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Comparative Study on Seismic performance of Dry Precast Beam-Column connection with Monolithic Beam Column connection: A Review

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ABSTRACT: For any structure, connection between two load transferring members are very important. Improving the performance of connection is really big challenge. In this study new type of dry precast joint is studied which is designed and analysed for static loading. To analyse that dry precast joint for seismic behaviour various parameters are required. In this we briefly discussed about all the parameters which are previously used to analyse different types of connections under seismic condition. From this study we can say that it is possible to analyse the connection for seismic condition.

KEYWORDS: Dry precast Connection, Hysteresis, Degradation, Incremental Loading, Monotonic Loading, Dynamic Loading, Reverse Cyclic Loading, Drift Ratio, Energy Dissipation

I. INTRODUCTION

In any type of R.C. structure beam and column are main load transferring members. During transferring the load, beam column connection plays main role. The strength of beam column joint is directly proportional to amount of load carrying capacity of structure. For this purpose monolithic connection is best suited option. Because monolithic connection gives the best performance in every situation as compared to other type of connections.

As the world is developing rapidly new types of construction processes are emerging to full fill the need of construction industry. Precast construction is one of the type of construction process which is very much convenient as compared to traditional construction process from quality control point of view and convenience point of view. But during assembly main challenge is connecting different members with each other in such a way that it will perform efficiently. To overcome this challenge various researches are carried out and various types of connections are developed. These types of connections are called as precast connection which is broadly classified as wet precast connection and dry precast connection. Both have their advantages and disadvantages.

In dry precast connection achieving strength as good as monolithic connection is still challenging. But assembling dry precast connection is easier in many ways. So investigating about dry precast connection has broad future scope.

II. LITERATURE REVIEW

Junghare Surajkumar Ambadas *et.al* (2019), About 70 years ago, precast construction applications first emerged. The technology has continued to hold the title of "The Least Understood Form of Construction" in the construction business. The reaction and properties of the beam-to-column connection have had a significant impact on the performance of the precast concrete construction. It is challenging to design a safe structural system without a thorough understanding of the connection response and features. The connection response to incremental loads is covered in this study. One precast connections and one monolithic structure are built and tested. In order to create a new sort of connection that is stiff. Focus has been placed on maintaining connection continuity.



Figure 1: Monolithic Connection placed on Moment Frame



Figure 2: Dry Precast Connection placed on Moment Reaction Frame

By using incremental loading, the monolithic beam-column junction was put to the test. The specimen was set up in the structural engineering lab's reaction frame at IIT Kharagpur.

Monolithic Specimen:- The weight is then gradually imparted to the beam's end. Up until 10 kN, the load increment was 1 kN; after that, it was lowered to 0.5 kN until failure load. In this testing, three dial gauge numbers were used. The first one is positioned 50 mm from the beam's end, and the other two are spaced 100 mm and 200 mm from the junction, respectively.

Precast Specimen:- The beam's end is subjected to the load gradually. Up until 10 kN, the load increment was 1 kN; after that, it was lowered to 0.5 kN until failure load. In this testing, two dial gauges were used. The first one is placed 410 mm from the junction and 150 mm from the end of the beam.

Conclusion:- Precast connections were found to be nearly 9.67% stronger than monolithic ones in this project, making them a good option. It is worthwhile going into depth since the connection suggested here (In low seismic locations) can give the precast construction sector an advantage. If seismic severity is taken into account, there may be an opportunity to further improve the link and monitor changes in its behaviour.

Jianxin Xhang, Zonghu Pei, *et.al* (2022) In this study 3 precast specimens are prepared to study the seismic effect on the precast connections. To investigate the seismic behaviour reverse cyclic loading is used in 2 stages. First stage is load controlled stage and second stage is displacement stage.

