

# Comparative Study and Analysis of Dry and Wet Connections of Precast Beam-Column under Cyclic Load

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**Abstract:** *At present the Precast building are more focus for the building industrialization and main objective of this study to find the most appropriate types of beam-column connection, the purpose of this study is to investigate and high result of precast beam column joint with two types of dry mechanical connection & two types of wet connection were analysis and compared with monolithic connection to know the performance of the joints. the primary test variable were the type of connection cleat angle, dowel bar, fibre reinforced concrete, steel plate, anchor rod and the pre tension bolt are used in this joints the advantage of the precast concrete structure components are assemble in which are fabricated off-site and then connect on-site in term of less resource consumption, more rapid construction, better quality control and less field wet operation.*

**Keywords:** Precast Concrete, Beam-Column Connection, Dry Vs Wet Comparison

## I. INTRODUCTION

The Prefabricated Building(also known as “precast”) has been recognized as a one of the alternative solutions to changing the speed of conventional construction methods at a fast rate. Precast construction is being utilized in many countries for its enormous advantage and then transported to the site for assembly easily prefabricated building construction systems comprise modular of volumetric units that are typically manufactured complete with architectural finishes and services at an off-site, quality-controlled factory. Reductions in cost and time are the major advantages offered by the prefabricated building systems. When compared to conventional construction methods can also be dismantled and reused because of precast concrete provides high quality structural element ,construction efficiency and overall cost of investment and also we observed that precast concrete structure are more failure occur in joint past during earthquake. Generally precast structure are more preferable to bridge construction. The aim of these paper is to analysis the behaviour and performance of dry and wet connection by using the dowel bar, cleat angle, anchor rod, steel plate, bolts and fibre reinforced concrete are used to connection in both connection to compare that we use the monolithic specimen as shown in the result

## II. LITERATURE REVIEW

**G.Metelli P.Riva et. al,(2008):** This paper aim is presenting the results of experimental test concerning the cyclic behaviour of a particular beam-column dry connection from the precast concrete elements and also the joints are connected by high strength steel bar to fibre reinforced grout pad in the ‘z’ shaped beam column interface to increasing the shear resistance in the joint. Through that it give good performance to the joint by the terms of resistance, ductility and energy dissipation, and also we observer a small amount of damage will occur in the connection members. From these research paper he developed a ductile beam column joint able to absorb a high negative moment(upper tensioned fibres) in the case of earthquake And the joints system are consists of four upper and two lower bushes to connect the threaded bars to the column by the ‘Z’ shaped steel plates from the result of these experiment the failure occur in the horizontal displacement due to the limited capacity of brittle failure in the column joints. The joints are stable behaviour during the 1st cycle with the limited stiffness, at last we occur initial flexural cracks appeared in beam at 9<sup>th</sup> cycle the joints area are increase considerably with loading cycle

**R. Vidjeapriya and K.P. Jaya et. al,(2011):** Aim of these experimental is focus on comparing the performance of precast and monolithic beam-column connection subjected to cyclic loading and then the precast beam-column connection are made by corbel using J-bolt & cleat angle .The specimen are subjected through reverse cyclic loading and The result of the specimen were compared by monolithic connection and then the (400KN) capacity actuator applied to the column to find the axial load and also another two more actuator are apply to the beam to know the cyclic loading (positive load cycle and negative load cycle) .The performance for the precast &monolithic beam-column connections were compared by load carrying capacity, energy dissipation capacity, hysteresis behaviour and the ductility factor. The advantages of precast concrete is mainly in reliability ,durability, faster construction, higher quality and all weather construction. And also these type of construction are more preferable in flyover etc. precast concrete construction are most versatile from of construction and saving time and overall cost of investment. In these specimen the monolithic and precast specimen cast and the behavior under cyclic loading was experimentally investigated from the result we find the monolithic specimen is more than the precast specimen and also precast concrete carry ductile to the more energy compared with monolithic specimen due to the increased stiffness in the negative direction at the presence of corbel.

