PCTC 박판 블록 용접 변형에 관한 연구

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A Study on Welding Deformation of thin plate block in PCTC

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Abstract

The use of thin plate increases due to the need for light weight in large ship. Thin plate is easily distorted and has residual stress by welding heat. Therefore, the thin plate should be carefully joined to minimize the welding deformation which costs time and money for repair. For one effort to reduce welding deformation, it is very useful to predict welding deformation before welding execution.

There are two methods to analyze welding deformation. One is simple linear analysis. The other is nonlinear analysis. The simple linear analysis is elastic analysis using the equivalent load method or inherent strain method from welding experiments. The nonlinear analysis is thermo-elastic analysis which gives consideration to the nonlinearity of material dependent on temperature and time, welding current, voltage, speed, sequence and constraint.

In this study, the welding deformation is analyzed by using thermo-elastic method for PCTC(Pure Car and Truck Carrier) which carries cars and trucks. PCTC uses thin plates of 6mm thickness which is susceptible to welding heat.

The analysis dimension is 19,200mm(length) * 13,825mm(width) * 376mm(height). MARC and MENTAT are used as pre and post processor and solver.

The boundary conditions are based on the real situation in shipyard. The simulations contain convection and gravity. The material of the thin block is mild steel with 235N/mm^2 yield strength. Its nonlinearity of conductivity, specific heat, Young's modulus and yield strength is applied in simulations. Welding is done in two pass. First pass lasts 2,100 second, then it rests for 900 second, then second pass lasts 2,100 second and then it rests for 20,000 second.

The displacement at 0 sec is caused by its own weight. It is maximum 19mm at the free side. The welding line expands, shrinks during welding and finally experiences shrinkage. It results in angular distortion of thin block. Final maximum displacement, 17mm occurs around welding line. The maximum residual stress happens at the welding line, where the stress is above the yield strength. Also, the maximum equivalent plastic strain occurs at the welding line. The plastic strain of first pass is more than that of second pass.

The flatness of plate in longitudinal direction is calculated in parallel with the direction of girder and compared with deformation standard of ±15mm. Calculated value is within the standard range. The flatness of plate in transverse direction is calculated in perpendicular to the direction of girder and compared with deformation standard of ±6mm. It satisfies the standard. Buckle of plate is calculated between each longitudinal and compared with the deformation standard. All buckle value is within the standard range of ±6mm.

Key Words : Nonlinear analysis method, welding deformation, thin plate