Finite Element Analyses for RC Hollow and Solid Columns Subjected to Pure Torsional Loading

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Summary

In this study, the simulation analyses using Finite Element Method (FEM) of previous experiments of RC columns under cyclic torsional loading were conducted. As a result, it was clarified the torsional skeleton curves and the crack distributions of the FEM results in the torsional yielding strength and the maximum strengths traced those of the experimental results accurately. From the experimental results and the FEM results, it was verified the thicknesses of cross sections and the pitches of hoop ties affected the torsional failure modes highly. In addition, FEM analyses varied with thicknesses of cross sections for which experiments have not been conducted were conducted. The effects of these to crack, torsional yielding and maximum capacity were investigated in detail.

Keywords: torsion; RC column; hollow section; FEM; wall thickness.

1. Introduction

The structural members subjected to large torsional loading, i.e. arch libs in arch bridges and L-shape piers, are increasing with the constructions of long span bridges and the constraint condition of bridge design. Therefore, the torsional nonlinearity and the interaction curves between bending moment and torsional moment needs to be considered in general earthquake response analyses, but generally, the equivalent linear analyses are only conducted for torsion. In the equivalent analyses, the torsional rigidities are assumed to be nearly 0.1 times of the initial rigidities when the diagonal cracks are expected to occur. The torsional nonlinearity and the interaction curves between bending moment and torsional moment aren't considered in the equivalent analyses. As a result, the torsional response of the member subjected large torsional loading may be evaluated lower compared to the torsional response calculated by the torsional nonlinearity analyses. It is because the torsional performance isn't clarified sufficiently and the interaction curves between bending and torsion and the torsional nonlinearity aren't considered.

Previously, the experiments of solid RC columns subjected to pure torsional loading, pure bending loading or combined loadings between bending and torsion were conducted in our lab.[1] The torsional skeletons and the interaction curves between bending and torsion were proposed for solid RC columns. [2]

This study aims for clarifying the torsional performance of the one-hollow RC columns sufficiently and proposing the torsional skeletons using the experimental and FEM results. The experiments of 4 one-hollow columns were newly conducted under pure torsional loading. It is because the experiments of hollow members are very few compared to those of solid members and seismic torsional performance of the hollow members isn't clarified currently. Two types of wall thickness (60mm and 100mm) and pitch of hoop ties (30mm and 60mm) were prepared. In this paper, the simulation analyses using Finite Element Method (FEM) of the experiments of 4 one-hollow and 2 solid RC columns under cyclic torsional loading were conducted and the applicability of FEM models were confirmed. In addition, FEM analyses varied with the thicknesses of cross sections for which experiments have not been conducted were conducted. The effect of the wall thickness to the event capacities (the crack capacity, the torsional yielding capacities and the maximum capacities)

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