*Quest Journals*
*Journal of Architecture and Civil Engineering*
*Volume 9 ~ Issue 4 (2024) pp: 47-49*
*ISSN(Online) : 2321-8193*
www.questjournals.org

**Research Paper**

# A Comprehensive Review of Structural Considerations for Closure Pour Joints in Accelerated Bridge Construction (ABC)

Mouralidasse J[1], Dr. P.S. Charpe[2]
*[1]Research Scholar, Department of Civil Engineering, Kalinga University, Naya Raipur, India.*
*[2]Professor & Head, Department of Civil Engineering, Kalinga University, Naya Raipur, India*

## I. Introduction

In large-scale bridge and flyover endeavors, integrating Accelerated Bridge Construction (ABC) techniques is crucial. These techniques encompass a spectrum of innovations, including novel materials, streamlined design processes, advanced construction methods, and updated project management approaches. Given the current demand for swift project completion, ABC techniques are indispensable for expediting these endeavors, significantly shortening project timelines. ABC relies on meticulous planning, incorporating state-of-the-art designs, materials, and construction techniques to ensure safety and cost-efficiency, ultimately reducing on-site construction duration. Key elements such as high-performance concrete (both reinforced and prestressed), high-strength steel, and innovative joint systems play pivotal roles in accelerating construction speed overall.

This literature review delves into the structural considerations surrounding closure pour joints in Accelerated Bridge Construction (ABC) projects. Closure pour joints are critical elements in bridge construction, facilitating the connection between precast bridge segments. Understanding their structural behavior, design principles, and construction techniques is vital for ensuring the integrity and performance of ABC bridges. This review synthesizes existing research, highlighting key findings, methodologies, and areas for further investigation.

## II. Accelerated Bridge Construction

In his study, Mishal Alashari (2016) outlines the developmental trajectory of bridge technology, delineating two distinct epochs. The initial period, spanning from 2,000 B.C. to the late eighteenth century, was profoundly shaped by Roman architectural influences. Stone arches were prominently employed during this era, leaving enduring traces across global bridge constructions. The subsequent phase commenced with the advent of commercially available steel as a construction material in the mid-19th century. This pivotal development facilitated the realization of diverse modern bridge typologies, encompassing beam bridges, truss bridges, cantilever bridges, arch bridges, tied arch bridges, suspension bridges, and cable-styled bridges, particularly those boasting extended lifespans, owing to the exceptional tensile and compressive strengths of steel. Nearly a century ago, engineers introduced concrete into the fold, catalyzing a transformative shift in the construction industry. The adoption of prestressing techniques effectively mitigated concrete's propensity for post-construction splitting. Presently, the predominant materials employed in bridge construction are steel and prestressed concrete, underpinning the enduring resilience and ubiquity of these structures in the contemporary built environment.

Chandolu's (2005) study aimed to assess the necessity and effectiveness of intermediate diaphragms (IDs) in prestressed concrete girder bridges, while also comparing the performance of steel diaphragms to reinforced concrete counterparts. Employing sophisticated finite element models calibrated under live loads, the research conducted parametric analyses across a range of bridge configurations, encompassing unsupported, continuous, straight, and skewed bridges. The findings of the study revealed several key insights regarding the role of IDs in bridge performance. Firstly, it was observed that IDs had a discernible impact on load distribution factors, reducing them for interior girders while simultaneously increasing them for exterior girders. This suggests that IDs play a significant role in redistributing loads across the bridge structure, potentially enhancing overall structural efficiency.

## III. Structural Considerations of using Closure Pour Connections in Accelerated Bridge Construction (ABC)

Prefabricated elements and systems for bridges represent a prevalent technology employed in Accelerated Bridge Construction (ABC). ABC technology is comprised of prefabricated structural members, which reduces both construction time and cost (Milliam, 2004). On-site assembly of prefabricated components with limited volume closure pours using high performance materials, typically steel and concrete. In order to assure adequate load transfer between structural components prior to the bridge's use, concrete closure pours must develop high strengths rapidly. The closure pour materials contain proprietary components, such as ultra-high performance concrete (UHPC) with steel fibres or rapid setting concrete with proprietary cements. These materials currently used for ABC closure layers contain propriety components, making them prohibitively expensive for widespread use and impeding their widespread application. Additionally, it is challenging to procure proprietary materials from a single source for state bridge projects, making it impractical to specify these materials for ABC.

