Literature Review on various Connections between Precast Column and Footing

Nageswari R1 Anitha Raj2
1PG Student 2Assistant Professor
1,2Department of Civil Engineering
1,2CKC, India

Abstract— Due to speedy construction, the precast column–footing connections were widely accepted in the construction field. These connections are mostly suitable for the construction of bridges. Nowadays, the transportation agencies are mostly using the Accelerated Bridge Construction (ABC) because it saves construction time on site. This research is mainly focusing on the different connections between precast column and footing and it also identifies the most suitable connection that can be used in bridge construction. The better connections between precast column and footing can be identified by considering the factors like structural properties, site implementation.

Key words: Precast column–Footin g Connection, Accelerated Bridge Construction (ABC)

I. INTRODUCTION

Traffic delays are mainly occurred due to the bridge construction because it consumes time, money etc. The column–footing construction plays an important role in the construction of bridges. This is because it transfers the load of the superstructure to the footing. This connection will resist all kinds of loads acting on the structure, but it is very difficult to inspect and repair also it consumes time, money etc. The above problems can be overcome by using the precast column and footing connection.

Nowadays, Accelerated Bridge Construction are widely accepted by the transportation agencies for reducing the amount of site work and also it reduce the environmental impacts. Accelerated Bridge Construction is constructed by using precast elements. This construction will improve safety for both motorizing public and highway workers. Due to these reasons, Accelerated Bridge Construction are mostly used in many urban construction projects. This construction would save the time on site. The benefits of using Accelerated Bridge Construction on the site are,
- Minimize traffic delays.
- Improve safety to workers.
- Quality of the work can be improved.
- Reduced Life-cycle cost.
- Productivity can be improved.

II. LITERATURE SURVEY

A. D.D Magura and R.W LaFraugh,”Connections In Precast Concrete Structures Column Base Plate”, PCI Journal, pp.18-39, December 1966

This paper is mainly investigated on strength and deformation characteristics of base plate connections between precast columns and their footings. The column base–plate connections consist of a rectangular steel plate welded to the column reinforcement and were connected by bolts embedded in the foundation. They considered three specimens of different thickness of the plate. Each column was attached to a square concrete footing slab that was supported above the laboratory floor. The hydraulic rams were used to provide eccentricity load to the column. The eccentricity increased due to specimen deformation when the column load was applied and the corresponding moment will be calculated. The moment-rotation curve was plotted and this curve will be non-linear. Under same eccentricity load, it was observed that the stiffness of extended base-plate connections depends on the thickness of the plate. Connections incorporating base plates flush with the column on all sides appear to be more effective as compared with base plates extended beyond the column.


This paper is mainly focused on the inelastic behavior of a composite steel column that was connected to the foundation block through the traditional bolted steel end plate and an innovative socket type system. They considered two specimens, one was innovative socket type joints and another was traditional bolted steel end plate. The composite specimens were subjected to monotonic (push over) loads for accessing the inelastic performance of the structure. The loads are given by the hydraulic jack. Transducers (LVDTs) were provided at the column–base region for measuring the displacement. It was observed that the composite column fails are mainly due to the inelastic connection on anchor bolt. By comparing the two specimens the socket type showed more ductile performance than traditional type. Since the ultimate deformation capacity of the socket type connection is about 75% higher than the traditional type, so it can be reliably used for designing of structures such as those in earthquake-prone regions [2].


In this research, two aspects were investigated on the design procedure of base plates with stiffeners and degree of rigidity of the connection with foundation. Column base plates were analyzed and designed on the assumption that the plate was rigid and its thickness was determined from the cantilever action of the plate projection beyond the column face. The analytical studies of the column base plate connection are done by considering the three-dimensional model of column base plate with stiffener and without stiffener. They considered two different loads, one was axial load and the another was the combination of axial load and moments. The analytical results were compared with the
experimental results inferred that the rigidity of the connection and the rotational behavior towards the rigid connection increases. But the behavior does not guarantee a fully rigid connection. However, other parameters such as increasing base plate thickness altered the rotational behavior towards a more rigid connection. The connection between footing and column using base plate was greatly depended on the anchor bolt under the base plate. So proper element should be chosen for anchor bolt because the stresses will be concentrated more on the anchor bolt.


