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Construction Stage Challenges in Balanced Cantilever Concrete Box Girder Bridges: Time-Dependent Deformation and Closure Alignment

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The balanced cantilever construction method enables efficient erection of prestressed concrete box girder bridges in locations where falsework is impractical; however, maintaining geometric control and achieving accurate closure alignment during construction remain critical challenges due to time-dependent material behavior. This study examines construction stage challenges in balanced cantilever concrete box girder bridges by numerically evaluating time-dependent deformation and its influence on cantilever alignment and closure sensitivity. A step-by-step finite element simulation is employed to model the sequential erection of segments, prestress application, and material aging, incorporating the effects of concrete creep and shrinkage, prestressing steel relaxation, prestress losses, loading age, and construction sequence. The results show that concrete creep governs construction-stage and long-term deflection behavior, while shrinkage and tendon relaxation contribute secondary, but measurable, effects. Sensitivity analyses indicate that segment casting intervals and loading age significantly influence differential cantilever deflections and closure alignment. Model predictions are assessed by comparing them with real-world observations, as reported in the literature. The findings emphasize the importance of integrating time-dependent analysis into construction stage planning and erection control to support camber adjustment, reduce the risk of closure misalignment, and enhance the reliability of balanced cantilever bridge construction.

Keywords: Balanced cantilever, finite element modeling of construction stages, prestressed concrete box girder, creep and shrinkage, closure alignment

Introduction

The balanced cantilever method is widely used for constructing long-span prestressed concrete box girder bridges, particularly in locations where ground-based falsework is impractical due to deep valleys, waterways, or existing infrastructure. By erecting segments sequentially from piers in a symmetric manner, this method offers significant flexibility and minimizes disruption to the surrounding environment. However, the progressive nature of cantilever construction introduces substantial challenges related to geometric control, internal force redistribution, and alignment accuracy during the erection process. As the structure evolves from a series of statically determinate stages to a continuous system, time-dependent material behavior plays a critical role in governing construction-

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stage performance. Concrete creep and shrinkage, together with relaxation of prestressing steel, develop over time and interact with construction sequencing, loading age, and prestressing operations. These effects can lead to differential deflections between opposing cantilevers, particularly in long-span configurations where segments are cast over extended durations. If not properly anticipated, such differential deformations may result in closure misalignment, increased corrective work during erection, schedule delays, and additional construction costs. Field observations and analytical studies have shown that simplified elastic or empirical approaches commonly adopted in practice often underestimate these effects, as they do not fully capture the interaction between material aging, stress history, and staged construction processes. Advances in finite element modeling have enabled detailed simulation of construction stages, allowing the sequential activation of segments, prestressing tendons, and time-dependent material behavior to be represented explicitly. Prior research has demonstrated that such models can reproduce observed deformation trends and provide insight into the influence of creep, shrinkage, and prestress losses on bridge response. Nevertheless, much of the existing literature has focused on long-term structural behavior or post-construction performance, with limited emphasis on how time-dependent effects influence decision-making during the construction stage. In particular, the sensitivity of cantilever alignment and closure conditions to construction variables such as loading age, casting intervals, and erection sequence remains insufficiently addressed from a construction planning perspective.

The significance of this study lies in its focus on construction-stage behavior as a control problem rather than a design-only assessment. Segmental bridge construction is highly sensitive to schedule variability and geometric tolerances; small deviations in cantilever alignment can have a disproportionate impact on closure operations and project risk. This study aims to bridge the gap between time-dependent structural analysis and construction engineering practice by employing a step-by-step finite element simulation of balanced cantilever erection that explicitly accounts for material aging, prestress relaxation, and construction sequencing. The objectives of the study are to (1) evaluate the evolution of time-dependent deformation during cantilever construction, (2) quantify the sensitivity of cantilever alignment and closure conditions to loading age and construction sequence, and (3) demonstrate how numerical predictions can support camber adjustment and closure planning during construction. By framing time-dependent analysis as a construction-stage decision-support tool, the study contributes to improved geometric control, reduced alignment risk, and enhanced reliability in balanced cantilever bridge projects.

