Analysis for optimization of spiral reinforcement in pre-fabricated bridge columns

Lubos Rehounek, Jan Cervenka, Radomir Pukl

Cervenka Consulting s.r.o., Prague, Czech Republic

Contact: jan.cervenka@cervenka.cz

Abstract

Savings and optimization in the use of steel and concrete can significantly contribute to the reduction of CO2 emission and energy consumption, promoting a greener environment for the place we live. It has been shown that the use of multi-spiral reinforcement (MSR) in square or rectangular columns can significantly save the amount of steel for transverse reinforcement and yet can still achieve a higher structural performance than conventional tie reinforcement. The paper presents a validation of a numerical model for nonlinear analysis of novel multi-spiral reinforcement in prefabricated columns. The validated model will be used for the subsequent studies and optimization of the spiral reinforcement location, diameter and pitch. Selected arrangements of the multi-spiral reinforcements have been analysed to demonstrate their effectiveness in static and cyclic response.

Keywords: Spiral reinforcement; reinforced concrete columns; cycling loading; nonlinear simulation; finite element analysis.

1 Introduction

Savings and optimization in the use of steel and concrete can significantly contribute to the reduction of CO2 emission and energy consumption, promoting a greener environment for our planet. It has been shown by previous studies [1, 2] that the use of multi-spiral reinforcement (MSR) in square or rectangular columns can significantly save the amount of steel for transverse reinforcement and yet can still achieve a higher structural performance than conventional tie reinforcement. A higher structural performance means a further save in steel reinforcement and concrete can be made for a given structural performance. The multi-spiral column has an amount of transverse reinforcement only 80% the amount used in a conventional tied column but still shows a 29% higher axial strength than the conventional tied column. The multi-spiral column used only 69% the amount of transverse reinforcement used in the conventional tied column but still showed an 18% increase in lateral strength and a 59% increase in energy dissipation. These test results have demonstrated that concrete confined by multi-spiral reinforcement as a new form of confined concrete material can reduce the use of concrete and steel as compared with conventional confined concrete and hence promote savings in energy and CO_2 emission.

The paper presents nonlinear analysis of novel multi-spiral reinforcement for prefabricated columns. A special program module was developed for future simulations of spiral-reinforced concrete columns and optimization of reinforcement geometry.

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