WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Seismic Analysis of Beam-Column Connections in Precast Structures- An Review

R. Subashri[1], Mr. P. Nandhakumar[2], Dr. R. Manju[3]

PG Student[1], Professor[2,3]
Department of Civil Engineering, Kumaraguru College of Technology,
Coimbatore– 641 049, Tamil Nadu, India
Corresponding author E-mail ID: subashri911@gmail.com.

ABSTRACT:

The behavior of wet precast beam-column connections in a progressive collapse scenario is covered in this research. The performance of monolithic and precast wet connections in terms of strength, ductility, and load carrying capacity are compared in this study. In comparison to monolithic connections, the experimental analysis demonstrates that the precast wet connections taken into consideration in the study are more ductile and capable of withstanding greater load.

Keywords: Precast constructions, Wet beam column connections, Progressive collapse, Glass fiber.

INTRODUCTION:

The behavior of wet precast beam column connections in a progressive collapse scenario is covered in this research. It includes experimental research that evaluates these connections' reaction in terms of deflection and ultimate load carrying capacity. The study finds that precast connections are more ductile and capable of withstanding greater loads when comparing the performance of precast wet connections to monolithic connections. A review of the literature on progressive collapse and the principles for creating structures resistant to progressive collapse is also included in this study. A novel precast concrete beam-to-column connection for moment-resisting frames is suggested in the paper. Similar to monolithic connections, the suggested connection is intended to be simple to construct and to have enough earthquake protection. But no tests have been conducted to evaluate its seismic performance under reversal cycle loading. The seismic performance of the suggested connection using tests on a reference monolithic specimen as well as two precast beam-to-column specimens. In comparison to the monolithic specimen, the results demonstrate that the suggested precast system functions effectively under reversing cyclic loading.

LITERATURE REVIEW:

Rohit B. Nimse et.al (December 2014) The paper focuses on studying the behavior of wet precast beam column connections under a progressive collapse scenario. Precast connections are constructed using different connection detailing, such as reinforced concrete corbel and steel billet. The performance of the connections is evaluated based on the ultimate load carrying capacity, maximum deflection, and deflection along the span of the beam. The results show that the load carrying capacity and ductility of the precast connections studied in this experiment are higher than that of monolithic connections. The study highlights the importance of studying the performance of connections between beam and column in precast concrete construction to prevent progressive collapse. Precast concrete construction offers advantages such as speedy construction, reduced formwork and scaffolding, less requirement of skilled labor, reduced construction waste, better quality, and better surface finishing.

Hemanth Balineni et.al (April 2020) The paper investigates the behavior of precast beam-column joints using ABAQUS software, focusing on two types of dry mechanical connections and two types of wet connections. Concrete tests were conducted for M30 grade concrete and M40 grade fiber reinforced concrete. The wet connections showed more fixity, which is desirable in precast technology, while the dry connections performed less efficiently compared to monolithic and wet connections. The performance of dry connections can be improved with sophisticated detailing of mechanical components. Precast construction offers better quality control, time-effective construction, architectural flexibility, and sustainability benefits.

Dongzhi Guan et.al (11 November 2016) The paper introduces a new precast concrete beam-to-column connection that utilizes both longitudinal bar anchoring and lap splicing for beam reinforcement continuity. The seismic performance of the proposed precast system is evaluated through experimental investigations under reversal cyclic loading. The results show that the proposed precast system performs satisfactorily compared to the monolithic specimen, and the additional lap-splicing bars can be included in the strength calculation. The plastic hinge length of the proposed precast beam-to-column connection can be estimated using models for monolithic specimens. The study also discusses factors such as hysteretic behavior, strength,

ductility, stiffness, and energy dissipation in evaluating the seismic performance of the precast system. The paper highlights the importance of achieving beam reinforcement continuity in precast concrete systems for easy construction and satisfactory seismic resistance.

Kulondwa Kahama Espoir et.al (December 2020) The paper discusses the importance of the connection of precast concrete members and focuses on the grouted sleeve connection, which consists of reinforced bars, high strength grouting materials, and a ductile iron cylinder. Experimental research findings are compared to establish the relationship between the components of the connector and enhance its performance. The tensile performance of the connector increases with the embedded length of the bar, and an effective embedded length set between 6 and 8 times the diameter of the bar maximizes the tensile performance. The diameter of the sleeve cylinder, the compressive strength of the grout, and the length and surface of the bar embedded also affect the bond performance and mode of failure under tensile load.

Mingming Ji et.al (27 December 2022) The paper explores the application of robotic cranes in expediting the construction of industrial facilities in China, with a specific focus on the beam-to-column connections in precast beams. Three large-scale exterior beam-to-column connections underwent fabrication and testing, subject to lateral load reversals. The comparison involved two anchorage forms, namely mechanical splices and grouted sleeves, against the monolithically cast specimen. Test results revealed that the specimen using grouted sleeves exhibited seismic performance similar to the cast-in-place specimen. In contrast, the specimen using mechanical splices displayed notable post-peak deterioration under positive beam bending moments. This was attributed to steel bar congestion within the joint core, creating difficulty in fully tightening the beam bottom bars into the threaded couplers and compromising the cyclic behavior of the specimen. The findings underscore the suitability and reliability of grouted sleeves in the new construction method, emphasizing the importance of meticulous considerations in intelligent construction. Notably, specimen LZ2 demonstrated significant slip at the beam-to-column interface when subjected to upward beam loading, indicating a potential concern with this specific connection**.**

Jian Feng et.al (15 May 2020) This paper presents an experimental study of the seismic performance of internal beam-column connections with beams reinforced with Grade 600MPa longitudinal steel bars. Six full-scale reinforcement concrete (RC) internal joints with varying longitudinal and axial reinforcement ratios are constructed and tested under reversed cyclic stresses. Failure mechanisms, energy dissipation capacity, hysteretic curves, skeleton curves, and the ductility of joints' hysteretic curves are all the subject of systematic investigation. Moreover, the effects of different longitudinal reinforcement ratios and axial compression ratios on the seismic behavior of the joints are thoroughly examined. When the specimens with larger reinforcement ratios are compared, it can be shown that the ones with 600 MPa high strength steel bars in the beam-column joints have greater energy dissipation capability, slower stiffness deterioration, and lower ductility.

