Analytical and Experimental Study on the Thickness Effect to Fatigue Strength
(1st Report - Results of Fundamental Specimens)

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ABSTRACT

Thickness effect is known as a weakening factor in fatigue strength. However, sufficient knowledge is still unavailable with regard to what factors are dominating such thickness effect and also how the different structural or joint types or different loading patterns influence such thickness effect. In this paper, the results of fundamental experiment are shown in combination with the associated finite element analysis. Some observations are demonstrated to clearly thickness effect, and based on the observations, preliminary proposal of the method to estimate thickness effect was derived.

KEY WORDS: fatigue strength, thickness effect, fatigue test, stress concentration, stress gradient, fatigue strength reduction factor, Siebel’s diagram

INTRODUCTION

It is commonly known as thickness effect that increase in plate thickness causes a decrease in fatigue strength. However, sufficient knowledge is still unavailable with regard to what factors are dominating such thickness effect and also how the different structural or joint types or different loading patterns influence such thickness effect. As a result, it is envisaged that the existing fatigue rules and codes incorporate this thickness effect in rather conservative way because of the many unknown factors.

To cope with this problem, some analytical or experimental studies have been carried out recently (Nakamura and Yamamoto, 2007; Polezhayeva and Badger, 2009; Fukuoka and Mochizuki, 2010). However, more comprehensive study is necessary to establish more reasonable and reliable method to evaluate thickness effect applicable to variations of details of actual ship structures. To this end, a Joint Research Project, whose secretariat is ClassNK, was undertaken by the Shipbuilders’ Association of Japan (SAJ) and Nippon Kaiji Kyokai (ClassNK).

In this project, three types of experimental study were planned:

- Fundamental experiment to reveal the difference of stress concentration and stress gradient to the thickness direction around the weld toe depending on the thickness difference. Small specimens which simulate the contour shape of fillet weld joint section of a series of different thicknesses were cut out from the steel plate of 20mm thickness, and were prepared to fatigue