Stress-strain Model Adapted to Bolted Connection in Ultimate Behaviour Considering Energy Absorption

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Abstract

Bolted connection is one of the well-used techniques to connect structural members of steel bridges. Not only load capacity but also energy absorption are important characteristics of the structure to resist seismic action. In a finite element analysis, a true stress-true strain material model is needed to obtain an accurate evaluation in case the structure is exposed to excessive forces and deformed largely, although the true stress-true strain model is almost the same as to nominal stress-strain model in the small strain part. This study proposes a simple true stress-true strain model. And, the validity of the model was confirmed by the compare the finite element analysis and steel material tensile test or tensile experiment of bolted connection. Some true stress-true strain models were investigated and discussed from the viewpoint of load capacity and energy absorption.

Keywords: true stress-true strain model; steel plate; bolted connection; ultimate behaviour; energy absorption.

1 Introduction

Bolted connection is one of the major on-site connection techniques for steel structures in Japan. The design method of highway bridges was recently changed from the allowable stress design method [1] to the limit state design method [2]. Previously, a bolted connection is verified the slip resistance and the yield resistance before the slip. Additionally, the bolted connection was verified the yield resistance of plates in post-slip behaviour and the ultimate resistance of bolt shank shear. Thus, it is important not only to yield behaviour but also ultimate behaviour.

By the way, a true stress-true strain material model is needed in finite element analysis to obtain the accurate behaviour of steel structures including large plastic deformation. We can obtain a stress-strain relationship by the material tensile test of the steel plate. The stress-strain relationship obtained is a nominal one. However, the true stress-true strain is needed for the evaluation by finite element analysis. The difference between nominal and true stress-strain relationship before reach to tensile strength is small and is increased after the tensile strength because the partial deformation of the test specimen called necking occurred after tensile strength. The authors had proposed a simple true stress-true strain model [3, 4]. That was a tri-linear model and determined by the data in the inspection certificate of the steel plate and other values which was complemented by the relational expressions between material properties.

For seismic resistance, the important structural characteristics are not only the load capacity but also energy absorption. The validity of the proposed stress-strain model was checked from

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