

Introduction

This is a documentation of the explicit exposed column base (XCB) model that can be used for two-dimensional analysis of steel moment-resisting frames (MRFs). The model was developed according to Inamasu et al. (2020).

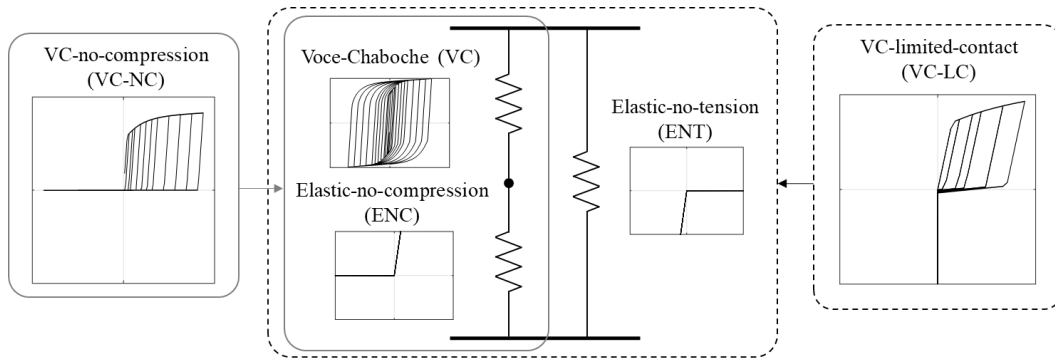
The model consists of two main subroutine files:

- 1) XCB_material.tcl
- 2) Generate_XCB.tcl

A main frame tcl file ‘Two_Story_DissipativeXCB_MCE_LD_GM1.tcl’ is also provided as an example.

XCB_material.tcl

This tcl file defines the uniaxial materials for XCB model. The arguments are tags for materials, steel material parameters are used for the Voce-Chaboche model. The Voce-Chaboche material model is available in OpenSees version 3.1.0+ as ‘UVCuniaxial’ (Hartloper et al. 2020). For a set of consistent model parameters, a reader is referred to OpenSees wiki page for UVCuniaxial (Updated Voce-Chaboche) as well as de Castro e Sousa et al. (2020). The materials as well as their names are presented in Fig. 1. The material tags are defined in the tcl file and they need to be used in the Generate_XCB.tcl.

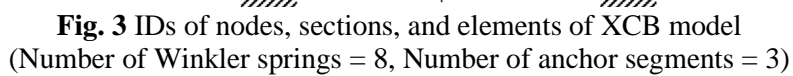
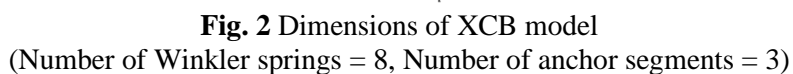


VC: Voce-Chaboche; NC: No compression; LC: Limited contact

Fig. 1 Constitutive material models for XCB model

Generate_XCB.tcl

This tcl file constructs an XCB model for a column. The arguments are dimensions and properties for the column, base plate, anchor rods, and foundations, material tags used in XCB_material.tcl, coordinates of vertical centerline axis and ground level axis, tag of the bottom node of the column, damping factors applied to the anchor and Winkler spring elements, and geometric transformation tags. Dimensions as well as IDs of nodes, sections, and elements of the XCB model are organized as shown in Figs. 2 and 3.



Two_Story_DissipativeXCB_MCE_LD_GM1.tcl

This is an example main frame file in which the XCB_material.tcl and Generate_XCB.tcl are used. This is one case from the simulations presented in Inamasu et al. (2020). The frame is a 2-story MRF with three bays that consider the lateral resistance of the gravity framing as discussed in Elkady and Lignos (2015). One can see from this file how to utilize XCB_material.tcl and Generate_XCB.tcl in a main frame file. The ground motion record used in this file is from the 1974 Lima Peru Earthquake recorded at Arequipa station and is scaled to match the maximum considered earthquake (MCE). The seismic response of the two-story steel MRF for this record is presented in Inamasu et al. (2020).

References

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2. H. Inamasu and D. G. Lignos (2019), “Concepts to Minimize Earthquake-Induced Column Axial Shortening in Steel Moment-Resisting Frames”, Proceedings of 12th Pacific Structural Steel Conference (PSSC), Tokyo, Japan.
3. A. de Castro e Sousa, H. Inamasu, and D. G. Lignos (2019), “An Explicit Model for Exposed Column Base Connections and Its Parameter Sensitivity”, Proceedings of 12th Pacific Structural Steel Conference (PSSC), Tokyo, Japan.
4. H. Inamasu, A. de Castro e Sousa, G. Bartrina, and D. G. Lignos (2019), “Exposed Column Base Connections for Minimizing Earthquake-Induced Residual Deformations in Steel Moment-Resisting Frames”, Proceedings of Society for Earthquake and Civil Engineering Dynamics (SECED) 2019 Conference, Greenwich, UK.
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7. A. Elkady, and D. G. Lignos (2015), “Effect of Gravity Framing on the Overstrength and Collapse Capacity of Steel Frame Buildings with Perimeter Special Moment Frames”, Earthquake Engineering & Structural Dynamics, Vol. 44, Issue 8, 1289-1307.