主　論　文　の　要　約

論文題目　**PERFORMANCE IMPROVEMENT FOR WELDED STEEL STRUCTURAL MEMBERS BY HEAT TREATMENT TECHNIQUES**

(熱処理技術による溶接鋼構造部材の性能向上に関する研究)

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論　文　内　容　の　要　約

Welding is the main source of joining materials in the repair and reinforcement works of the damaged and deteriorated members in steel bridges due to its superior benefits. However, weld-related problems, such as residual stresses and deformations, are inevitable. The presence of residual stresses associated with the weld-induced deformations promotes detrimental effects on the structural performance capacity and integrity of the welded structural members. Therefore, there is a need for finding appropriate treatment methods to manipulate weld-induced residual stresses effectively. The current dissertation focused on two types of thermal treatment methods which are known as stress relief method and stress control method using two heating apparatus such as sheet-type ceramic heater and induction heating (IH) for the reduction of residual stress and improvement of performance capacity of the welded members.

An extensive study of two heat treatment methods on the various types of welded steel members was implemented experimentally and numerically. Localized heating of the stress control method with IH was focused on the simple steel plates without involving the welding process to comprehensively understand the characteristics and behavior of residual stresses by IH. It was observed that the localized heating with IH was able to generate compressive residual stress, which would be beneficial for fatigue performance improvement. Besides, stress control method with IH was applied to the gusset-welded joint, and four-point bending test was conducted to examine the effectiveness of the

proposed method on the reduction of the weld-induced tensile residual stresses at the weld toe and improvement of fatigue performance. It was proved that localized heating with IH could reduce completely the weld-induced tensile residual stresses, and even some extent of compressive residual stresses was produced at the weld toe. Consequently, it could enhance the fatigue life of the gusset-welded joint about 2 to 5 times for high cycle fatigue.

Another proposed heat treatment method, namely stress relief method of Post-weld heat treatment (PWHT), was also employed for my research. In this method, JIS standard specifications were adopted for the heat treatment process, including heating rate, holding temperature, holding time, and cooling rate. The stress relief PWHT with IH was employed to the patch-plate joints to evaluate the effect of the proposed treatment method on the welding residual stresses and fatigue performance of the patch-plate joints. The study proved that the proposed method was able to improve the fatigue life of the patch-plate joint by reducing the welding tensile residual stress. Another heating apparatus, the sheet-type ceramic heater was applied for the stress relief PWHT to examine the improvement of the load-carrying capacity of the non-stiffened welded box members by reducing the welding residual stresses. The results confirmed that the proposed stress relief PWHT with the ceramic heater could improve about 32% of the load-carrying capacity of the as-welded specimens by reducing 78 % to 88% of the weld-induced residual stresses.

Basic numerical simulation models of the heat treatment methods were established in each experimental work to be applied for the other welded members in future since implementing and investigating the actually large steel members in the laboratory is difficult and expensive. All numerical models could simulate the temperature histories for the welding process and heat treatment process. Besides, they agreed well the residual stresses generated by the welding and heat treatment experiments. The numerical model for the welded box members could simulate the compressive behavior and mode of deformations of the loading experiment. Thus, it could be concluded that numerical models for both localized and overall treatment methods could be successfully developed and validated by the experimental results.