Effect of Impact Energy on Brittle Crack Propagation Behavior of Crack Arrest Toughness Specimen
- Study on Standard Test Method for Crack Arrest Toughness, $K_{ca}$ -3-

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ABSTRACT

In case impact energy in a brittle crack arrest toughness test is excessively large, the impact energy gives conservative test results. In this research, effects of impact energy on arrest toughness, $K_{ca}$, of in crack arrest toughness specimens were investigated by dynamic elastic FEM analysis.

The FEM analysis results of the record of $K_d$ showed that the effect of impact was strongest immediately after impact, and gradually decreased thereafter. The judgment of whether the impact had an effect on the results was made by calculating the ratio of the values of $K_d$ for both cases of considering impact and not considering impact.

To verify these calculation results using a steel plate with a known value of brittle crack arrest toughness under standard conditions, experiments were conducted under near limit conditions (whether the impact had an effect on the results). The evaluation values of test specimens were nearly located on the existing evaluation line.

From the above results, in the range with no need to consider the effect of impact determined from the simplified calculation results, evaluation was able to be conducted with little consideration of the effect of impact.

KEY WORDS: brittle fracture; test method for crack arrest toughness, Impact Energy.

INTRODUCTION

In a standard test method for crack arrest toughness, temperature gradient is set in the width direction of a test specimen, a uniform stress is applied to the test specimen, and the test specimen struck to initiate a brittle crack from the mechanical notch at the side of the test specimen.

The arrest toughness, $K_{ca}$, at the temperature, $T$, shall be calculated from equation (1) using the arrest crack length, $a$, and the applied stress, $\sigma$.

$$K_{ca} = \sigma \sqrt{\frac{a}{\pi}} \sqrt{\frac{2W}{\pi a} \tan \left( \frac{\pi a}{2W} \right)}$$

Where $\sigma$ is the applied stress, $a$ is arrest crack length, and $W$ is test plate width.

But in case impact energy in a brittle crack arrest toughness test is excessively large, the test gives conservative test results. Fig. 1 shows an example of the effect of impact energy on the results of brittle crack arrest toughness tests (Oguchi, 2010). The numerical values expressed to three decimal placed in the figure are the ratios of the values of $K_d$ for both cases of considering impact and not considering impact.

In this research, assuming that a $K_d$ ratio of 1.5 is the threshold value between effect and no effect on evaluation values, numerical experimental evaluation was conducted on the effects of impact energy.