Castine A. (2017) explains in his research that a need has arisen for the creation of concrete mixtures constituted of generic components. These concrete formulations must continue to meet certain performance requirements for ABC closure pours, such as a high rate of strength gain and long-term durability.

FHWA. (2018) detail strength tests conducted to assess whether specimens with joints exhibited comparable strength to those without joints. All specimens underwent both loading and boundary tests. Specifically, the joined specimen endured two-line stresses 10 cm away from the outermost interface surface. Continuous stresses were applied to all specimens using two hydraulic actuators equipped with load cells to monitor applied loads. Loading persisted until each specimen reached failure. Visual inspections were conducted multiple times throughout the investigation period. The following conclusions were drawn:

(i) During strength loading conditions, it became evident that specimens containing joints displayed slightly reduced cracking loads in comparison to specimens without joints. This implies that the presence of joints might exert a minimal effect on the specimens' capacity to endure applied loads prior to cracking. These observations offer valuable insights into the structural response of the specimens under stress, underscoring the possible influence of joint presence on load-bearing capability. A thorough examination and contemplation of these outcomes could aid in refining the design and construction of structures, particularly in situations where joints play a crucial role.

(ii) The development of cracks at the crossing point of the connection suggests potential stress concentrations or structural deficiencies within that particular area. However, it is noteworthy that there were no instances of concrete crushing or cracking observed within the Ultra-High Performance Concrete pour itself. This suggests that while there may have been localized issues at the connection points, the UHPC material remained intact and resilient, indicating its high strength and durability properties. Such observations underscore the effectiveness of UHPC in withstanding loading conditions and maintaining structural integrity despite localized cracking at connection interfaces. Further analysis of these findings could provide valuable insights into improving the design and construction of similar structures in the future.

## IV. Relationship between Diaphragms and Bridge Performance

In their 2002 study, Cai et al. undertook a comprehensive evaluation aimed at investigating the influence of diaphragms on live load distribution factors and maximum strain in six prestressed concrete bridges. Their analysis involved employing numerical predictions and comparing them with data obtained from load testing conducted on these bridges. The researchers meticulously examined a range of factors crucial to bridge performance, including the types of AASHTO girders utilized, skew angles, span lengths, diaphragm configurations, and lane counts. To facilitate their investigation, various scenarios were simulated using the slab-on-grid finite element technique, which accounted for the presence and impact of both end and intermediate diaphragms on bridge behavior. A notable aspect of their study was the consideration of different stiffness levels for intermediate diaphragms, acknowledging the potential development of cracking in concrete over time. Additionally, the researchers hypothesized composite behavior between intermediate diaphragms and the slab in certain models, further enriching their analysis and providing insights into the complex interaction between diaphragms and bridge structures. By rigorously exploring these factors and employing advanced computational techniques, Cai et al. aimed to enhance our understanding of the role of diaphragms in prestressed concrete bridges. Their findings not only contribute to improving the accuracy of live load distribution factor predictions but also offer valuable insights for optimizing bridge design and construction practices.

*Corresponding Author: Mouralidasse J 

In their seminal 1973 study, Sengupta and Breen delved into a thorough investigation of the impact of intermediate diaphragms on prestressed concrete bridges. Their research employed microconcrete models supported by simple structures, allowing for controlled experimentation under both static and dynamic loading conditions.

Green et al.'s 2004 study further explored the impact of intermediate diaphragms (IDs), bearing stiffness, thermal variations, and bridge skew on prestressed concrete bridges. They confirmed that IDs reduced maximum deflection, likely due to a more even distribution of stiffness.

