A numerical study on seismic response of self-centring precast segmental columns at different post-tensioning forces

ABSTRACT

Precast bridge columns have shown increasing demand over the past few years due to the advantages of such columns when compared against conventional bridge columns, particularly due to the fact that precast bridge columns can be constructed off site and erected in a short period of time. The present study analytically investigates the behaviour of self-centring precast segmental bridge columns under nonlinear-static and pseudo-dynamic loading at different prestressing strand levels. Self-centring segmental columns are composed of prefabricated reinforced concrete segments which are connected by central post-tensioning (PT) strands. The present study develops a three dimensional (3D) nonlinear finite element model for hybrid post-tensioned precast segmental bridge columns. The model is subjected to constant axial loading and lateral reverse cyclic loading. The lateral force displacement results of the analysed columns show good agreement with the experimental response of the columns. Bonded post-tensioned segmental columns at 25%, 40% and 70% prestressing strand stress levels are analysed and compared with an emulative monolithic conventional column. The columns with a higher initial prestressing strand levels show greater initial stiffness and strength but show higher stiffness reduction at large drifts. In the time-history analysis, the column samples are subjected to different earthquake records to investigate the effect post-tensioning force levels on their lateral seismic response in low and higher seismicity zones. The results indicate that, for low seismicity zones, post-tensioned segmental columns with a higher initial stress level deflect lower lateral peak displacement. However, in higher seismicity zones, applying a high initial stress level should be avoided for precast segmental self-centring columns with low energy dissipation capacity.

Keyword: Precast segmental columns; Post-tensioning forces; Energy dissipation capacity; Lateral peak displacement; Finite element method