This paper is mainly focused on the development and implementation of a precast concrete bridge system suitable for accelerated bridge construction in the high seismic region. At the base of the bent, the column was connected to a spread footing using a socket connection and at the top of the column was joined to the cap beam using bars grouted in ducts [4]. The socket connection can be constructed by precasting the column, erecting it, and casting the reinforced concrete footing around it. For evaluating the connection response to combined cyclic lateral load and constant vertical load, the laboratory test was conducted. They considered three specimens in which the two specimens had footing depth equal to the column diameter and the third specimen was constructed with a footing depth that contained only half the column diameter. It was observed that the precast column and socket connection perform better than, a comparable cast-in-place system. Precast bridge systems are more economical and effective means for rapid bridge construction. Precasting methods eliminates traffic congestions during bridge construction while maintaining quality and long-term performance.


This paper is mainly focused on the seismic behavior of the socket connection between column and footing. They considered three specimens with different footing arrangement. All these specimens were roughened to improve adhesion to the surrounding cast-in-place concrete. The SF1 and SF2 specimens have sufficient amount of reinforcement and SF3 specimen had an only little amount of reinforcement. The specimens were subjected to both axial load and lateral load.

From the study, the following conclusions can be made,

- The two specimens suffered no footing failure during the lateral loading sequence was then loaded axially to failure.
- It was observed that the connection could resist column axial load and lateral load.
- The moment-drift response of the SF1and SF2 specimens were less and maintained a constant small vertical displacement throughout the test.
- By providing the diagonal steel and ties to the footing, the SF1and SF2 specimens had less strain as compared to the SF3 specimen.


This research is mainly focused on the seismic performance of new bridge column elements based on using the mechanical reinforcement splices for connecting precast columns to cast in place footings. For the study, two mechanical spliced connectors were used one was upset headed coupler with and without the pedestal and other was grouted sleeve coupler with and without the pedestal. The addition of mechanical couplers to the plastic hinge zone can alter the mechanism of a plastic hinge. These couplers were subjected to axial load and lateral load. It was observed that due to the shifting of plastic deformation into the footing reduced displacement ductility and drift capacity of the grouted coupler columns than the up-set headed coupler. But the up-set headed coupler connections were cumbersome to construct and would require extra time in the field than the up-set headed coupler but not more than cast in place construction.


This paper is mainly focused on the cyclic behavior of a column and foundation for precast concrete elements. The grouted sleeve connections were made by introducing dowel bars which come out from the bottom of the column into steel boxes place in the footing and then it is filled with high strength mortar. They considered two specimen, one was cast in place column used as the reference and another was precast column was connected to the foundation by grouting the rebars. The horizontal load was provided at the top of the column by using electro-mechanical jack. This displacement was recorded by providing a transducer that was placed at the top of the column. By using displacement, they plotted a graph with horizontal load versus drift curve. In this paper numerical model was implemented by using finite element code. This numerical model was compared with experimental results inferred that the amount of energy are dissipated by hysteresis. The test results showed that cast in place column does not behave as perfectly fixed while the connection between the precast column and footing shows higher structural continuity between column and footing. So
there is a need to consider the bar slips at the base of the column to properly obtaining the experimental results.