Background

Balanced cantilever construction is a widely used method for prestressed concrete box girder bridges where access from below is restricted or impractical. By erecting segments symmetrically from piers, the method eliminates extensive falsework but requires strict construction-stage control to maintain geometric alignment as the structure transitions from a statically determinate system to a continuous configuration. Numerous studies have demonstrated that time-dependent deformations, including concrete creep and shrinkage, as well as the relaxation of prestressing steel, accumulate during erection and significantly influence internal forces and cantilever alignment (Malm & Sundquist, 2010; Purba et al., 2023). Early investigations established that construction sequence and environmental conditions strongly affect deformation development in segmental bridges. Iglesias (2006) and Malm and Sundquist (2010) demonstrated that nonuniform deformation between cantilever arms can lead to misalignment of closure and residual stresses at continuity joints. Akbar (2021) further demonstrated that nonuniform creep and shrinkage across segments lead to cumulative geometric distortions, particularly when construction is prolonged over variable humidity and temperature conditions. Advances in computational modeling and field monitoring have enabled the simulation of construction stages with greater realism. Dolinajová and Šajgalík (2013) and Jurišić et al. (2024) demonstrated that finite element models incorporating construction chronology and time-dependent material behavior can accurately reproduce measured deflections and strains, highlighting the interaction between prestress losses and early-age concrete creep. These studies confirm that integrating time-dependent analysis with construction-stage simulation improves alignment prediction and construction reliability. Recent research has further emphasized the role of construction sequencing in deformation development. Purba et al. (2022, 2023) showed that construction sequence has a cumulative influence on short-term and long-term deflections when advanced creep models are used. Rincón et al. (2022) similarly confirmed that realistic modeling of time intervals between segment casting is critical for predicting cantilever deflections during erection. Rashed and Mehanny (2023) demonstrated that simplified analytical methods underestimate creep-induced moment redistribution during construction compared with nonlinear time-dependent simulations, limiting their applicability for construction control. Several studies have examined long-term bridge behavior as a continuation of the effects observed during construction. Gao et al. (2025) found that early-stage time-dependent deformations significantly influence long-term performance and maintenance needs, while Sconocchia et al. (2024) demonstrated that residual stresses originating during construction persist throughout the service life. Shen et al. (2025) further demonstrated that construction-stage imbalances amplify stress concentration through shear-lag effects in long-span continuous bridges. Despite these advances, construction-stage analysis in practice is often treated separately from material time-dependence. Evidence from Akbar (2021), Purba et al. (2022), and Jurišić et al. (2024) suggests that this decoupling results in discrepancies between predicted and observed behavior, particularly in terms of closure alignment. The present study builds on this body of work by focusing on construction-stage simulation of balanced cantilever bridges using ABAQUS to evaluate time-dependent deformation and support closure alignment control, thereby strengthening the connection between numerical modeling and construction practice.

