第 I 部門 Numerical Study for the effect of Additional welding treated by Grinding on Fatigue Strength in Out-of-Plane Gusset Welded joint

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1. Introduction

Concerning the aging of structures, fatigue damages have become serious problem. In steel bridges, the fatigue strength of welded joints is one of the critical aspects that determine the life of the structure. Many cases[1), 2)] show that cracks usually occurred at weld toe in the welded joints. This phenomenon is mostly influenced by the weld bead shape and the tensile residual stress induced during welding process. Therefore, various methods have been proposed for improving the fatigue strength by decreasing the stress concentration and the tensile residual stress at weld toe.

For the deeper understanding of extension mechanism of fatigue life by weld bead shape and also to search for an optimum condition of their processes, it is expected to perform numerical studies. In this work, numerical investigations were carried out to characterize the effect of the shape of weld toe on fatigue strength of out-of-plane welded gusset. The fatigue crack initiation life of out-of-plane gusset welded joint is evaluated by using local response obtained by cyclic plasticity analysis, and the subsequent propagation life is evaluated based on fracture mechanics analysis with Pari's law.

2. FE model and boundary condition

3D finite element (FE) models were generated based on the specimen geometries measured by a 3D scanner, as shown in Fig.1. Considering the shape of the test specimens and for the purpose of reducing numerical costs, only 1/8 of geometry was modeled in 3D for as-weld and additional weld. In addition, the FE models, with additional welding and grinding specimen, were divided into three types named B0, B2, B4, B0G, B2G, B4G, depending on the distance of the additional weld target position from the weld toe (i.e. 0mm, 2mm and 4mm). The parameters of weld bead including toe radii and flank angle were depicted in Table 1 and the symmetric boundary conditions was applied. Cyclic elastoplasticity analyses[3),] were conducted to detect the accumulation of irreversible deformations to investigate the crack formation as consequence of the plastic strain localization. Subsequently, once defined the location of the crack, its propagation was studied by conducting linear fracture mechanics analyses.

3. Results and discussion

The results for the different specimens, listed in Table.1, show that the smaller flank angles and bigger weld toe radii are found at longer distances form weld toe. In addition, more improvement of weld bead shape can be obtained by grinding treatment after additional welding. The results of the elastic analyses revealed that the additional welding treated by grinding remarkably reduces the stress concentration at the weld toe compare with other cases. it need to be mentioned that , after grinding treatment ,the bigger maximum stress concentration is found from B4G model compare with B0G,B2G cases and the location changed to weld bead shape transition at middle part of weld bead. Fatigue crack initiation lives for all cases are illustrated in Fig.3 The additional weld treated by grinding models show an improvement of the crack initiation life, due to lower stress concentration. Finally, fatigue life is illustrated in the

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last figure. It shows the additional weld treated by grinding remarkably improved fatigue strength of out-of-plane gusset.

