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論 文 内 容 の 要 旨
Abstract of Dissertation

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Numerous studies have shown that, in steel truss bridges, corrosion is frequently found on the gusset plates which connect members, particularly where the plate connects to the upper flange of the lower chord member. The corrosion of gusset plate connections has been confirmed to decrease load-carrying capacity, and it can lead to the collapse of an entire bridge. Besides, attachment of stiffening plate and member replacement are among the conventional methods often applied to repair corroded structures. However, these repair works lack efficacy because of the heavy machinery and welding facilities required. Therefore, a simpler and more effective repair method for the corroded gusset plate connection is urgently needed.

This study focuses on the following main objectives: 1) evaluating the remaining load-carrying capacity of the corroded gusset plate connection; 2) establishing a proper repair method for the corroded gusset plate connection; with main contents described as the following.

Firstly, laboratory loading tests and FEM analyses were conducted using approximately half-scale models of real bridges on two different forms of corrosion of a critical gusset plate: the corrosion loss of the lower chord flange-to-gusset weld and the corrosion loss of the gusset plate thickness. This study then implemented parametric FEM analyses of the effects of the degree of corrosion on the remaining load-carrying capacity of the gusset plate connection with the model of specimen and a full-scale model of an actual bridge. Additionally, based on the results of the parametric FEM analysis in the cases with the corrosion loss of the gusset plate thickness, an evaluation method for determining the local buckling strength of the corroded section was proposed.

Secondly, this study focused on investigating the effectiveness of repair method by using carbon fiber reinforced polymers (CFRP) for the corroded gusset plate connection. Loading tests were conducted with a model approximately 50% the size of an actual bridge and the degree of corrosion assumed to be approximately 50% of the gusset plate thickness. Further, the loading tests were carried out with three parameters of the repair method including the area of the bonded CFRP sheets, the direction (±45, ±56, and 90&0 degrees) of bonded CFRP sheets, and the location of bonded CFRP sheets (out-side bonding and both-sides bonding).

Thirdly, a nonlinear theoretical analysis method considering the peeling condition of CFRP sheets, and a nonlinear material condition of all members on the analytical model were established, for a steel plate bonding a layer of CFRP sheet under uniaxial tensile loading. Moreover, after grasping the peeling mechanism of CFRP sheet from the proposed nonlinear theoretical analysis, FEM analyses were implemented on the repaired gusset plate connections to reproduce the obtained experimental results. Then, a parametric FEM analysis was carried out on the repaired connection by varying the number of bonding CFRP sheets, to clarify the appropriate number of CFRP sheets bonding into the corroded gusset plate.

Finally, this study proposed a design method to repair the corroded gusset plate connection, after the effectiveness of the repair method using CFRP sheets was investigated.