Methodology

Finite Element Modeling Framework

The present study adopts a numerical simulation-based methodology to analyze the construction-stage behavior of prestressed concrete box girder bridges constructed using the balanced cantilever method. The procedure integrates time-dependent material modeling, sequential construction, and finite element analysis to capture the evolution of construction stages, deflections, and internal force redistribution throughout the erection process. A three-dimensional finite element (FE) model was developed in ABAQUS to simulate the construction sequence of a representative multi-span balanced cantilever bridge. Shell elements were used to model the top and bottom slabs and webs of the box girder, while embedded truss elements represented internal and external prestressing tendons. Geometry, material properties, and boundary conditions were defined to reflect a realistic segmental bridge prototype. Each segment included appropriate dimensions, reinforcement layout, tendon anchorage zones, segment joints, shear keys, and connection stiffness. Figure 1 illustrates the general bridge geometry and segment configuration. Supports were modeled using idealized hinge and roller constraints at pier and abutment locations to allow realistic movement during erection. Prestressing tendons were defined using tendon elements with relaxation losses incorporated in accordance with ACI recommendations. A mesh refinement study confirmed convergence of displacement and stress responses while maintaining computational efficiency. The bridge geometry was based on the analytical model of Ketchum and Scordelis (1986) and refined within ABAQUS to enhance numerical stability and accuracy. The modeled bridge represents a typical balanced cantilever concrete box girder used for construction-stage assessment rather than a project-specific design. Each cantilever consisted of ten equal-length segments, with a constant-depth box girder cross-section and uniform slab and web thicknesses representative of long-span bridges. The adopted geometry is consistent with values reported in prior analytical studies

(Ketchum and Scordelis, 1986; Malm and Sundquist, 2010) and is intended to capture realistic stiffness and deformation behavior during construction.

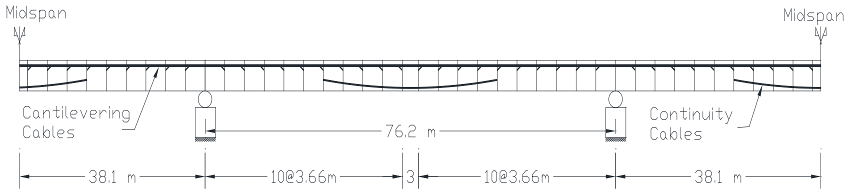

Figure 1. Bridge geometry and cable layout

Time-Dependent Material Modeling and Model Validation

Concrete creep and shrinkage were modeled using the ACI provisions, which account for material aging, environmental conditions, and stress history. Time-dependent behavior was represented using the ACI 209R creep and shrinkage formulation implemented through a user-defined material subroutine (UMAT) in ABAQUS. A constant ambient relative humidity representative of typical field conditions was assumed, while temperature effects were not explicitly varied. Model parameters were selected within recommended ACI ranges and were not calibrated to a specific bridge, as the objective was to represent typical construction-stage behavior rather than project-specific conditions. The constitutive formulation computes creep strain incrementally based on effective age and sustained stress level. Prestressing steel relaxation was incorporated as a function of tendon type, temperature, and initial stress ratio, and both instantaneous and delayed deformations were included in the stepwise analysis. Concrete strength gain was modeled through age-dependent modulus evolution, while shrinkage strain was applied as a predefined field varying with relative humidity and segment casting date. Model validation was conducted by comparing predicted mid-span deflections and internal moment redistribution with published experimental and analytical results. Figure 2 illustrates the creep coefficient–time relationship adopted in the simulation and its consistency with experimental data reported by Chiu et al. (1996). The numerical deflection profiles showed good agreement with field-measured trends, with differences in midspan deflection within a few millimeters at early ages (approximately 30 days) and remaining within the same order of magnitude at intermediate (180 days) and long-term (365 days) durations. Sensitivity analyses were performed on creep parameters, tendon relaxation rates, and casting intervals to quantify their influence on closure alignment and deformation trends. Additional benchmarking against documented construction-stage observations confirmed strong consistency with the deformation patterns and moment redistribution reported by Rashed and Mehanny (2023), demonstrating that the adopted modeling framework provides a realistic representation of construction-stage behavior despite differences in bridge geometry and environmental conditions.

