On the Weld-Induced Deformation of Thin Panels to Welding Process

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ABSTRACT

It has been well appreciated that the weld-induced deformation control is one of the most issues from view point of efficiency in marine structure production. The weld-induced deformation of thin plate block is relatively more serious than thick plate block due to several reasons. Among weld-induced deformation, buckling deformation due to longitudinal shrinkage and residual stress in weld line direction is one of the most serious deformation types. This paper is concerned with investigating the weld-induced deformation of thin panel block to different stiffener type and welding process. Welding tests have been carried out for fillet welding of flat bar type stiffener and C shape channel stiffener with changing space of the intermittent welding. Thermo-elasto-plastic analysis has been also carried with varying the affecting parameters on weld-induced deformation. Results of welding test and numerical simulations are compared from view point of quantitative weld-induced deformation and deformed shape. Bending test has been also carried out to compare the strength to change in welding process.

KEY WORDS: Butt welding; C-channel type stiffener; Continuous welding; Fillet welding; Intermittent welding; Weld-induced deformation

INTRODUCTION

It has been well appreciated that although the weld-induce deformation is inevitable, it should be controlled to be as low as possible for the sake of production efficiency of ship’s blocks. Recently, the portion of thin plate usage increases to reduce hull weight, and it is expected that thin plate will take more portion in the case of ship having multi-deck. From view point of heat transfer characteristics, the weld-induced deformation of thin plates should be more seriously considered than thick plates because heat affect zone is wider than that of thick plate when the same amount of heat is inputted. In addition to this the weld-induced deformation of thin plates is more sensitive to both the internal and external constraints than thick plates. In the case of thin plates, buckling deformation is one of the major deformation type due to the longitudinal shrinkage and the compressive residual stress in the weld direction(Jang and Seo, 1998; Kim, 2003; Matsubuchi, 1980). The weld-induced deformation becomes the obstacle in enhancing the productivity of ship structure since it cause to increase correction hours in fitting and adjusting works in ship production process (Jang and Lee, 1998; Lee, 2004; Seo, 2005).

This paper is concerned with investigating the weld-induced deformation characteristics of thin panel block to the stiffener types, say flat bar and C shaped channel, and welding process. Welding test and thermo-elasto-plastic analysis have been carried out for several thin panel models. The validity of thermo-elasto-plastic analysis procedure has been verified by comparing the results with those of welding tests from view point of magnitude and distribution of weld-induced deformation(Lee, 2009).

Transverse angular distortions to change in welding process, say continuous and intermittent welding are compared to illustrate the benefit of the intermittent welding. Bending tests have been also carried out to compare the strength of unit panel block for two stiffener types and three welding processes.

WELDING TEST

To compare the weld-induced deformation for the different type of stiffener, two types of stiffener are chosen as shown in Fig. 1, that is flat bar and C shaped channel. The models of which stiffener is flat bar and C shaped channel are denoted as Model A and Model B, respectively. Model A1 is one side fillet weld and Model A2 is both side fillet welding. Model B1 has butt weld joint, but Model B2 does not have it. Details for the present models are illustrated in Table 1. Table 2 and 3 show the size of specimen and welding condition. The same welding conditions are used for all models, and CO2 welder is used for the welding test. Fig. 2 shows the welding bead for the continuous welding, intermittent welding of 3 intervals and intermittent welding of 5 intervals. In case of intermittent welding, distance of welded and unwelded part are same.