Evaluation of Fatigue Crack Initiation Point of Load Carrying Cruciform Welded Joints

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Summary

Incomplete penetration occurred in load carrying cruciform welded joints by poor welding in spite of full penetration in design. There is a high possibility that the tip of incomplete penetration may be an initiation point of a fatigue crack due to high stress concentration. In this study, in order to grasp influences of incomplete penetration on the initiation point of the fatigue crack in load carrying cruciform welded joints, parametric FEM analyses using effective notch stress approach were carried out. As a result, the influence of incomplete penetration increases with an increase of the plate thickness, and the reduction of stress at the weld root by increasing the weld size with the increase of the plate thickness on was not expected due to the unequal leg length welding.

Keywords: effective notch stress; incomplete penetration; load carrying cruciform welded joints.

1. Introduction

Load carrying cruciform welded joints are used in steel bridges, such as beam-to-column connections of steel bridge frame piers. Incomplete penetration occurred in the joints by poor welding in spite of full penetration in design [1]. There is a possibility that incomplete penetration may be an initiation point of a fatigue crack. It is difficult to detect the fatigue cracks initiated from the incomplete penetration, because such cracks initiate and propagate in the inside of the weld joint. Therefore, it is desirable that the cracks initiated from the incomplete penetration were prevented.

To prevent the cracks initiated from the incomplete penetration, it is necessary to clarify influences of incomplete penetration on the initiation point of fatigue crack. In general, the fatigue crack initiated from the weld toe or the tip of the incomplete penetration (the weld root) of the load carrying cruciform welded joints. One of the methods for preventing fatigue cracks initiated from the weld root is to delay the initiation of fatigue crack from the weld and root after the initiation of fatigue crack from the weld toe. This indicated that the fatigue strength of the weld joints was determined without regard to initiation of fatigue crack from the weld roots. Therefore, it is able to prevent the fatigue cracks initiated from the incomplete penetration by comparing the initiation of fatigue cracks from the weld toe with that of the weld root.

Many studies on the initiation points of fatigue cracks of the weld joints have been conducted experimentally and analytically. Kainuma and Mori [2] investigated the crack initiation points of the load-carrying fillet cruciform joints by comparing the crack propagation initiated from the weld toe with the crack propagation initiated from the weld root based on fatigue tests and fracture mechanics approach, and they proposed the fillet welding size for preventing the fatigue crack initiated from the weld roots. However, previous studies focused the fatigue strength when weld joint was fractured. Hence, in order to prevent the fatigue crack initiated from the weld root more properly, it is necessary to focus the fatigue crack initiation strength at the weld toe and the weld root.

In this study, in order to grasp the influence of incomplete penetration on the initiation points of the fatigue crack in the load carrying cruciform welded joints, parametric FEM analyses using effective notch stress approach were carried out. Based on analytical results, allowable incomplete penetration sizes for preventing the fatigue cracks initiated from the weld root were proposed.

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