Construction Sequence Simulation

The construction process was simulated step-by-step to represent the progressive nature of balanced cantilever erection. Segment pairs were activated symmetrically from the pier head, with self-weight applied concurrently with tendon prestressing. Construction was divided into discrete time steps corresponding to typical field casting intervals of 3-7 days, and cumulative creep, shrinkage, and prestress relaxation effects were evaluated at each stage. Continuity was achieved by simulating the closure segment, after which final continuity prestressing was applied once equilibrium was established between the opposing cantilever arms. The time-dependent response was tracked to quantify differential cantilever tip deflection prior to closure, and camber adjustment strategies were numerically evaluated to minimize alignment discrepancies, consistent with field practices reported by Jurišić et al. (2024) and

Rincón et al. (2022). Prestressing was modeled using longitudinal tendons arranged at multiple vertical levels within the box girder, activated sequentially as segments were erected. Anchorage locations were assigned at segment joints in accordance with balanced cantilever construction practice, with prestressing forces applied to counteract self-weight and construction-stage bending. Boundary conditions were defined using restrained translational degrees of freedom at the piers with longitudinal rotational release, while abutments were idealized as roller supports permitting longitudinal movement, consistent with standard assumptions in construction-stage bridge analysis.

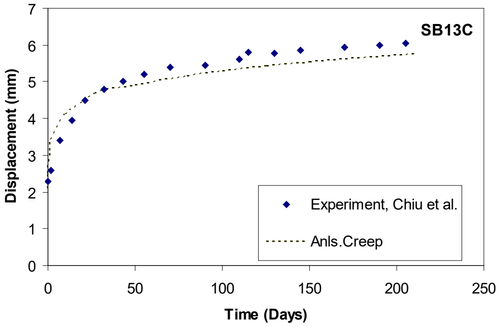

Figure 2. Experimental and creep analysis results

Summary of Methodological Framework

The adopted methodology provides an integrated approach for evaluating construction-stage challenges in balanced cantilever bridges. By combining finite element simulation, time-dependent constitutive modeling, and stage-by-stage analysis, it enables a realistic prediction of geometric and stress evolution during bridge assembly. The model framework can be extended to assess the effects of alternative construction sequences, climatic conditions, and prestressing strategies. The findings from this simulation form the foundation for developing practical construction control guidelines that ensure closure precision and structural serviceability of balanced cantilever concrete box girder bridges. Although this study does not propose a closed-form algorithm for camber determination, the adopted modeling approach provides a practical framework for supporting decisions on camber and closure alignment during construction. The framework consists of simulating staged segment erection with time-dependent material behavior, tracking cantilever tip deflections as a function of construction time, and evaluating the sensitivity of alignment to loading age and casting intervals. By comparing predicted deflection histories under alternative construction scenarios, engineers can identify construction sequences and camber adjustments that minimize differential cantilever deflection prior to closure. In this sense, the framework serves as a decision-support tool that links numerical prediction with construction planning rather than as a prescriptive design procedure.

Sensitivity to loading age and construction sequence

In addition to creep and prestress relaxation, the influence of loading age and construction sequence was evaluated through a supplementary sensitivity analysis. Loading age was varied by modifying the time at which each newly cast segment was activated and prestressed, reflecting realistic construction scenarios in which delays or accelerated schedules occur. Earlier loading ages resulted in increased creep-induced deformation due to lower concrete maturity, leading to larger cumulative deflections at the cantilever tip. Conversely, delayed loading reduced early-age creep effects but introduced greater differential deformation between opposing cantilevers when construction durations became asymmetric. The effect of construction sequence was investigated by varying the time intervals between successive segment castings while maintaining identical geometric and material properties. The results indicate that extended casting intervals amplify time-dependent deformation, particularly near the closure region, increasing the sensitivity of closure alignment to schedule variability. These findings are consistent with those reported by Gao et al. (2025), who demonstrated that construction chronology plays a crucial role in the development of long-term deformation. The results confirm that loading age and construction sequence act as coupled parameters with creep behavior and should be explicitly considered during construction-stage planning and erection control.