Helmi Alguhi et.al (23 May 2023) The research delved into the flexural and cracking behavior of fiber-reinforced concrete (FRC) through a combination of experimental and analytical methods. Testing involved 40 prisms and 50 cylinders to evaluate how the addition of steel and/or glass fibers influenced flexural and splitting tensile responses. Utilizing Digital Image Correlation, the study examined crack formation and propagation during flexure tests. Employing Inverse Analysis (IA), the team generated the tensile stress-strain response for FRC and developed a proposed model for this response. Results indicated a significant enhancement in flexural strength, splitting tensile strength, residual stresses, and toughness with the inclusion of fibers. The simplified model effectively represented the flexural response of FRC. Flexural strength was determined based on the peak load from load-deflection curves. The study employed quantitative approaches to assess the correlation between IA and test results, conducting tests on forty prisms using a 1000 KN capacity machine.

Morteza Madhkhan et.al (23 July 2019) The paper investigates the mechanical properties and aging of glass fiber reinforced concrete (GFRC) with different types of pozzolanic materials. The study uses two methods, premix and spray-up, to manufacture GFRC with AR glass fibers and three types of pozzolans. The toughness index and modulus of rupture of GFRC decline over time due to aging. Nanosilica (Aerosil) is one of the pozzolanic materials used, and it contributes to a lower decline in the specific modulus of rupture compared to other mix designs. The toughness indices of GFRC vary with time, and the specimens containing metakaolin show the highest values. Aging has a significant effect on the toughness indices, particularly on I10 and I20 values. The premix specimens experience a sharp decline in toughness indices after 90 days, while acceptable I20 values are maintained.

SUMMARY:

The comprehensive review covers various aspects of precast concrete construction, particularly focusing on connection methods, seismic performance, and material properties. Investigations into wet precast beam-column connections underscore their robustness under progressive collapse scenarios. The study evaluates different detailing techniques, highlighting higher load-carrying capacity and ductility in precast connections compared to monolithic ones. Additionally, the use of ABAQUS software to analyze precast beam-column joints reveals wet connections' favorable fixity and the potential improvement of dry connections with sophisticated detailing. The integration of a new precast concrete beam-to-column connection enhances beam reinforcement continuity, showcasing satisfactory seismic performance. The examination of grouted sleeve connections emphasizes the crucial relationship between connector components, affecting tensile performance and failure modes. Robotic cranes in Chinese industrial construction demonstrate the effectiveness of grouted sleeves over mechanical splices in beam-to-column connections, ensuring seismic resilience. Lastly, the exploration of glass fiber-reinforced concrete (GFRC) delves into mechanical properties and aging effects, with nanosilica contributing to sustained specific modulus of rupture in certain mix designs.

REFERENCES:

1. Wei Ma, Yue Li, Kewei Ding, Baoquan Cheng, Jianhua Liu, Jianli Hao, Vivian Wing Yam Tam, Mechanical Properties of New Dry-Type Beam-Column Bolt Connection Joint, Published: 17 June 2019

2. Hemanth Balineni a, Durga Chaitanya Kumar Jagarapu a, Arunakanthi Eluru,Analysis of dry and wet connections in precast beam-column joint using ANSYS software,Materials Today: Proceedings, Volume 33, Part 1,2020

3. H. Park, H. Im, an experimental study on beam-column connections with precast concrete u-shaped beam shells, Published 2008.

4. Alaee, P.; Li, B. Analytical Investigations of Reinforced Concrete Beam–Column Joints Constructed Using High-Strength Materials. J. Earthq. Eng. 2018, 24, 774–802.

5. D. Camarena, Finite element analysis of precast prestressed beam-column concrete connection in seismic construction, 2006.

6. R.B. Nimse, D.D. Joshi, P.V. Patel, Behavior of wet precast beam column connections under progressive collapse scenario: an experimental study, Int. J. Adv. Struct. Eng. (IJASE) 6 (4) (2014) 149–159.

7. R. Vidjeapriya, K. Jaya, Experimental study on two simple mechanical precast beam-column connections under reverse cyclic loading, J. Perform. Constr. Facil. 27 (4) (2013) 402–414.

8. Lu, Z., et al., Mechanical behaviour of grouted sleeve splice under uniaxial tensile loading. Engineering Structures, 2019. 186: p. 421-435.

9. Xue W, Yang X (2010) Seismic tests of precast concrete, moment resisting frames and connections. PCI J 55:102–121

10. H. Yang et al., Development and testing of precast concrete beam-to-column connections with high-strength hooked bars under cyclic loading, Adv. Struct. Eng. 22 (14) (2019) 3042–3054.

11. D.J. Provost-Smith, M. Elsayed, M.L. Nehdi, Investigation of grouted dowel connections for precast wall construction, ACI Struct. J. 116 (1) (2019) 41.

12. R. Vidjeapriya, K. Jaya, Behaviour of precast beam-column mechanical connections under cyclic loading, 2012.