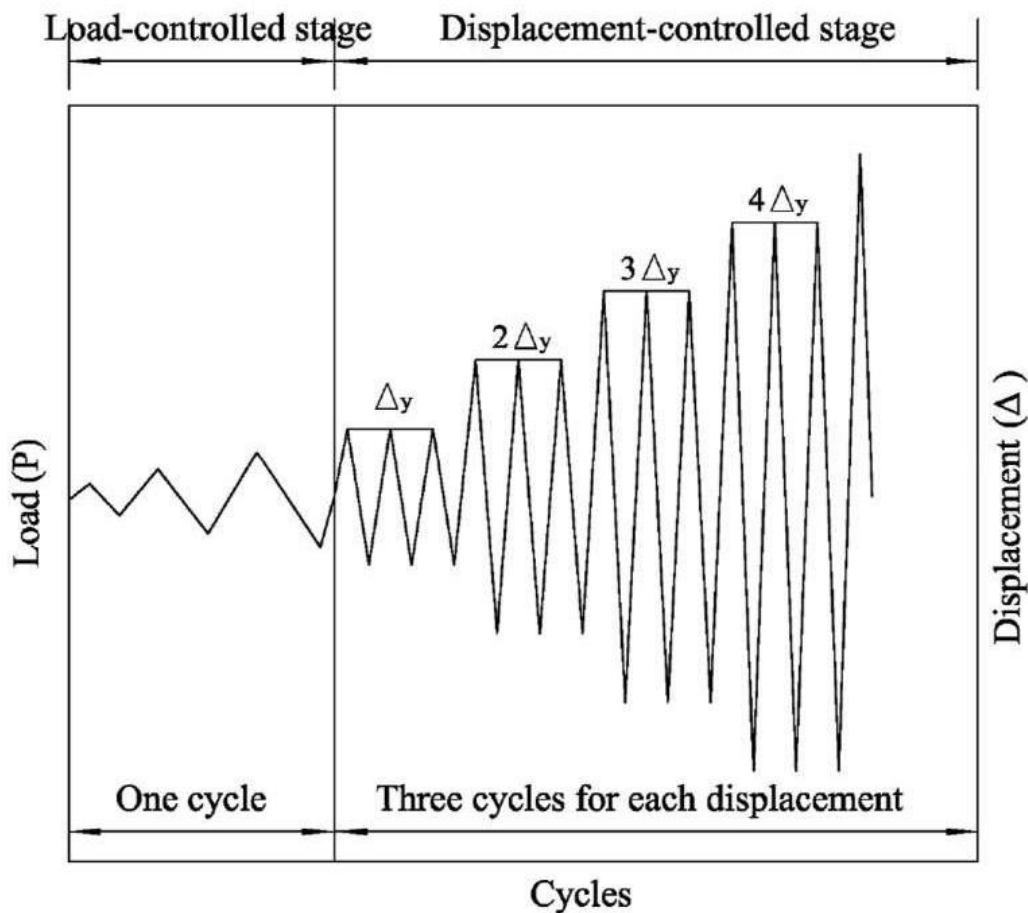


Figure 3: Loading Cycle

As shown in figure3 in first cycle loads are changed for each cycle. P_y is yield load taken which is depended on yield capacity of reinforcement used. For each cycle $0.25P_y$, $0.5P_y$, $0.75P_y$, $1P_y$ load increases. In displacement controlled stage group of 3 cycles of same displacements are created. For each group the displacement Δy increased by $1\Delta y$, $2\Delta y$, $3\Delta y$, $4\Delta y$.

The result shows that proposed joints are easily analysed for seismic condition for various Parameters.

Mehmet Senturka, *c et.al* (2020) The objective of this work is to create a revolutionary precast beam-column connection for reinforced concrete (RC) constructions that resembles a monolith. In order to ascertain the seismic performance of the suggested connections, an experimental examination was initially conducted. Six full-scale, precast and monolithic T-shape beam-column connection specimens with various reinforcement ratios, specimen dimensions, and details were tested while the axial load on the column was kept constant. Utilizing the results of the experiment, the specimens' cyclic behaviour, curvature distribution, failure mode, energy dissipation capacity, and ductility were determined. Then, using ABAQUS, precise non-linear finite element (FE) models were created. The entire performance of the

precast connections in terms of initial stiffness, lateral load-bearing capacity, and post-peak behaviour is demonstrated to be accurately predicted by the FE models.

