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EXTENDED ABSTRACT

Introducing of a Typical Beam-to-Column Connection and Comparison of Its Behavior with Conventional Connections

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1. Introduction

Precasting is defined as casting structures element in factory and connecting them in construction site. Therefore precast structures have different connections in comparison with monolithic ones. The purpose of this research is investigation of precast connections behavior because as a result of these connections, precast structures have a different seismic behavior. According to the recent studies, the most important problem in these structures is due to connection joints. Introducing of new connection and comparison of its behavior with conventional precast and monolithic connections is subjected to promote current weakness of precast structures in this research.

Results indicate that the new connection has better behavior in strength, ductility, energy dissipation than conventional precast and equivalent monolithic connections under applied efforts.

2. Methodology

2.1. Discussed connections

In order to investigate the suggested precast connection and comparing it with common monolithic connections, a four-story residential structure with moment resistant frames was designed by using spectral dynamical analysis in Etabs software. This structure was designed according to 2800 building code (2012). In modeled structure, height of stories is 3.2 m and number of spans is considered 4 with length of 6m. This model is assumed symmetrical. Applied loads include dead, live and seismic loads. Process of loading was done in a way that 3D modeled frame can be a good represented of such structure. In order to evaluate connection joint, one of the middle joints of inner frame in the second story was selected. For the selected joint, designing was done according to ACI 318-08(2008) and PCI (2004) in monolithic and precast forms.

2.2. Behavioral models of materials

Selected behavioral model for materials includes behavioral model of concrete, rebar, bond slip of concrete and rebar, steel segments and contact surface of segments with each other and with concrete.
For modeling of concrete's behavior, behavioral model of CEB-FIP (1990) is used. This model consists of the following parts: tension zone before cracking, tension zone after cracking, compression zone before maximum stress and compression zone after maximum stress.

For modeling the rebar, a “distinctive” behavioral model was used. Bond slip model is represented by CEB-FIP (1990).

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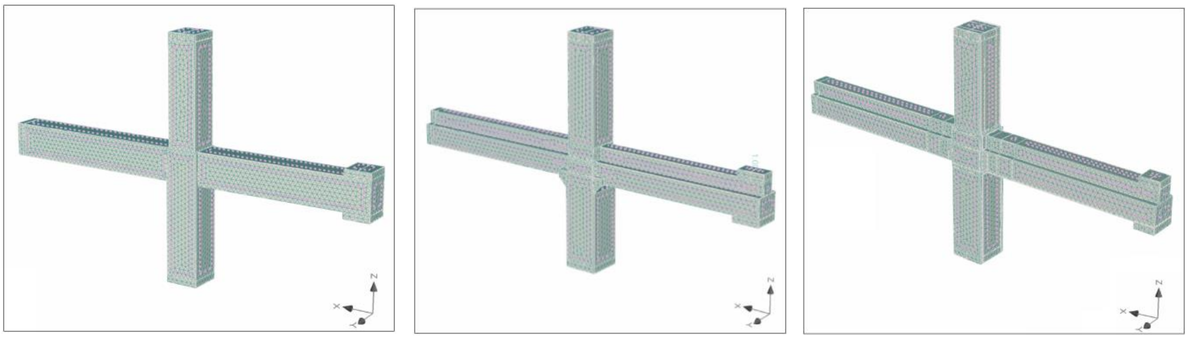
In order to investigate steel connecting segments, plasticity model of Von Mises which also is called j_2 was used. And for anticipation of materials' behavior in their contact surface, a behavioral model according to the theory of Mohr- Couloumb was used.

2.3. Finite element model

In order to use finite element analysis in solving the problem of one and three dimensional members, truss and three dimensional elements will be needed. For this purpose, in the case of one dimensional elements, three-jointed linear element and for three dimensional elements, 20-noded brick element and 10-noded tetra element was used. In Fig. 1, finite element model of monolithic and precast member is represented.



(a) (b) (c)

Fig. 1. Finite element model of members: (a) Monolithic joint, (b) Common precast joint, (c) Suggested precast joint

2.4. Load and analysis programming

Loading was done in two phases with Atena 3D software. In the first phase, column was subjected to 70 tons compression axial load. This phase of loading was done in 20 steps in a force control form. In second phase, another load was applied at the end of one of the beams and there are hinged supports at end of other three elements. This phase of loading was done in a displacement control form and in each step, a displacement around 1 mm was applied to the end of beam.

3. Results and discussion

In order to investigate and compare the functions of monolithic and precast connections, their function was investigated by means of several parameters such as ultimate strength, yield strength, failure strength, energy dissipation level, strength reduction percent in ultimate drift, ductility and initial stiffness. These parameters are represented in table 1.

Table 1. Parameters of force-drift curves

Connection / Parameter	Monolithic joint, Hogging moment	Monolithic joint, Sagging moment	Common precast joint, Hogging moment	Common precast joint, Sagging moment	Suggested precast joint, Hogging moment	Suggested precast joint, Sagging moment
Ultimate strength (ton)	18.99	5.81	4.89	3.02	22.23	7.27
Yield strength (ton)	18.67	4.95	4.57	2.29	21.96	6.41
Failure strength (ton)	18.01	5.15	4.52	2.39	20.91	4.31
Energy dissipation (ton)	103.63	31.44	27.93	9.38	121.96	38.06
Strength reduction (%)	5.20	11	6.67	25	5.9	25
Ductility	>9.20	>41.16	>22.77	26.66	>8.03	30.43
Initial stiffness (ton)	26.07	33.93	17.31	45.02	29.40	39.68

4. Conclusions

A summary of obtained results from function of investigated connections can be represented like followings:

Suggested precast connection, having a desired function in comparison with monolithic connection in the case of strength, energy dissipation and ductility can be used as a moment resistant connection in precast structures.

Investigations indicated that common precast connection are weak in the case of strength, ductility and energy dissipation and cannot be used alone as a moment resistant connection in precast frames.

5. References

ACI 318M-08, "Building code requirements for structural concrete and commentary", American Concrete Institute (ACI) Committee, Farmington Hills, Michigan, 2008.

CEB-FIP Model Code, "Committee Euro-international du beton", Bulletin information No. 195,196, 1990.

PCI-04, "Precast/Prestressed concrete institute, design handbook", 6th Edition, Chicago, Illinois, 2004.

Standard No.2800-05, "Iranian code of practice for seismic resistant design of buildings", Permanent Committee for Revising the Iranian Code of Practice for Seismic Resistant Design of Buildings, 4rd Edition, Tehran, Iran, 2012.