This paper is mainly focused on the seismic performance of the grouted splice sleeve connections for reinforced precast concrete column–to–footing joints. Connections between precast concrete elements must be able to withstand significant stresses and deformations in earthquakes. They considered three specimens, one was grouted splice sleeve connectors that were located in the column plastic hinge zone, the second was the connector that was located in the cap beam and the third one was a monolithic cast-in-place concrete specimen. These specimens were subjected to axial load and lateral load. It was observed that the precast specimen with the fastened and grouted splice sleeve connectors inside the cap beam achieved a drift capacity of 7.0%, which exceeds the drift demand expected in large earthquakes and also achieved satisfactory hysteretic performance and energy dissipation. In addition, it was observed that the displacement ductility of 5.8 which was greater than grouted splice sleeve connector that was provided in the column plastic hinge zone. This is because if the connector that was provided at the base of the column, it was observed that gradual strength reduction was noted as a result of bond degradation between the dowel bar and grout inside the fastened and grouted splices sleeve connectors. Precast concrete joints constructed with this connection will perform adequately in moderate to high seismic regions.


This paper is mainly focused on the seismic performance of threaded rebar coupler system when the specimens were tested under cyclic loading. Nowadays, there are many using of threaded reinforcing bars in construction fields due to the absence of providing additional screw processing system when connecting reinforcing bar by a threaded coupler. They considered three specimens, one had no mechanical splice of longitudinal reinforcement and other two specimens had a splice. For the test setup, the footing of the specimen was fixed by connecting it to the strong floor using high strength post-tensioning bars. A cyclic lateral load was applied at the top of the column under constant axial load. It was observed that when the lateral drifts ratio increase, the flexural cracks increases and it further increases near the ends of the coupler. The load – displacement curve was used to determined the yield displacement that was developed in the connection region and the stresses were more concentrated just outside the mechanical coupler and the stiffness of the specimen decreased. In order to overcome above defects, connection ratio of mechanical coupler should be below 50% and reduced stiffness of the specimen should be considered in designing.


This research is mainly focused on the seismic behavior of precast pocket foundation connection. The pocket foundation can be constructed by casting an in-situ concrete foundation using a tapered box shutter to form the pocket. For design and detailing of pocket foundation connection, they considered a three - story reinforced concrete frame building and analyzed using ETABS software against seismic forces for obtaining the resultant forces and moments in the critical column to footing region and also for obtaining the base shear value. By using this values, the pocket connection has been modeled and analyzed using ANSYS package. From the study, the following conclusions can be made.

- Displacement corresponding to the vertical load and moment was slightly lesser than the base shear combination.
- Initially, the specimen was started yielding at the top of the column
- It shows that the member was initially getting yield before the connection yield.
- The stress distribution follows the same path in the both vertical load and moment and the base shear combination but the values were slightly greater for the base shear combination.
- The pocket depth and the thickness were sufficient to withstand the base shear and the failure of connection was avoided.

III. FINDINGS

The column base plate connection entirely depends on the anchor bolt under the base plate. So the structure having this connection is not capable of withstanding the larger loads because the stresses are concentrated more on the anchor bolt. In threaded rebar coupler system, it will reduce the stiffness of the structure. In mechanical reinforcement splice connectors, it will not show any improvement in the displacement ductility. In precast pocket foundation connection, the stress will be concentrated more on the top of the column. So it is very difficult to transmit the load from the superstructure to the foundation. In grouted splice sleeve connection, it reduces the strength due to the bond degradation between the connections. In socket connection, the precast column and cast in place footing have the capability to resist the larger loads.

From the study, it can be concluded that the socket connection between the precast column and cast -in- place footing have excellent structural properties and it is easy to implement on the site. It can be reliably used for designing of structures.

IV. CONCLUSION

Due to rapid construction, the precast column and footing connections were widely used for the construction of bridges. From the study, I learned that the socket connection is more suitable for the construction of bridges when compared to the other connections between the precast
column and footing. This is because it provides excellent performance under vertical and lateral loadings. Since it is very easy to implement on site, so the socket connection is preferred for my detail study.

**ACKNOWLEDGMENT**

First and foremost, I thank Lord Almighty for his grace, strength and hope to carry out and complete the paper. I record my sincere thanks to Er. Shwetha Saju, head of the department, Civil engineering at CKC mannoor Muvattupuzha, Er. Anue Marry Mathew Class tutor and also extend my special thanks to Er. Anitha Raj, my project guide.

**REFERENCES**


