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Mechanical models for the analysis of bolted T-stub connections under cyclic loads

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ABSTRACT

The mechanical models used to simulate the complete behavior of full-scale bolted T-stub connections under cyclic loads are mainly treated in this paper. These mechanical models are composed of individual T-stub components modeled as nonlinear spring elements in order to reliably reproduce their various response mechanisms interacting with one another in the connection. The hysteresis behaviors of the T-stub components including bolt/flange uplift, stem elongation, and relative slip deformation combined with bolt bearing are simulated by the multi-linear cyclic stiffness models characterized from their actual force–deformation response mechanisms each. The nonlinear component springs, which contain these idealized stiffness properties, are implemented into the user joint element produced based on the mechanical model so as to numerically generate the complete behavior of the full-scale connections with considerable accuracy. The analytical predictions performed on the joint element are evaluated against the experimental tests with respect to stiffness, strength, and deformation. Thus, the adequacy of the proposed modeling approach is verified through comparisons between analytical predictions and experimental test results. Finally, it can be shown that the mechanical model proposed in this study has the satisfactory potential to predict the response of the T-stub components as well as the behavior of the T-stub connections through analytical studies.

1. Introduction

This paper represents an approach toward formulating mechanical models to numerically predict the complete behavior of full-scale bolted T-stub connections commonly used in the steel frame structures. Actually, the modeling of such behavior is quite complex because the response mechanisms of individual connection components interact with each other [1–5]. In addition, the connection models require a large number of stiffness components in order to take various types of their deformation mechanisms into consideration [6]. However, structural connections were designed in the past as rigid or pinned ones in achieving the computational convenience, and thus the necessity for the simulation of actual connection behavior was very limited [4,7]. Most connections including bolted ones show the intermediate behavior between rigid to pinned connection cases [4].

The modeling approach considered herein is capable of simulating the behavior of bolted connections quite closely, provided that it takes into account the stiffness contributions of individual connection components together with their interaction inside the connection. For the mechanical models, the connection components can be modeled as nonlinear spring elements with their own behavioral properties. Therefore, the mechanical models formed as an assembly of component springs are adequate to simulate complex connection behavior. Most of all, this modeling approach provides the excellent flexibility

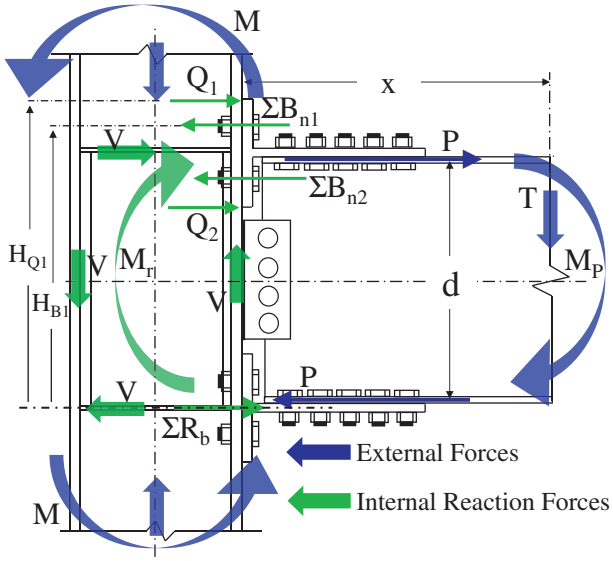

Fig. 1. Force distribution and transfer acting on the full-scale T-stub connection.

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