Results and Discussion

Figure 3 illustrates the deflected shape of half the bridge span under two conditions: at the completion of construction and after long-term deformation due to concrete creep. The results reveal a clear increase in downward deflection across the cantilever arm as time-dependent effects develop. The initial elastic deflection recorded at the end of construction represents the combined effects of self-weight and prestressing; however, after creep development, the vertical displacement increased significantly, particularly at the cantilever tip and mid-span regions. The numerical simulation shows that long-term creep deformation increases the maximum downward displacement at the cantilever tip by approximately about 55% percent compared with the elastic response at the end of construction. This cumulative deflection is most pronounced near the mid-span, where bending moments reach their maximum values. The finite element results clearly demonstrate that the long-term deformation profile differs in curvature from the short-term elastic shape. This distinction confirms that creep does not simply scale the instantaneous deflection but alters the internal moment distribution along the cantilever. The analysis further indicates that the rate of deflection growth diminishes over time, with most of the creep-induced deformation occurring within the first two years after construction and stabilizing gradually thereafter. The observed trends underscore the importance of incorporating time-dependent effects in predicting construction-stage geometry and in determining suitable camber corrections to maintain proper alignment during closure. Overall, the results highlight that neglecting creep during the design or construction phases can result in underestimation of long-term deflections by several millimeters, leading to potential mismatches between cantilever tips and increased difficulty in achieving closure accuracy.

Figure 4 presents the behavior of the cantilever tips during sequential construction stages, illustrating the influence of short-term prestress losses on the overall deflection response. During the early stages of construction, each newly installed segment undergoes an immediate downward deflection primarily governed by its self-weight and the corresponding prestressing force. For instance, following the installation of segment No. 5, the numerical analysis indicates a tip deflection of approximately 8 mm, reflecting the instantaneous deformation of the partially completed cantilever. However, as additional segments are added and subsequent tendons are stressed, the structural stiffness of the cantilever increases, resulting in a partial recovery of the earlier deflection. By the time all ten segments are installed and post-tensioned, the deflection at the same location is reduced to roughly 3 mm, demonstrating the compensating effect of prestressing on the incremental deformation. The analysis reveals that instantaneous prestress losses significantly influence the early deformation behavior, whereas the gradual stage-by-stage effects contribute to only a minor additional deflection. These results highlight the importance of considering both instantaneous and progressive losses in predicting construction-stage geometry, ensuring that the camber adjustments applied during erection accurately offset the expected displacements and maintain proper alignment between opposing cantilevers. Figure 5 compares the effects of various time-dependent phenomena on the deflection of bridge segments both during construction and after completion of all cantilever segments. The analysis distinguishes between instantaneous and long-term deformations, capturing the cumulative effects of creep and shrinkage of concrete, as well as the relaxation of prestressing steel, throughout the construction process. The results clearly demonstrate that time-dependent material effects result in a noticeable increase in the downward displacement of the cantilever deck. During the construction stages, each newly added segment experiences progressive deformation as the structure ages and the sustained stresses continue to induce creep strains. After the cantilever is completed, these deformations persist, resulting in additional long-term sagging that modifies the bridge's final profile compared to its shape at the end of construction. Among the various time-dependent mechanisms considered, the creep of concrete has the most significant influence on the overall behavior of the cantilever system. Its contribution to total deflection is considerably greater than that of shrinkage or tendon relaxation, particularly in regions near the cantilever tips where bending stresses are highest. The shrinkage of concrete, while present, produces a relatively uniform contraction that affects the global alignment but does not substantially alter curvature. Relaxation of the prestressing tendons has a more gradual but smaller impact, leading to minor additional deflection over time. The results further indicate that creep-induced deflection should be prioritized when defining camber requirements, as it represents the primary source of long-term deformation in balanced cantilever box-girder bridges. Consequently, the modeling approach shown in Figure 5 provides a reliable framework for optimizing camber adjustments and maintaining alignment precision during the erection process. To directly relate the numerical results to closure alignment, closure mismatch is herein defined as the vertical displacement difference between the opposing cantilever tips at the time of closure. While Figures 3–5 present deflection profiles along the span, the predicted cantilever tip displacements at the closure age indicate that time-dependent deformation can lead to a measurable vertical mismatch between the left and right cantilevers. This mismatch is primarily governed by asymmetric creep development associated with construction sequencing and loading age, even when nominally symmetric erection procedures are adopted.