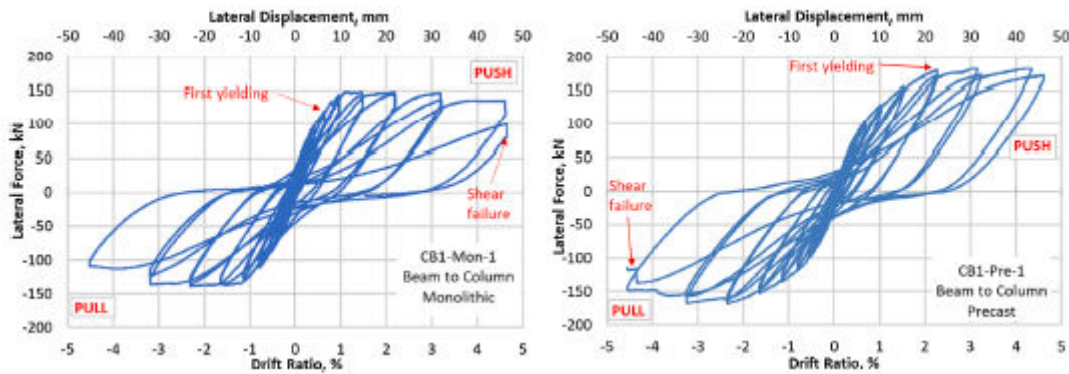


Figure 4: Hysteresis Curve

The relative top displacement of the beam, which was derived by subtracting the displacement of the beam-column interface from the beam top displacement, was plotted against the lateral load provided by the actuator to determine the cyclic behaviour of the connections. The joint displacement as seen in figure was expected to be equivalent to the lateral displacement of the beam-column contact. Following that, the drift ratios were determined using the formula:

$$\xi = \Delta/L$$

Where ξ is the drift ratio, Δ is the relative top displacement of the beam, and L is the length of the lever arm. The length of the lever arm was determined using the beam-column interface to the loading point.

The proposed monolithic-like precast connections could achieve at least a 3.5% drift ratio with less than a 25% decrease in their load-bearing capacity, which would meet the requirements of ACI. In accordance with ASCE, the precast connections could also achieve the Collapse Prevention (CP) seismic performance standard without suffering significant damage. Consequently, it follows that the suggested connecting technique is appropriate for RC constructions in seismic areas.

M.B. Tadi Beni *et.al* (2022) had designed two innovative precast beam-column connections using steel profiles as corbels and high-strength bolt fasteners. These connections were created for usage in intermediate moment frames in seismically active areas. The benefit of these connections is that they remove the need for elaborate concrete formwork, temporary supports, and a high need for in-situ concrete during construction. They also give rise to the potential of floors being built concurrently. Six specimens, including four precast and two monolithic connections with various rebar ratios, were created in order to examine the seismic performance of proposed connections. To acquire the load-displacement curves, the specimens were subjected to a horizontal displacement-controlled cyclic loading. Precast connectors' maximum lateral strength, ductility, strength deterioration, stiffness reduction, and energy dissipation.

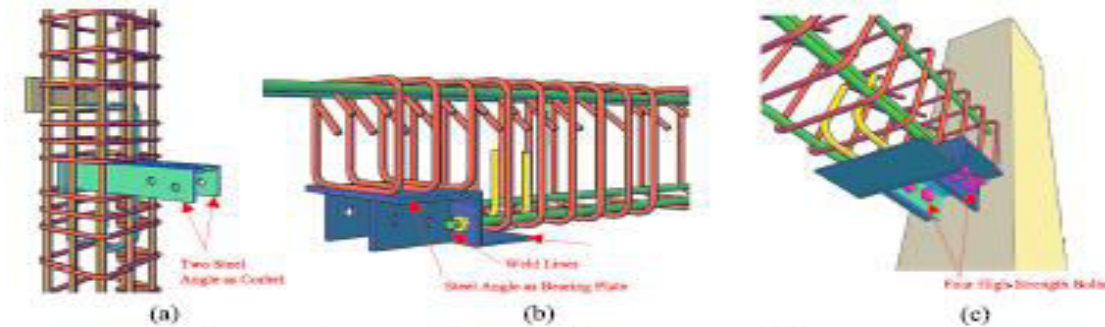


Fig. 3. View of PCI-s connection elements (a) Column; (b) Beam; (c) Assembled connection.

