was deflected between high cycle fatigue region and low cycle fatigue region. The local stress ratio in high cycle fatigue region is constant and equal to the remote applied stress ratio. It started to decrease at the kinked point and decreased with increasing the nominal strain amplitude and then reached -1 in low cycle fatigue region. The region of local stress ratio variation can be defined as the transition region. The fatigue lives of notched specimens in wide range from low cycle fatigue and high cycle fatigue including transition region were successfully predicted by taking account the local stress ratio variation at notch root based on SWT parameter combined with elastic-plastic finite element analysis under cyclic loading.

Chapter 4: Notch fatigue behavior of A2024-T4 alloy in high cycle fatigue, transition and low cycle fatigue regions — The detail of local stress ratio variation and its effect on notch fatigue behavior of different material has been investigated by using A2024-T4 alloy. Based on the results, similar transition behavior in S-N curve and the local stress ratio variation have been found. The local stress ratio variation was more significant in A2024-T4 alloy with lower yield stress. In addition, the fatigue life prediction method proposed in chapter-3 could be also successfully applied to the A2024-T4 alloy.

Chapter 5: Summary — The conclusions obtained in the current work have been summarized. Also future works have been addressed.