Wong and Gamble (1973) embarked on an extensive research endeavor aimed at thoroughly investigating the impact of diaphragms on the load distribution characteristics of continuous, straight slab, and girder highway bridges. The focal point of their study was to gain a comprehensive understanding of how the stiffness and positioning of diaphragms influence the magnitude of maximum positive and negative moments experienced by these bridge structures. The research conducted by Wong and Gamble involved a meticulous analysis of various scenarios, encompassing a wide range of diaphragm configurations. By systematically varying the levels of diaphragm rigidity and their placement along the span of the bridges, the researchers sought to uncover the nuanced effects of these factors on the structural behavior of the bridges under consideration.

Through their rigorous investigation, Wong and Gamble aimed to shed light on the intricate relationship between diaphragms and bridge performance. One of the key findings of their study was the identification of an optimal threshold for diaphragm stiffness. They observed that when diaphragm stiffness exceeded this threshold, the exterior beams of the bridges experienced significantly higher maximum moments compared to bridges without intermediate diaphragms. This crucial observation underscores the pivotal role played by diaphragms in the redistribution of loads and the management of structural forces within continuous bridge systems. By elucidating these mechanisms, Wong and Gamble's study provided valuable insights that contribute to the refinement of bridge design and construction practices, ultimately enhancing the safety and efficiency of transportation infrastructure.

## V. Summary

An extensive literature review is presented, focusing on the analysis pertinent to monitoring closure joint performance in bridges. Further it sought to address practical challenges encountered in the field, such as ensuring structural integrity, minimizing deflections, and enhancing load distribution across the bridge. By evaluating the effectiveness of various longitudinal joint configurations and diaphragm placements, the study aimed to identify strategies for improving the overall performance and longevity of precast girder bridges. The insights gleaned from this review of literature contribute to a more comprehensive understanding of bridge engineering practices, paving the way for safer, more durable, and economically viable infrastructure solutions.

## References

[1]. AASHTO (2012). “AASHTO LRFD Bridge Design Specification”. American Association of State Highway and Transportation Officials, Washington, D.C.
[2]. Alashari, Mishal. (2016). Accelerated Bridge Construction (ABC), A Better Approach to Bridge Construction?. International Journal for Innovation Education and Research. 4. 42-71. 10.31686/ijier.vol4.iss8.577.
[3]. Cai, C. S., Shahawy, M., and Peterman, R. J. (2002). “Effect of diaphragms on load distribution of prestressed concrete bridges”. Transportation research record, 1814(1), 47-54.
[4]. Castine, S. (2017), "Development of High Early-Strength Concrete for Accelerated Bridge Construction Closure Pour Connections".Masters Theses. 498.
[5]. Chandolu, K. (2005) "Assessing the needs for intermediate diaphragms in prestressed concrete girder bridges". Master's Theses, 2829, Louisiana State University.
[6]. FHWA, (2011). “Contracting and construction of ABC projects with prefabricated bridge elements and systems.” USA: Federal Highway Administration report FHWA-HIF-17-020.
[7]. FHWA, (2018). “Performance of grouted connections for prefabricated bridge deck elements.” USA: Federal Highway Administration report FHWA-HIF-19-003.conference on soil mechanics and geotechnical engineering 2013.
[8]. Green, T., Yazdani, N., and Spainhour, L. (2004). “Contribution of intermediate diaphragms in enhancing precast bridge girder performance”. Journal of performance of constructed facilities, 18(3), 142-146. 131
[9]. Milliam, J. L. (2004). “Single-lane live load distribution factor for decked precast, prestressed concrete girder bridges”. Master’s Theses, University of Alaska Fairbanks.
[10]. Sengupta, S. and Breen, J. E., (1973). “The effects of diaphragms in prestressed concrete girder and slab bridges”. Research Report 158-1F, Project 3-5-71-158, Center for Highway Research, University of Texas at Austin, Texas.
[11]. Wong, A. Y. C., and Gamble, W. L. (1973). “Effects of diaphragms in continuous slab and girder highway bridges”. University of Illinois Engineering Experiment Station, College of Engineering, University of Illinois at Urbana-Champaign.