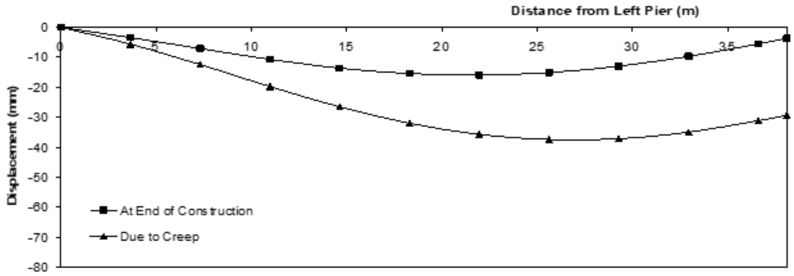

Figure 3. Deflection profile at the end of construction and due to the creep effect

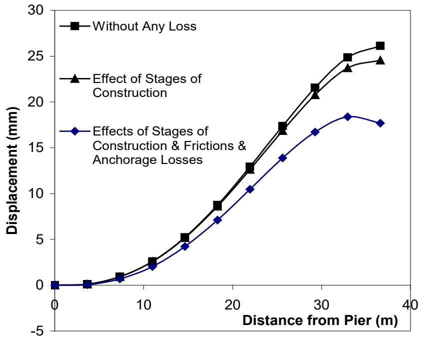

Figure 4. Cantilever tips during construction due to short-term prestress losses

A simplified example of camber adjustment is considered to illustrate how the predicted closure mismatch can be mitigated in practice. Using the computed cantilever tip displacements at the closure age, an upward camber adjustment is applied to the cantilever exhibiting the larger downward deflection. The objective of this adjustment is not to modify the overall deflection profile, but to offset the predicted tip mismatch at closure. The adjusted case demonstrates a clear reduction in differential cantilever elevation at the closure location, indicating that closure alignment can be effectively controlled when camber decisions are informed by construction-stage, time-dependent predictions rather than relying solely on elastic deflection.

Implications for Construction Planning and Erection Control

The numerical results have direct implications for construction planning and erection control of balanced cantilever bridges. Stage-by-stage simulations show that differential deflections between opposing cantilevers are highly sensitive to construction sequencing and segment casting intervals. Extended delays between segment installations amplify creep-induced deformation, increasing the risk of closure misalignment and the need for corrective actions during erection. From a construction management perspective, these findings emphasize the importance of maintaining consistent casting cycles and closely coordinating prestressing operations with segment placement. The results further indicate that camber should be treated as an adaptive construction control parameter rather than a fixed design input. Because creep dominates long-term deformation, camber values defined early in construction may become inadequate if schedule disruptions occur. The proposed modeling framework enables engineers to evaluate alternative erection scenarios, assess the impact of schedule changes on alignment tolerances, and update camber targets prior to closure. This proactive approach reduces the likelihood of field rework, closure delays, and schedule overruns. The quantified contributions of creep, shrinkage, and prestress relaxation also support prioritizing monitoring and quality control efforts during construction. Since creep governs most alignment deviation, construction-stage surveys should focus on cantilever tips and be aligned with critical construction milestones.

