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Component-based model versus stress-resultant plasticity modelling of bolted end-plate connection: Numerical implementation

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Abstract

This paper deals with the analysis of a steel beam-to-column bolted end-plate connection subjected to cyclic loading. The proposed model consists of an improved component-based approach that closely follows the joint behavior. The study reminds the component-based analysis and shows how to implement two proposed improvements by the use of an elasto-plastic formulation and discuss their influences on the joint behavior. The first modification concerns possible separation between the end-plate and the column flange on which it is bolted (gap effect) and the second one concerns the group of two or more than two bolt-rows (group effect). Examples are subsequently detailed for validation and highlight the robustness of the proposed model. These modifications allows to the well-known component based model a new variant that gives more accurate results and remains easy-to-implement in structural analysis programs.

Keywords : Steel joint connection, cyclic load, component-based model, gap problem, group effect, Finite Element Method

1. Introduction

Safe and economic design of steel and composite structures requires a deep understanding of the joint response. Semi-rigid connections can provide several advantages including : economy and fabrication costs, robustness of the frames, ... Two different approaches have been adopted to model the behavior of semi-rigid connections, one can distinguish between:

- *Theoretical models:* these models propose empirical or semi-empirical Moment-Rotation curves generally fitted of experimental test data. Parameters of these models are often related to material/geometrical characteristics of the joint. They are formulated in a way to ease their implementation in a standard displacement-based analysis of frame. A nonlinear finite element analysis of frames considering the actual joint behavior provides a more accurate representation of the structure deformation and the corresponding internal forces. Significant improvements have been made to this approach since the 1980s with: Richard et al. [1] proposed to include experimental curves directly in a finite element procedure; several authors proposed multi-linear curves still dependent on a mathematical curve fitting such as: Moncarz and Gerstle [2] in 1981,