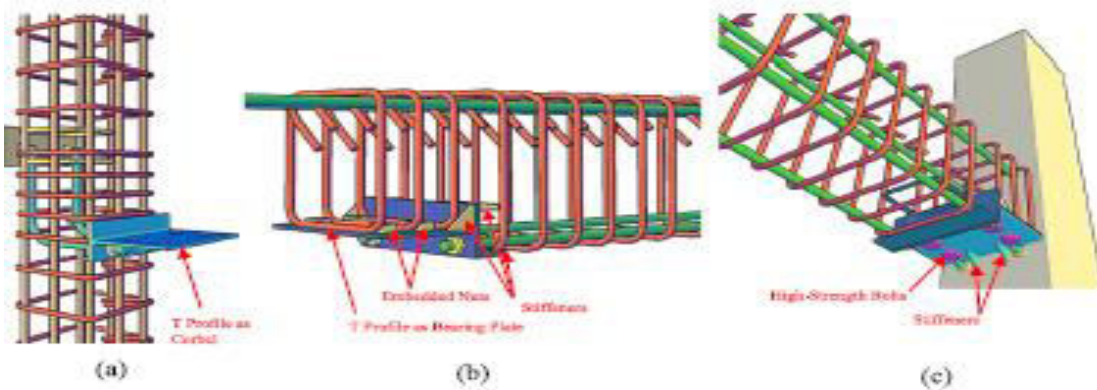


Figure 5: Beam Column Connection with corbel arrangement

The yield point definition: - In the references, various techniques have been presented to find the load-displacement curve's yield point. Four approaches were used for this investigation, and the outcomes of each were contrasted with one another. The minimum drift related to the rebar's yield can be calculated using the strain gauge results in the first technique. The yield point in the second technique is found at the junction of two lines. "Equivalent energy method", is the name of the third technique. The fourth approach is the one that ASCE, has suggested. The maximum lateral strength loss of 15% is used to define the final displacement achieved in the connection. This displacement corresponds to that point. Table displays the maximum values for yield displacement, ultimate displacement, and lateral strength for the four approaches. The influence of strain hardening and bond-slip of the reinforcement in high drifts is not taken into consideration in the first technique since only the rebar yield is taken into account. As a result, this method's yield displacement calculation is lower than that of other approaches.

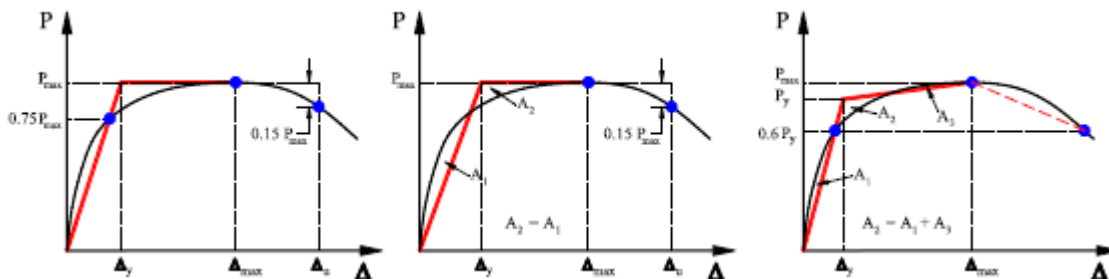


Figure 6: Yield Point Determination



Table 1

Lateral resistance, final displacement, and yield point in the specimens.

| Direction | F _{max} (kN) | | Δ _y (mm) | | Δ _y (mm) | | | | | | | |
|-----------|-----------------------|------|---------------------|------|---------------------|------|----------|------|----------|------|----------|------|
| | + | - | + | - | Method 1 | | Method 2 | | Method 3 | | Method 4 | |
| | | | | | + | - | + | - | + | - | + | - |
| MC-a | 48.0 | 45.8 | 67.5 | 67.5 | 11.3 | 7.5 | 24.8 | 24.4 | 26.2 | 25.3 | 21.5 | 21.7 |
| MC-b | 68.0 | 73.8 | 67.5 | 67.5 | 11.3 | 7.5 | 24.5 | 26.1 | 24.5 | 27.3 | 16.0 | 16.5 |
| PC1-a | 59.9 | 38.8 | 67.5 | 56.3 | — | 11.3 | 40.1 | 11.8 | 39.5 | 15.6 | 17.9 | 12.1 |
| PC1-b | 67.2 | 58.6 | 67.5 | 54.6 | — | 7.5 | 22.2 | 19.1 | 32.6 | 27.8 | 12.6 | 13.9 |
| PC2-a | 46.1 | 39.2 | 67.5 | 50.6 | — | 7.5 | 31.1 | 9.5 | 30.5 | 15.9 | 10.5 | 7.7 |
| PC2-b | 68.0 | 58.2 | 67.5 | 60.8 | — | 11.3 | 41.7 | 17.6 | 39.6 | 26.0 | 15.4 | 15.3 |

Ductility: - The available ductility coefficient of the structure determines the size of the seismic design loads.

$$\mu = \Delta u / \Delta y$$

In Equation, μ is the ductility coefficient, Δu is the maximum horizontal displacement of the structure under seismic loads without significant loss of strength, and Δy is the displacement of the first yield point defined by assuming the elastic behaviour of the cracked structure. According

to this definition, structures are classified into three categories: ductile (μ =5), finite ductile (μ =3), and structures with almost elastic behaviour (μ =1.5).