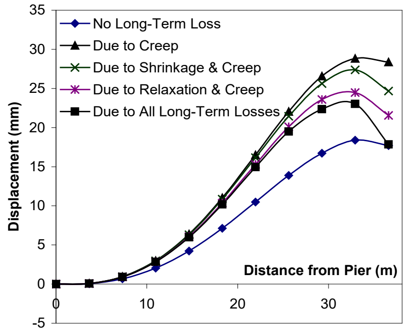

Figure 5. Cantilever tips due to time-dependent effects

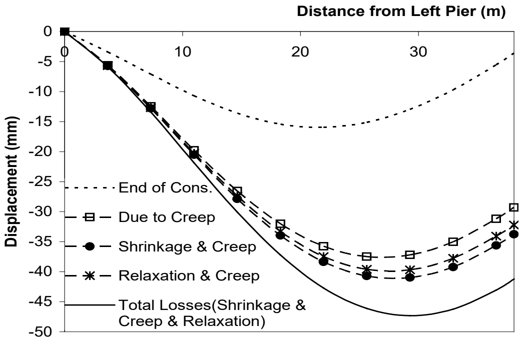

Figure 6. Deflection of the bridge at the end of construction and in the long term

Figure 6 illustrates the deflection profile of half the bridge span at the end of construction and after thirty years, demonstrating the cumulative influence of time-dependent material behavior. Concrete creep produces the largest increase in long-term deflection, confirming its dominant role in modifying bridge geometry, while shrinkage and prestress relaxation contribute smaller but non-negligible effects. Together, these mechanisms result in a pronounced increase in curvature, particularly near mid-span, underscoring the importance of incorporating time-dependent effects into construction planning and long-term performance assessment.

From a construction risk and quality management perspective, closure alignment represents a critical control point in balanced cantilever bridge projects. Even small deviations in cantilever tip elevation can lead to prolonged closure operations, additional prestressing adjustments, or localized rework, all of which have direct cost and schedule implications. The results demonstrate that time-dependent deformation introduces a measurable and predictable source of alignment risk that evolves throughout construction rather than emerging only at closure. By quantifying the relationship between construction sequencing, time-dependent material behavior, and geometric deviation, the modeling framework allows engineers to establish decision thresholds for corrective action during erection. For example, predicted deflection growth can be used to define acceptable tolerance bands beyond which camber modifications or schedule adjustments should be implemented. This shifts construction control from a reactive approach, where corrections are made at closure, to a proactive risk mitigation strategy embedded within the construction plan. Moreover, the ability to simulate alternative construction scenarios enables project teams to evaluate cost–schedule trade-offs associated with delayed segment casting, modified prestressing sequences, or environmental exposure. Rather than treating time-dependent effects as unavoidable uncertainties, the framework supports their integration into construction planning, inspection scheduling, and quality assurance procedures, contributing to improved predictability and construction reliability in segmental bridge projects.

Conclusion

This study investigated construction stage challenges in balanced cantilever concrete box girder bridges, focusing on the effects of time-dependent material behavior on geometric control and closure alignment. A step-by-step finite element simulation using ABAQUS was employed to model sequential segment erection, prestressing operations, and material aging, incorporating concrete creep and shrinkage, prestress relaxation, and the various construction stages. The results demonstrate that time-dependent deformation substantially alters cantilever geometry during construction and governs alignment conditions at closure. Concrete creep was identified as the dominant contributor to both construction-stage and long-term deflection, while shrinkage and prestress relaxation produced secondary but measurable effects. Instantaneous losses such as anchorage slip and friction primarily affected early-stage deflections, whereas time-dependent behavior controlled deformation evolution as construction progressed. Parametric evaluations further showed that loading age and casting intervals significantly influence differential cantilever deflection and closure sensitivity, underscoring the importance of construction sequencing in alignment control. From a construction engineering and management perspective, the key contribution of this study is to demonstrate the use of time-dependent staged analysis as a construction-stage decision-support framework, rather than a design-only tool. By linking numerical predictions with erection sequencing and camber adjustment, the proposed approach supports proactive closure planning, reduces alignment risk, and improves construction reliability. These findings highlight the importance of integrating time-dependent analysis into construction planning to enhance geometric precision during erection and ensure satisfactory service performance of balanced cantilever bridges.

