



Nonlinear Finite Element Analysis of Welded Connection of Three Steel Beams to Lateral Reinforced Concrete Column

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Abstract

To facilitate the analysis, design and construction process of RCS frames (Reinforced concrete columns and steel beams), this paper introduces a type of rigid beam to column connection and discusses its seismic behavior obtained from finite element analysis using Opensees software. The study shows that Opensees may simulate the behavior of exterior RCS connection under static reversed cyclic loading very well. Furthermore, the other static behaviors of exterior RCS connection, such as distribution of the minimum principal stress of the joint panel zone, concrete minimum principal stress-equivalent uniaxial strain relationship are investigated to gain more information and important data that can not be obtained in the experimental studies.

Keywords: RCS Frames, Connection, Nonlinear finite element, Opensees.

1. INTRODUCTION

A new composite structural system, consisting of reinforced concrete columns and steel beams (RCS), has gained popularity in recent twenty years. Engineering practices show that beams and columns made of two different materials may fully develop the merits of each of them, and thus combine rationality with economy in terms of material selection.

Despite the extensive research conducted on RCS connections, research methods are mainly through experiments and analyses of RCS connections using finite element method still remain in the beginning stage. Compared to the experiment, finite element method is more effective from an economical viewpoint, and can also gain important data that could not be measured in experiment[1].

Therefore, in this study, a nonlinear three-dimensional finite element analysis of an exterior RCS connection specimen is performed by Opensees finite element program, and some numerical results are compared each other to supplement the analytical data.

2. FINITE ELEMENT MODELING

Open System for Earthquake Engineering Simulation (Opensees) is an open source software framework for simulating the seismic response of structural and geotechnical system. This software that is continually evolving as researchers improve existing models and add new models and features. This section will specifically discuss the uniaxial materials and elements in Opensees that can be used to represent the behavior of composite RCS frames[2].

The Tcl scripting language was chosen to support the OpenSees commands, which are used to define the problem geometry, loading, formulation and solution. The uniaxial material models are the most basic components in Opensees to model a variety of force versus displacement (or stress versus strain) hysteretic responses. Material models can be used to make up the fiber cross-sections within beam-column elements or can be used in non-linear spring to represent the response of a designated degree of freedom (i.e. rotational, axial, or shear spring). There are a number of material models provided in Opensees. The three used in this