**Hong Hao, Tuan T Ngo et. al,(2019):** Prefabrication construction has been intensively studied because of its numerous advantage. The advantage of the precast specimen is reduces the site disruption especially the element are joint with dry joints and more over as disadvantage also occur in the dry joint that is corrosion in steel bolt and plates. The steel components at joint are prone to corrosion and also it affect the life cycle of maintenance costs and may even negatively affect the integrity of the structure. This study proposes to know the performance of carbon fibre reinforced polymer (CFRP) bolt &steel fibre reinforced concrete (SFRC) in the moment of resisting in precast beam-column joints. This is the first time we use CFRP and SFRC to improve the ductility of precast joints. One monolithic joint will compare with three type of dry exterior concrete joint under quasi-static cyclic loads until failure as compared to the monolithic joint the dry exterior joint is more excellent performance in term of load- carrying capacity, ductility. The proposed precast joint is obvious advantage compared to the conventional monolithic joints with conventional steel connectors, such as lower construction cost, shorter construction time and corrosion resistance from this study the structural performance of new kind of dry beam column joint made of SFRC & connected by using of CFRP bolts.

**Sergio M Alcocer, Rene Carranza And David Perez-Navarrete et. al, (2000) :** The behavior of a precast concrete beam-column connection an experimental study in this research paper they are two types beam-column joints tested under unidirection and bi-directional cyclic loading that simulated earthquake type motions. The most relevant feature to achieve beam continuity is that neither welding nor special bolt were used in one structure, continuity was achieved by placing hoops around the extension of 90-deg and another one is replaced by U-shaped pre-stressing stand that were lap-spliced to the bottom of the beam. A steel bar was inserted vertically through the intersection of looped stands specimen failure was controlled by joint shear, the first structure was inelastic deformation of hoops, yet unexpected as well as beam rotate inside the joint in both structure. The two type of connections tested provide to be efficient & reliable systems that simply the speed of the construction of precast concrete frame structure

**Yachao Zhong ,Feng Xiong et. al,(2019):**IN this paper a noval precast concrete frame with bolt connection and also it include the connection steel plate ,bolts and rubber layer to investigate the seismic performance of precast structure. They are two type of specimen include that is cruciform, reinforced concrete and a monolithic counterpart are tested under reversed cyclic loading for the precast specimens they are two different types of rubber are applied in the connection region respectively. Additionally the initial stiffness is obviously decreased by the way of adding rubber washers at the joint region, showing a semirigid characteristic. The most advantageous in precast is in term of less resource consumption, more rapid construction, better quality control and less field wet operation such as speed construction, easy erection and also the pollution reduction. The analyses of this paper to mention above the rubber washer (flexible layer) between the bolts and the steel plate obviously decreased the initial stiffness of precast specimens. The joint region plays a vital role in adjusting the stiffness of the beam.

**Abdul Karim Mirasa and Ahmad Baharuddin Abdul Rahman et. al,(2011) :** This study presented a comprehensive literature review finding from the study conducted to analyze and investigate the behavior of precast concrete system

and joints under simulated earthquake loading. The precast components joints connection are very much depended on the ductility capacity of the structure. It was learnt by the review among the two types of connection is hybride post-tensioned column connection and dywidag ductile connector were among the most widely used connection for precast construction in seismic prone region based on the past experiment analysis and lab investigation discusses in the precast concrete study ,that we recorded there exist some common principle are among all the developed connectors among the discussed and presented types of joints are ductile precast concrete frame for earthquake

**Thomas H.-K. Kang and Dong Joo Lee et. al,(2013):** This study carried out an experimental investigation of seismic performance in precast concrete element. In high seismic zones, the lateral ductility of a precast concrete frame system are one of the most critical design aspects. A totally 5 exterior precast beam column specimen including 2 reinforced concrete connections were tested under deformation reversals for assessing their seismic performance, precast concrete construction is a dry construction method and its advantages is all the members are same in quality be mass produced in the factory. The pre-tension bolting connection and it was developed by the purpose of maintaining the advantageous of precast concrete dry engineering method to improve the constructability of connection the members and the securing a ductility of the precast structural in the seismic region. Pure dry cast method used to join the beam column connection under pre-tension bolts. Since the embedded rod with rod is only the yielding part of the developed connection. This experimental result of pure dry connection method to indicate the better seismic performance in term of deformation capacity and ductility for precast concrete beam column joint in comparison to cast-in-place reinforced concrete beam-column joints. The capacity of load is transfer to step by step in height strength threaded bar to transfer steel bar, from steel block to pre-tension bolt, from the pre-tension bolt to anchor rod and finally from anchor rod to concrete inside and the joint was found to be very effectively.