Table 2:

Average ductility coefficient in specimens.

| Specimen | μ = (μ ⁺ + μ ⁻) / 2 | | | |
|----------|--|----------|----------|----------|
| | Method 1 | Method 2 | Method 3 | Method 4 |
| MC-a | 7.4 | 2.7 | 2.6 | 3.1 |
| MC-b | 7.4 | 2.6 | 2.6 | 4.1 |
| PC1-a | 5.0 | 3.2 | 2.6 | 4.2 |
| PC1-b | 7.3 | 2.9 | 2.0 | 4.6 |
| PC2-a | 6.7 | 3.7 | 2.7 | 6.5 |
| PC2-b | 5.4 | 2.5 | 2.0 | 4.1 |

Strength degradation :- According to the definition given in the FEMA-440 for connection strength degradation, there are two types of degradation that can be identified: the first is by comparing the strength reduction in different drifts, and the second is by taking into account the connection strength degradation in different cycles of a particular drift level. The degradation of the envelope load-displacement curve takes into account the first kind of strength degradation. The FEMA-440 has specified the coefficient i to assess the strength degradation throughout several cycles of a particular drift. i is defined as the difference between the maximum strength of each cycle (Pi) and the maximum strength of the first cycle of the same drift. In other words, this coefficient is expressed in equation.

$$ai = Pi / P1$$

There have been introduced two innovative beam-to-column connections with incorporated corbels. The suggested connections have the advantage of being simple to build and requiring no temporary support. To examine the performance of the suggested connections, two monolithic connections were created into four specimens and each was subjected to cyclic stress.

Ruijun Zhang *et.al* (2022) A novel style of dry-connection precast beam-column joint is suggested in this study. The dry connection is simple to put together, which can significantly lower the amount of manpower required on the construction site. In addition, it is simple to disassemble, making it possible to upgrade components and replace any that have been damaged by earthquakes during the course of the building's lifetime. It promotes industry and increases the building's resistance to earthquakes. It is appropriate for building in places with a harsh environment and significant seismic activity. Pseudo-static experiments were conducted along with the construction of precast joint models and cast-in-situ joint models in order to assess the seismic performance of the dry connection.

Skeleton curves and stiffness degradation curves:- Figure 1 depicts the two joints' skeleton curves, whereas Figure 2 depicts the stiffness degradation curves. Table displays the experimental mechanical parameter values. While the maximum negative load of PJ is 28% greater than that of CJ, the maximum positive force is comparable to that of CJ. The maximum drift ratio for the PJ is less than the maximum drift ratio for the CJ. PJ's positive yield load is

comparable to CJ's, and CJ's negative yield load is 1.39 times PJ's positive yield load. PJ has greater positive and negative yield displacements than CJ. PJ has less ductility than CJ. CJ has approximately 60% of the PJ's initial stiffness.

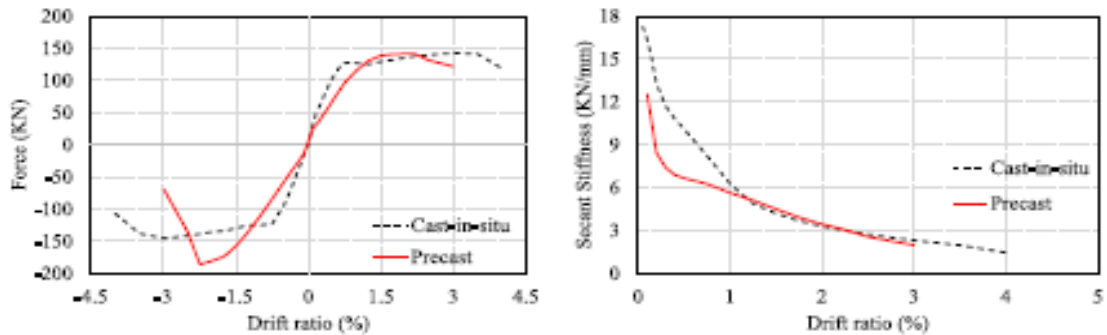


Figure 7: Skeleton Curve and Strength Degradation Curve

Table 3:

Experimental results of mechanical parameters.

