

Development of Production Technology for Thin-Plate Deckhouse Structures

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Introduction

From the economic viewpoint, one of important issues for shipbuilding companies is to employ thin-plate panel structures to various parts of ship structures. Recently cruise ships are on high demand in market and we are required to develop production technologies of typical thin-plate stiffened structures. As thin-plate structures are known to be susceptible to deformation during fabrication, research work was taken experimentally and numerically to investigate welding distortion behavior and evaluate dominant factors affecting final shapes during production stages. Model blocks were fabricated for research purpose and step-by-step approach was taken to investigate quantitatively welding distortion behavior from plate handling to final block assembly, being compared with Quality Standard Requirements.

Procedure

In order to develop distortion-resistant production method, two model blocks have been fabricated with base plates of 13,500mm length, 6,950mm width and 5.0/5.5mm thickness and transverse/longitudinal bulkheads, girders, longitudinal/transverse beams. Production procedures include plate unloading and handling, shot blasting, plasma cutting, sub-assembly fabrication, girders and bulkhead fabrication, block erection and final block assembly. Thin base plate deformation behavior was mainly investigated at each production stage to evaluate which stage has a dominant effect on deformation and what factors should be controlled to obtain reliable deckhouse structures. Also, numerical analyses were taken to determine proper welding sequences for girder fabrication.

Results and discussion

Experimental results indicate that thin base plate unloading and handling have a minor effect on surface quality except some local dent being damaged during unloading stage. Plasma cutting provides a reliable cutting tolerance in shrinkage and out-of-plane distortion. In sub-assembly, longitudinal girders of 13,500mm length and 440mm width were welded using co2

welding process and produced max. 50mm longitudinal bending distortion; line heating was resultantly applied to correct bending distortion, reducing to max. 5mm range. Three welding procedures with different constraint methods are suggested and numerical analysis results provide reasonable choice to less distortion welding procedure. Base plates (13,500x2,300x5.0/5.5mm) were welded using SA and GMA welding processes, and produced different out-of-plane distortion behavior. Block assembly was made with fillet welds deposited to connect all bulkhead and stiffeners to base plates. Out-of-plane distortion of base plates was measured after block assembly welding and final block was assembled with lower and upper structures. On site quality control was strictly made to evaluate whether production quality standard requirements are met.

Conclusions

As expected thin-plate unloading and handling produces a minor effect on deformation except local dent due to clamping, and plasma cutting was found to be less susceptible to distortion. On the other hand, fillet-welded longitudinal girders and base plates welded using SA and GMA welding processes produce larger welding distortion. Numerical analysis results suggest similar distortion behavior and proper welding sequences are proposed. In block assembly fillet welds produces smaller angular distortion of base plates due to increase of rigidity with connection of stiffeners and girders to base plates. It was finally concluded that fillet welded girders and butt welded base plates produced larger welding deformation compared with other production stages, and further research work will be performed to provide distortion control method.