**Li Bing Khoo J H et. al,(2002):** The main objective of this research is to study the seismic performance of the proposed precast frame system with its connection placed at the location respectively, the application requires additional design consideration espically for the design of beam column joints , which should be verified by experimental study. Providing the precast concrete beam column connection the core may result in distress within the joint core under seismic excitations due to large shear stress concentration and discontinuous joint reinforcement encompasses the lateral load displacement hysteresis loops, the tensile stain, longitudinal bar and crack patterns are study the each specimen with 5 type of test will conduct that is monolithic ,overlapped welding connection, overlapped 90degree hooks connection, overlapped 180 degree hooks connection and steel plate connection. The result of the fove specimen tested subassembly ages of the precast frame system to investigate the behaviour of satisfactorily under reversed cyclic loading with strength, ductility and energy dissipation levels to comparable with monolithic counterpart. All the subassembly ages were capable to undergoing the large story drift at failure occur in the specimen to hysteretic responses, as conclusion the precast concrete system based on beam to beam connection in this study as a feasible considerable promise.

**Hemanth Nalineni, Durga Chaitanaya Kumar Jagarapu, Arunakanthi Eluru et. al, (2020):** Observes the benefits of precast construction method and its necessity for construction of building. Their study is to investigate the behaviour of precast beam-column joint with two types of dry mechanical connections and two types of wet connections using ABAQUS software. The beam and column are designed and detailed as per the Indian standard code provisions. The beam dimensions used are of 300 mm 300 mm. While the column dimensions are 300 mm 300 mm. Five frame models consisting of two mechanical dry connections, two wet connection and a monolithic connection were analyzed using ABAQUS software. The test variables were the type of connection, use of cleat angles, use of dowel bars, use of fibre reinforced concrete. .The dry connections assessed here performed less efficiently compared to monolithic and wet connections, the performance of dry connection can be improved by sophisticated detailing of mechanical components in the connection. The wet connections showed more fixity which is the required criteria for the emulative approach in precast technology.

**Kristiyanto Hery, Triwiyono Andreas, Muslikh and Saputra Ashar et. al,(2019):** Observes that Connection is the most important aspect of precast concrete structures. This study shows that precast concrete is to improve productivity, quality control, and cost efficiency in reinforced concrete structure. Where the connection transfers force between the

precast components, to determine strength, stiffness, and ductility of the whole structure. Providing joint in the beam-column connection region always cause difficulties during the erection stage. Relocation of the connection at a certain distance from the column to the beam span is an alternative solution that creates the beam-to-beam connection. The study shows the connection of Concrete beam to steel beam connection, Concrete beam connection and Beam-to-beam connection in the middle of the span for load condition. The Beam-to-beam connection of precast concrete designed with careful design concepts and detail as well as careful fabrication and installation will result in high performance structures that resist earthquake. The beam-to-beam connection can be designed according to code for use in areas with high seismic hazards.

**Sayed Mohammed Arslan Inamdar et. al,(2018):**This shows that overall stability of a precast structure majorly depends on its connections and joints between elements, it is important to consider the role of these connections and joints in transferring the loads between its elements and to stabilize the foundation. The connections and joints should be designed so that it has to satisfy all the requirements of the building and to achieve shorter construction time. This study shows the alternate load path which can withstand the structure in case of failure of joints. Different types of joints and connections are also studied in this paper.

**Mohammad Hossein Saghaf, Hashem Shariatmadar, Ali Kheyroddin et. al, (2019) :** The purpose of this study is to investigate the performance of precast beam column joint using high-performance fibre reinforced cement composites (HPFRCC) to satisfy the requirement of transverse reinforcement under seismic loads. The cracking patterns are occur in the HPFRCC beam column connection was analyzed with hysteresis behaviour, ductility, energy dissipation with damping characteristics and joint shear capacity and compared to the cyclic load responses of normal concrete designed with seismic criteria of ACI. The experimental study in HPFRCC connection joints are remained intact without any cracks and damage until the test end.

### III. CONCLUSION

Based on analytical study the carried out to investigate the behaviour and performance of wet & dry connection in term of precast beam column connection under cyclic load. Construction benefits such as shortening construction period ,producing better quality control, less field wet operation, more rapid construction, less resource consumption compare to wet connection the dry connection is more efficiency to avoid cast-in-site place and greatly improve the construction economic efficiency and avoid the environmental pollution. The connection are used in the specimen is dowel bar, cleat angle, anchor rod ,steel plate, bolts and fibre reinforced concrete are the connectivity material to performance the connection compared with monolithic connection to analysis the result.

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