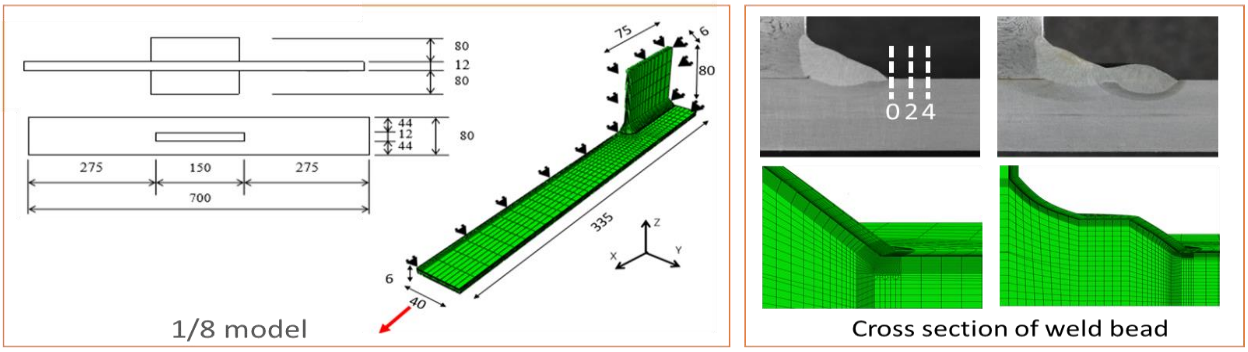

Fig.1 FE model

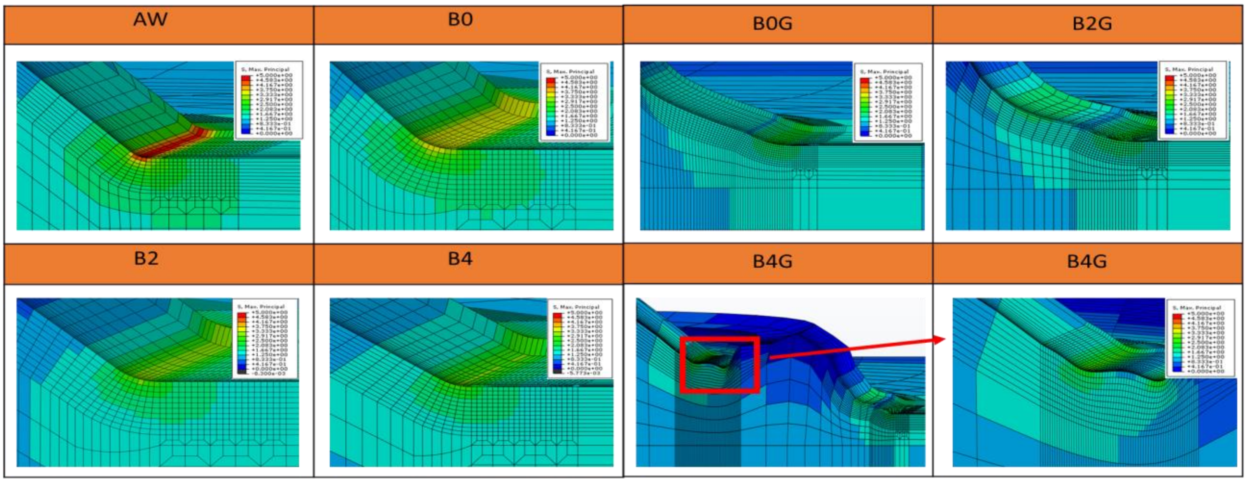

Fig.2 Maximum principal stress distribution

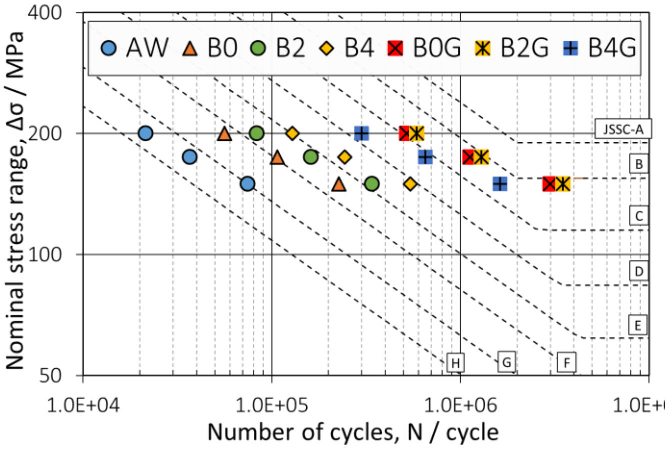

Fig.3 S-N curves for fatigue crack initiation life

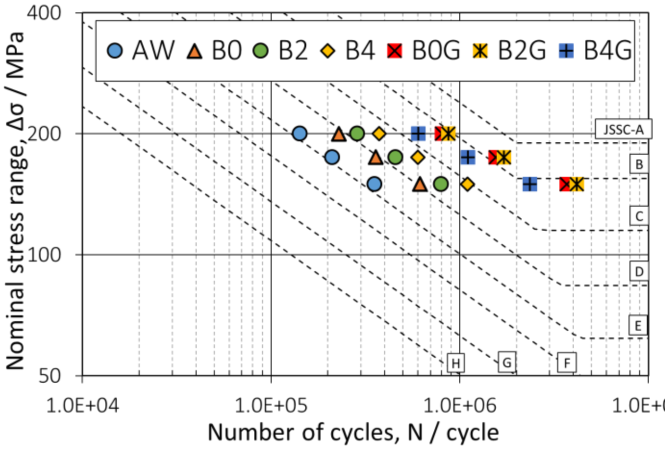

Fig.4 S-N curves for fatigue life

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