References

Akbar, S. (2021). Long-term deformation of balanced cantilever bridges due to non-uniform creep and shrinkage, KTH Royal Institute of Technology, Sweden. https://www.diva-portal.org/smash/record.jsf?pid=diva2%3A1589566

Chiu, H.S., Chern, J.C. and Chang K.C. 1996. Long-Term Deflection Control in Cantilever Prestressed Concrete Bridges, I and II. Journal of Engineering Mechanics, ASCE, 122: 489-501.

Dolinajová, K., & Šajgalík, J. (2013). Monitoring and numerical analysis of construction stages of a prestressed concrete bridge. Procedia Engineering, 57, 316–323. https://doi.org/10.1016/j.proeng.2013.04.043

Gao, W., Wang, B., Zhu, J., Wang, Y., Zhang, Y., Zhou, S., & Zhang, J. (2025). Long-term deformation behavior and hanger-force adjustment scheme of a prestressed concrete continuous rigid-frame arch bridge. Results in Engineering, 27, 106688. https://doi.org/10.1016/j.rineng.2025.106688

Iglesias, C. (2006). Long-term behavior of precast segmental cantilever bridges. Journal of Bridge Engineering, 11(3), 340–348. https://doi.org/10.1061/(ASCE)1084-0702(2006)11:3(340)

Jurišić, M., Bebek, N., Ćubela, D., & Harapin, A. (2024). Strain analysis on cast-in-place balanced cantilever prestressed concrete bridges during construction. Structural Engineering International (IABSE), 34(1), 1–11. https://doi.org/10.1080/10168664.2023.2296979

Ketchum, M.A. and Scordelis, A.C. 1986. Redistribution of Stresses in Segmentally Erected Prestressed Concrete Bridges, University of California, Berkeley, Report No. UCB/SESM-86-07.

Malm, R., & Sundquist, H. (2010). Time-dependent analyses of segmentally constructed balanced cantilever bridges. Engineering Structures, 32(4), 1038–1045. https://doi.org/10.1016/j.engstruct.2009.12.027

Purba, L. H., Supriyadi, B., & Suhendro, B. (2022). Effect of creep on the long-term deflection of box-girder balanced cantilever bridge structures using B3 model and CEB 2010. Journal of the Civil Engineering Forum, 9(1), 91–100. https://doi.org/10.22146/jcef.4905

Purba, L. H., Supriyadi, B., & Suhendro, B. (2023). Long-term deflection of prestressed concrete box-girder bridges due to creep and shrinkage. International Journal of GEOMATE, 25(107), 17–24. https://doi.org/10.21660/2023.107.3536

Rashed, M., & Mehanny, S. S. F. (2023). Simulating creep-induced moment redistribution in prestressed concrete bridges constructed by the balanced-cantilever method: Ad hoc traditional formulae versus real time-dependent analysis. Journal of Engineering and Applied Science, 70(1), 28. https://doi.org/10.1186/s44147-023-00199-4

Rincón, L. F., Viviescas, A., Osorio, E., Riveros-Jerez, C. A., & Lozano-Galant, J. A. (2022). Long-term deformation assessment of a long-span concrete bridge built by the cantilever erection method. Latin American Journal of Solids and Structures, 19(5), e456. https://doi.org/10.1590/1679-78257102

Sconocchia, G. G., Mariani, F., Ierimonti, L., Meoni, A., Venanzi, I., & Ubertini, F. (2024). Insights into structural assessment and long-term effects of a post-tensioned multispan concrete box-girder bridge with vertically prestressed internal joints. Structures, 60, 106396. https://doi.org/10.1016/j.istruc.2024.106396

Shen, Z., Zhou, C., Li, D., Meng, Y., Zhou, L., Yang, L., He, C., Wang, S., & Jin, S. (2025). Finite element analysis of shear-lag effect in long-span single-box continuous rigid bridges. arXiv preprint, arXiv:2501.03093. https://arxiv.org/abs/2501.03093