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EXTENDED ABSTRACT

Analytical Modeling of Precast Concrete Grouted Beam- column Joints under Cyclic Load

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1. Introduction

Precast concrete frame structures are in many respects superior to the traditional cast-in-place concrete structures. The structural components are built with good quality assurance in a controlled environment, and building construction requires less site work and can be done at a rapid paste. However, the seismic performance of these structures is significantly affected by the behavior of beam-column connections. Fig. 1 shows a typical connection in which the column reinforcements are passed through corrugated steel ducts (sleeves) within the precast beam. The moment resisting connection is finally formed by grouting the sleeves after the top column is set in place. In this paper, a simplified model is presented to simulate the behavior of such joints under cyclic loading conditions. The analytical model is verified with experiments that were carried out on five large-scale specimens representing such connections.

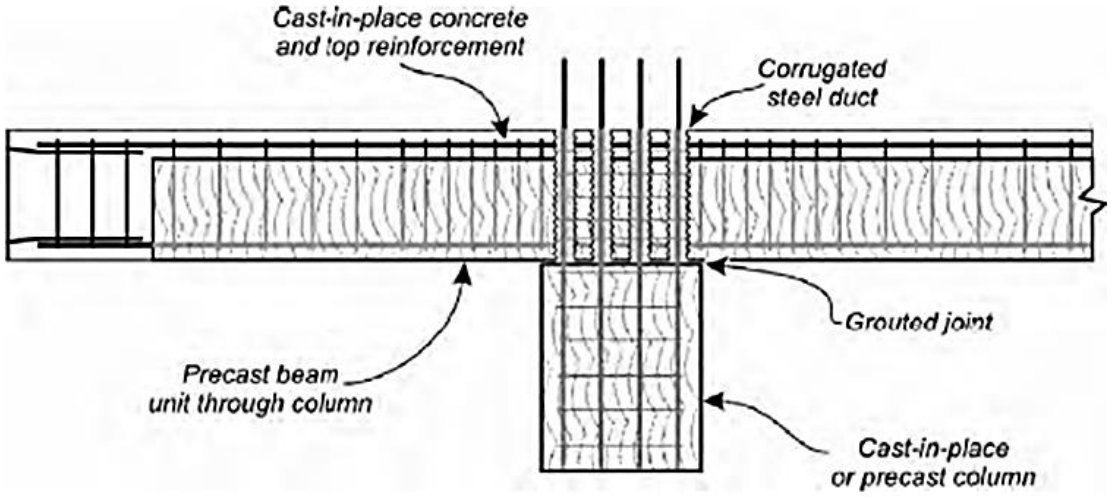

Fig. 1. Precast concrete grouted beam–column joint

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2. Methodology

The precast concrete joint model should simulate the failure mechanisms which may occur when the joint is subjected to cyclic loading. These mechanisms include:

- Joint shear failure within the panel zone,
- Bar-slip occurring at beams and columns interface with the joint,
- Shear failure at the joint's interface with beam and column.

In this paper, the joint is modeled using the method presented in Naserkhaki's research (2018). Fig. 2 shows the analytical model of the joint. The following elements are used to simulate the three possible failure mechanisms:

- Four rotational springs are located at the interface of the joints with beams and columns that simulate the rotational response due to bar-slip.
- Four transitional springs that simulate the shear response at the interface of joint with beams and columns.
- A rotational spring located at the center of the joint which simulates the shear behavior of the panel zone.

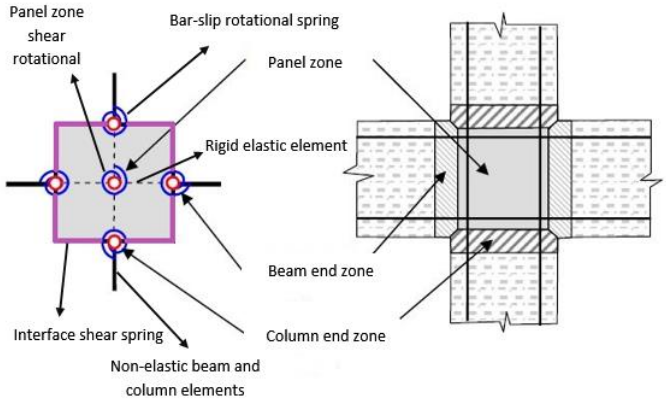

Fig. 2. Analytical model of the beam-column joint

2.1. Experimental study

In the experimental study conducted by Lin at the University of Canterbury (1999), the seismic behavior of several precast concrete joints was investigated. Specimens in this study were grouted precast concrete beam-column joints with a scale of 70%. Fig. 3 shows the test setup, and Fig. 4 shows details of one of the specimens. The specimens were first loaded axially and then subjected to cyclic lateral loads. In this paper, the test results from five specimens with various details and axial loads are used to verify the analytical model.

