Numerical Analysis on Seismic Performance of Hybrid Precast Segmental Bridge Columns

Yuye Zhang*, Ge Teng

Nanjing University of Science and Technology, Nanjing, Jiangsu, PR China

*Contact: zyy@njust.edu.cn

Abstract

Precast Segmental Bridge Columns (PSBCs) are always used for their fast construction and low intrusion into environment and urban life. Their inadequate seismic capacity, however, become the major concern for further development in earthquake regions. In search of balanced solution, an innovative Hybrid PSBC consisted of the hysteretic behaviour of monolithic columns and conventional PSBCs, was proposed in this study. 3-D FE models of monolithic reference column and PSBC with unbonded post-tensioning were verified against experimental data. Pushover analysis for proposed Hybrid PSBC was then carried out. Results showed that for a predefined drift level of 3 %, the Hybrid models exhibited superior seismic performance against reference columns, in terms of lateral strength, initial stiffness and ductility; the proposed Hybrid models could effectively mitigate damage to segment joints; and the monolithic length in Hybrid models was proved to be a critical design parameter.

Keywords: bridges; precast columns; post-tensioning; seismic performance; numerical analysis.

1 Introduction

Precast Segmental Bridge Columns (PSBCs) can be prefabricated off-site and assembled on-site quickly. It not only improves overall quality, reduces design time and cost, but also minimizes construction duration and traffic disruption [1], therefore, effectively mitigates the intrusion of bridge construction to environment and urban life.

Precast column segments in PSBCs were often connected purely by bonded or unbonded post-tensioning (PT), forming a series of dry segment joints with desirable re-centring ability. In seismic regions, PSBCs were found to reduce residual displacement and thus maximize post-event operability, while conventional bridge columns that develop high ductility demands tend to retain large permanent displacements [2].

In spite of the above-mentioned advantages, the application of PSBCs in seismic regions was limited due to inferior seismic performance, for instance, lower maximum lateral strength and insufficient energy dissipation, compared with conventional hysteretic behaviour of monolithic columns.

Throughout the years, researchers tried distinctive methods to improve seismic performance of PSBCs. On-going attempts include the addition of energy-dissipaters [3-4], steel or FRP jackets [5-6] and advanced materials [7-9] to enhance column ductility. However, considering the incompatibility with current design codes, these approaches may bring about excessive cost or complications for design and construction. On this account, Ou et al. [10] proposed and tested a column that combines

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