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ANALYTICAL MODELING OF SELF-CENTERING DUAL SHELL BRIDGE COLUMN

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Introduction

Analytical and experimental studies to control and reduce seismic damages to bridge bents have led to introduction of energy dissipating rocking systems with self-centering capability (Mashal et al., 2012; Guerini et al., 2014; White, 2014). One of these systems which was developed by Guerini et al. (2014) is a prefabricated composite dual shell bridge column technology with self-centering behavior induced by unbounded tendons. Figure 1 shows the configuration of the system which consists of prefabricated composite steel-concrete dual shell column, post-tensioned tendons, and external energy dissipators. High performance fiber reinforced concrete mortar is place at the column-footing and column-bent cap interfaces. Guerini et al. (2014) has conducted a full scale cyclic test on the lower half of the system as shown in Figure 2. In this test the tendons were supported on elastomeric bearing to prevent them from premature yielding during cyclic loads. In this paper, an analytical model is developed for the energy dissipating self-centering rocking system and the proposed model is verified with the Guerini et al. (2014) experimental results.

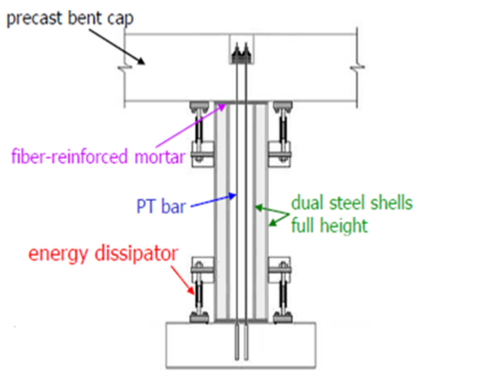

Figure 1. Energy dissipating self-centering rocking system (Guerini et al., 2014).

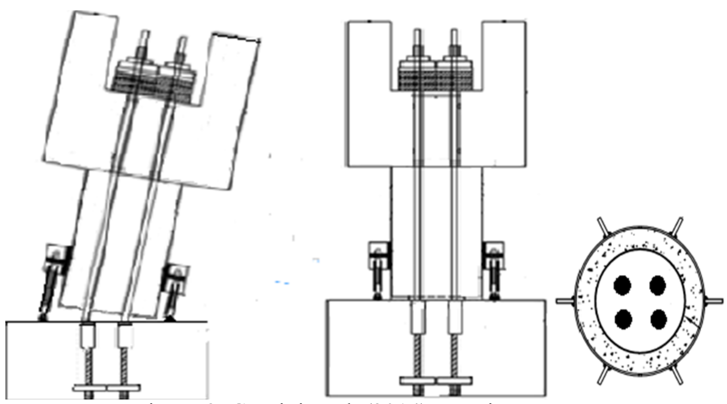

Figure 2. Guerini et al. (2014) experiment set-up.

METHODOLOGY

The test specimen was modeled in Seismostruct platform (Seismo soft, 2018) to investigate its seismic behavior. The elastic element was used to model the dual shell column. The tendon and the elastomer were modeled with axial truss element and linear link element respectively. Six external dampers, peripherally around the column, were modeled with nonlinear link elements. These elements were connected to the bottom of the column by rigid links. Figure 3 shows the various components of the numerical model. The mortar at column-footing interface is modelled by a nonlinear link element and a gap element at each side of the column as shown in Figure 4. The post-tensioning force in form of permanent displacement was applied at the end of the tendon. The column was subjected to cyclic lateral loads after application of axial gravity load.

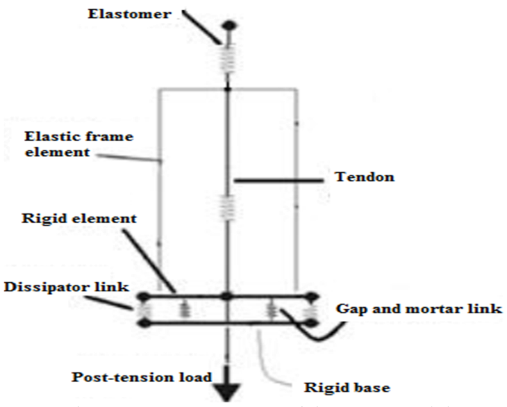

Figure 3. Components of the FEA model.

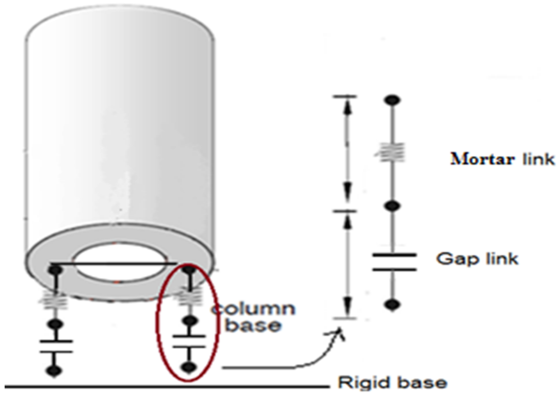

Figure 4. Position of the mortar and gap links.

RESULTS AND DISCUSSION

During the cyclic test, the dual shell columns and the tendons remained intact and the inelastic behavior was concentrated in the dissipators and the mortar bed. The analytical model adequately predicts the inelastic response of the dissipators and the mortar bed. Figure 5 shows the comparison between the experimental and analytical hysteresis curves. The results from the analysis are in good agreement with the experimental results. This figure also indicates that the self-centering rocking system controls the residual drift while dissipating seismic energy.

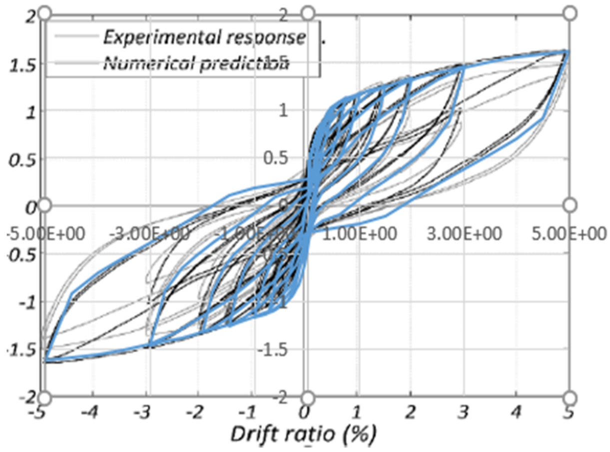

Figure 5. Comparison between experimental and analytical hysteresis curves.

CONCLUSIONS

The proposed model for the energy dissipating self-centering rocking system accurately predicts the failure mechanism observed during the test. It also adequately predicts the hysteretic response of the test specimen.

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