| Specimen | | Yielding load | | Maximum load | | Ductility factor | Initial stiffness (kN/mm) |
|----------|----------|----------------|------------|--------------|------------|------------------|-----------------------------|
| | | Δ_y (%) | F_y (kN) | Δ_u | F_u (kN) | | |
| CJ | Positive | 0.62 | 118.1 | 3 | 142.7 | 6.32 | 9.29 |
| | Negative | 0.75 | 123.1 | 3 | -145.3 | 4.99 | 8.01 |
| PJ | Positive | 1.25 | 130.8 | 2.25 | 141.4 | 2.40 | 5.10 |
| | Negative | 1.63 | 170.8 | 2.25 | -185.8 | 1.47 | 5.11 |

Energy dissipation capacity: - Figure represents the two joints' energy dissipation. The size of the hysteresis loop is used to calculate hysteretic energy dissipation, which is the energy dissipation brought on by the plastic deformation and failure of components. The cumulative energy dissipation of the PJ is 50% of that of the CJ at a drift ratio of 3%. CJ's energy dissipation is primarily brought on by the beam's plastic degradation. The energy dissipation is localized on the steel connectors, and the PJ beam has less cracks. The main reason for the lower energy dissipation is that the yield stress of the top connector and concealed corbel is too high to act as a damping mechanism. If the connector's material is changed of mild steel or has a smaller effective cross-sectional area, the capacity to dissipate energy will be significantly boosted.

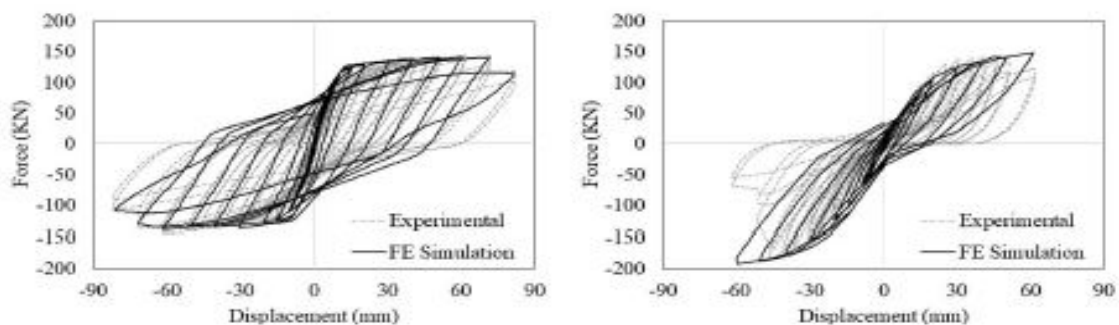


Figure 8: Hysteresis Curve

III. STUDY

The main objective of this review paper is to understand the parameter which can be used to analyse and design the dry precast joint which performs better in seismic condition. By studying various types of dry precast joint simple dry precast joint is selected which is stated in Reference [1]. To analyse this dry precast connection for seismic condition the loading condition is referred from reference [2]. So reverse cyclic loading is used to create seismic condition. After apply loading to study actual behaviour of connection under seismic condition different parameter such as drift ratio, hysteresis behaviour, energy dissipation, strength degradation, stiffness degradation, yield point determination and ductility [3, 4, 5].

IV. CONCLUSION

After reviewing all the previous researches it is possible to analyse the precast connection for seismic behaviour from different parameters and compare it with monolithic connection. From analytical results you can improve the quality and performance of dry precast connection in various manner.

REFERENCES

1. Junghare Surajkumar Ambadas (2019), Prof. Damodar Maity “COMPARATIVE STUDY OF BEHAVIOUR OF DRY PRECAST CONCRETE BEAM-COLUMN CONNECTION”, Department of Civil Engineering, Indian Institute of Technology, Kharagpur
2. Jianxin Zang, Zonghu Pei, (2022), “Experimental seismic study of an innovative precast steel-concrete composite beam-column joint”, School of Civil and Transportation Engineering, Hebei University of Technology, Tianjin, 300401, China
3. Mehmet Senturka,c, Selim Pula, Alper Ilkib, Iman Hajirasouliha,c, (2020), “Development of monolithic like precast beam column moment connection experimental and analytical investigation”, Department of Civil Engineering, Karadeniz Technical University, Trabzon, Turkey
4. M.B. Tadi Beni, M. Madhkhan, (2022), “Experimental study on two innovative ductile moment-resisting precast concrete beam-column connections”, Department of Civil Engineering, Isfahan University of Technology, Isfahan, Iran
5. Ruijun Zhang^a, Yu Zhang^a, Aiqun Li^{a,b,*}, T.Y. Yang^c (2022), “Experimental study on a new type of precast beam-column joint”, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.



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