報告番号	※ 甲 第 10736 号

主 論 文 の 要 旨

論文題目 Extremely Low Cycle Fatigue Assessment of Corner Crack in Concrete-Filled Steel Piers with Box Section （矩形断面を有するコンクリート充填橋脚の角割れに対する極低サイクル疲労照査法に関する研究）

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論 文 内 容 の 要 旨

After the Hyogo-ken Nanbu earthquake, concrete-filled steel bridge piers were often used to prevent local buckling and to improve seismic performance of existing steel bridge piers. The concrete-filled steel piers have high ductility and load carrying capacity due to confinement of filling concrete. Therefore, the concrete-filled steel piers are able to show certain resistance against large cyclic plastic deformations. When the piers endure the large cyclic plastic deformation, low cycle fatigue damage will become a key issue. This dissertation develops the extremely low cycle fatigue assessment method of concrete-filled steel piers with box section through several fatigue tests and elasto-plastic finite element analyses.

In the first part of the work, extremely low cycle behavior of the steel pier in which concrete was filled for retrofitting against local buckling was investigated experimentally. Besides, strain behaviors around the cracking sites in the pier were obtained by elasto-plastic finite element analyses. It was revealed that the low cycle fatigue crack from the corner weld is one of the main failure modes of concrete-filled steel piers with box section.

As the second part of the work, low cycle fatigue tests were conducted on small-scale corner welded joints with single bevel groove welding. The test results indicated that the low cycle fatigue strength of the corner welded joints strongly depends on the weld root size. Then, the fatigue strength of the corner joints was evaluated based on the effective notch strain at the weld root tip which was calculated by elasto-plastic finite element analyses. A unique relationship between the effective notch strain and the fatigue life of the joint was observed regardless of the weld root size. And the fatigue strength curve for corner welded joints was proposed based on the relationship.

In the final part of the work, the applicability of the proposed method to concrete- filled steel piers was confirmed. The effective notch strain was calculated by finite element analyses with sub-modeling technique. By comparing the effective notch strain to the proposed fatigue strengths curve, cumulative damage indexes were calculated. The predicted fatigue

lives by the method show relatively conservative results compared with the experiment. However, the proposed assessment method can give relatively accurate predictions of fatigue life of concrete-filled steel piers in the extremely low cycle fatigue region. In order to reduce the difference of fatigue lives between the prediction and the experiment, new fatigue strength curve was suggested by considering crack propagation. As a result, it was revealed that the fatigue lives of the specimens can be predicted more accurately by considering the crack propagation into the proposed method.