Hysteretic Model Development and Seismic Response of Unbonded Post-Tensioned Precast CFT Segmental Bridge Columns

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Summary

The aim of this research was to investigate experimentally the durability of the unbonded post-tensioned, precast concrete-filled tube (CFT) segmental bridge columns subjected twice to cyclic loading. In addition, a stiffness degrading flag shaped (SDFS) model was developed based on self-centering capability and stiffness degradation of the columns. The SDFS model overcomes the deficiency of prediction using a flag shaped (FS) mode, which self-centers with constant stiffness. The experimental and analytical results show that (1) the deformation of the column in two tests is similar but energy dissipation of that is significantly reduced in the second test, and (2) the SDFS model can predict the cyclic response of the column better than that using the FS model. A parametric study, performed on systems subjected to earthquake records, shows that increase of displacement ductility is significant for structures with low period and medium yield strength ratio.

Keywords: precast segmental bridge column; cyclic test; stiffness degrading flag shaped model; time-history analysis.

1. Introduction

Many studies [1-4] are available on the cyclic response of a concrete-filled tube (CFT) column, which consists of a steel tube filled with concrete. However, study of cyclic performance of an unbonded post-tensioned, precast segmental CFT column is limited [5-7], behavior of the column subjected twice to cyclic loading is unknown, and a hysteretic model with self-centering and stiffness-degrading capabilities is unavailable.

Hewes [8] investigated the cyclic behavior of unbonded post-tensioned, precast concrete segmental bridge columns using the flag shaped (FS) model, which self-centers with constant stiffness. Although the model can self-center with energy dissipation characteristics to be modelled explicitly, it fails to address degradation of strength and stiffness of the column under cyclic loading. The stiffness degrading flag shaped (SDFS) model was developed based on physical experiments of the columns; it accounts for degradation of strength and stiffness with increasing displacement, resulting in better prediction. Time-history analyses, carried out on single-degree-of-freedom (SDOF) systems using both models, show high discrepancy of displacement demands. Due to the high variability in seismic ground motions, a parametric study was conducted using the SDFS model to determine the influence of period, yield strength ratio, and energy dissipation capacity on the seismic behavior of the SDOF systems.

2. Objectives

The main objectives of the study [9] were: (1) to investigate experimental behavior of the unbonded post-tensioned, precast CFT segmental bridge columns under twice of cyclic loading, (2) to develop a SDFS model based on the hysteretic behavior of the column, (3) to compare seismic response of the SDOF system from both the FS model and SDFS model subjected to different earthquake

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