ANALYSIS OF WELD SHRINKAGE TO OBTAIN COMPENSATION FACTORS FOR SHIP HULL CONSTRUCTION

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DECLARATION

This report contains no material, which has been accepted for the award of any other degree or diploma in any University or equivalent institution in Sri Lanka or abroad, and that to the best of my knowledge and belief, contains no material previously published or written by any other person, except where due reference is made in the text of this report.

I carried out the work described in this report under the supervision of Dr. H. K. G. Punchihewa.

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Abstract

Modern manufacturing faces two main challenges: more quality at lower prices and the need for the productivity improvement. In ship building industry, companies need to respond to market requirements efficiently, keeping their products competitive while reducing the cost. When considering complicated ship production processes up to final hull block erection, the productivity of each work station for hull assembly mainly depends on the dimensional quality of hull blocks. Poor dimensional accuracy leads to reworks such as re cutting, mechanical or thermal correction against misalignment, excessive welding for wide gap and thermal straightening and this will subsequently increases the total production cost.

One of the major dimensional accuracy control activities is the shrinkage margin design, which means that the optimal excess of plate is calculated and assigned into ship production drawings in order to compensate for the accumulated welding shrinkage through block assembly phases. In Sri Lankan context the most common practise to compensate for shrinkage has been to add excess material, usually 50-100 mm on one or two sides of a block that would be trimmed at the erection stage. Normally, this added material would be adequate to compensate for any weld shrinkage incurred during block assembly. It is however, a commitment to rework. This has been adopted due to the lack of accurate and reliable weld shrinkage and distortion allowance data. Even though there are some research findings on shrinkage factors it can't be directly apply for the Sri Lankan industry as shrinkage factors may vary from shipyard to shipyard due to facilities, welding equipment, joint design, welding sequence, ambient temperature, and type of material.

This research project provides a comprehensive weld shrinkage factor identification that enables neat construction capabilities for the shipbuilding industry in Sri Lanka. A key component of the research is a predictive weld shrinkage factor based on current ship designs, materials, and construction practices. Through this study, the shrinkage factors will be identified by a statistical analysis of data. It will be done from the development of check sheets, establishing of checking procedures, data gathering, and finally the statistical analysis of data. Since variety of variables can affect the determination of a shrinkage factor, it has to be decided the most crucial factors for particular production process and consider only those factors as the variables. Even though there are three major processes (panel fabrication, block construction, block assembly) in ship building the data was analysed only for data collected from panel fabrication and sample testing. Finally two equations were derived for sample testing and panel fabrication separately by providing dedicated factor for each and every considered variable. The obtained results were validated again by means of another sample testing and the deviation is less than 0.2 mm. The other processes were not considered due to complexity of the structures and data collection difficulty with in limited time frame.

The block construction and assembly processes can be considered for the next step of this research and it can be done with the involvement of modelling software. From the modelling software the differences in each of complex blocks can be identified easily and measured values can be analysed against those differences. Then a comprehensive welding shrinkage compensation factor can be identified and it can be entered to the modelling software at the time of modelling the vessel.

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