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Abstract of Doctoral Thesis

Title: Property of Strength and Life Evaluation in Multiaxial Fatigue under Service Loading Condition

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Actual structures and components undergo multiaxial fatigue damage under service loading, e.g. non-proportional loading in which the direction of a principal stress and strain are changed in a cycle, wide range multiaxial loading and random loading. The experimental data under multiaxial loading conditions which are equivalent to service conditions are necessary for a safe design of the actual structures and components. However, a few experimental data under limited multiaxial loading conditions have been reported because of requirements of special testing stands and very high technique to carry out the tests.

This thesis studied properties of strength based on experimental results tested under wide ranged multiaxial stress and strain states using several types of the testing stands as well as presented the developed testing stands. This study also developed a modified strain parameter for fatigue life evaluation under complex multiaxial loadings in order to apply the parameter to a damage model for under the service loading conditions. The proposed parameter, the modified $\Delta\varepsilon_{NP}$ ($\Delta\varepsilon_{NP}^{mod}$), which was improved based on the non-proportional strain range ($\Delta\varepsilon_{NP}$) proposed by Itoh and Sakane et al. by taking account of factors resulted from non-proportional multiaxial loading conditions. The factors employed are the elastic-plastic dominant in high cycle regime, the intensity of multiaxial stress and strain, the notch effect and the phase of random loading. $\Delta\varepsilon_{NP}^{mod}$ had a good correlations of failure lives and was the suitable strain parameter applicable to damage model under non-proportional multiaxial loading conditions, which becomes quite useful for design and maintenance of the actual structures and components.