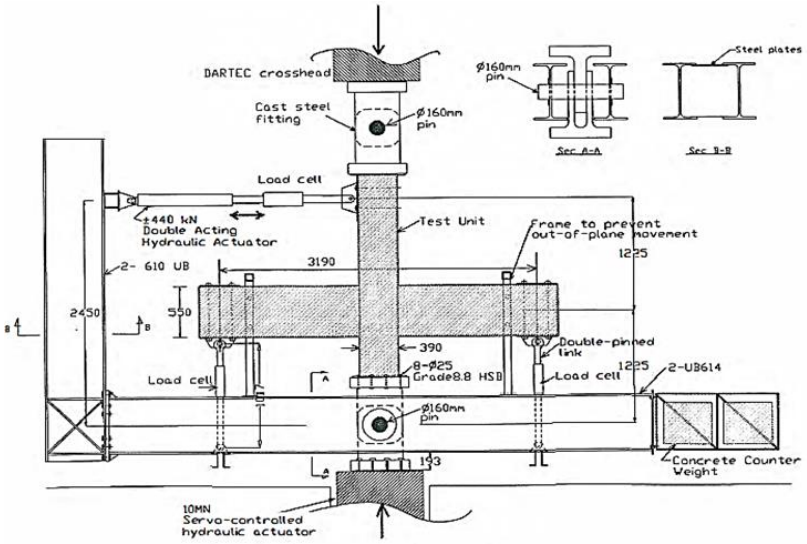

Fig. 3. Test set-up (Lin 1999)

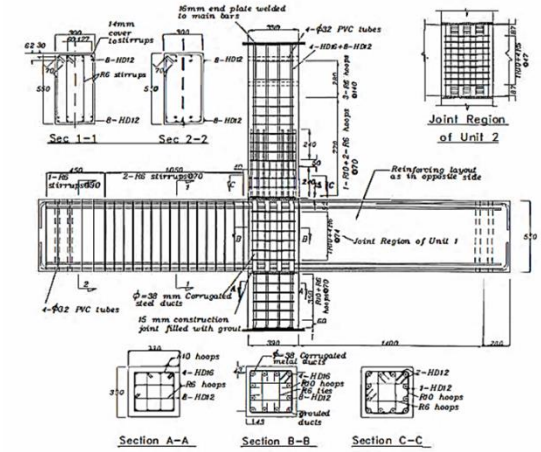

Fig. 4. Details of one of the specimens

3. Results and discussion

The test specimens are modeled in the Seismostruct platform (SeismoSoft 2018). Fiber elements are used to model beams and columns. Concrete and steel behaviors are modeled using Mander et al. (1988) and Mengotto and Pinto (1973) models, respectively. The joint is modeled using the method discussed previously. The results from the analyses are in good agreement with the experimental results. The initial stiffness, the ultimate strength, the unloading stiffness, and the pinching characteristics are adequately predicted in all specimens. The analytical models also accurately predict the failure mechanisms observed during the tests. Fig. 5 shows the comparison between the experimental and analytical hysteresis curves for one of the specimens.

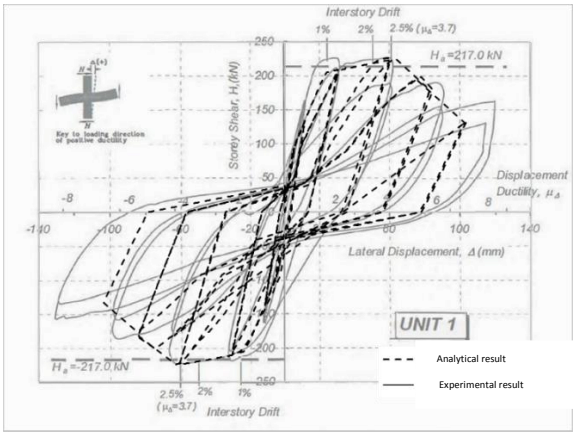

Fig. 5. Comparison between the experimental and analytical hysteresis curves

4. Conclusions

The analytical model presented in this study adequately simulates the hysteresis response of the grouted precast beam-column connections under cyclic loading. The model also adequately predicts the failure mechanism within the joint.

5. References

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