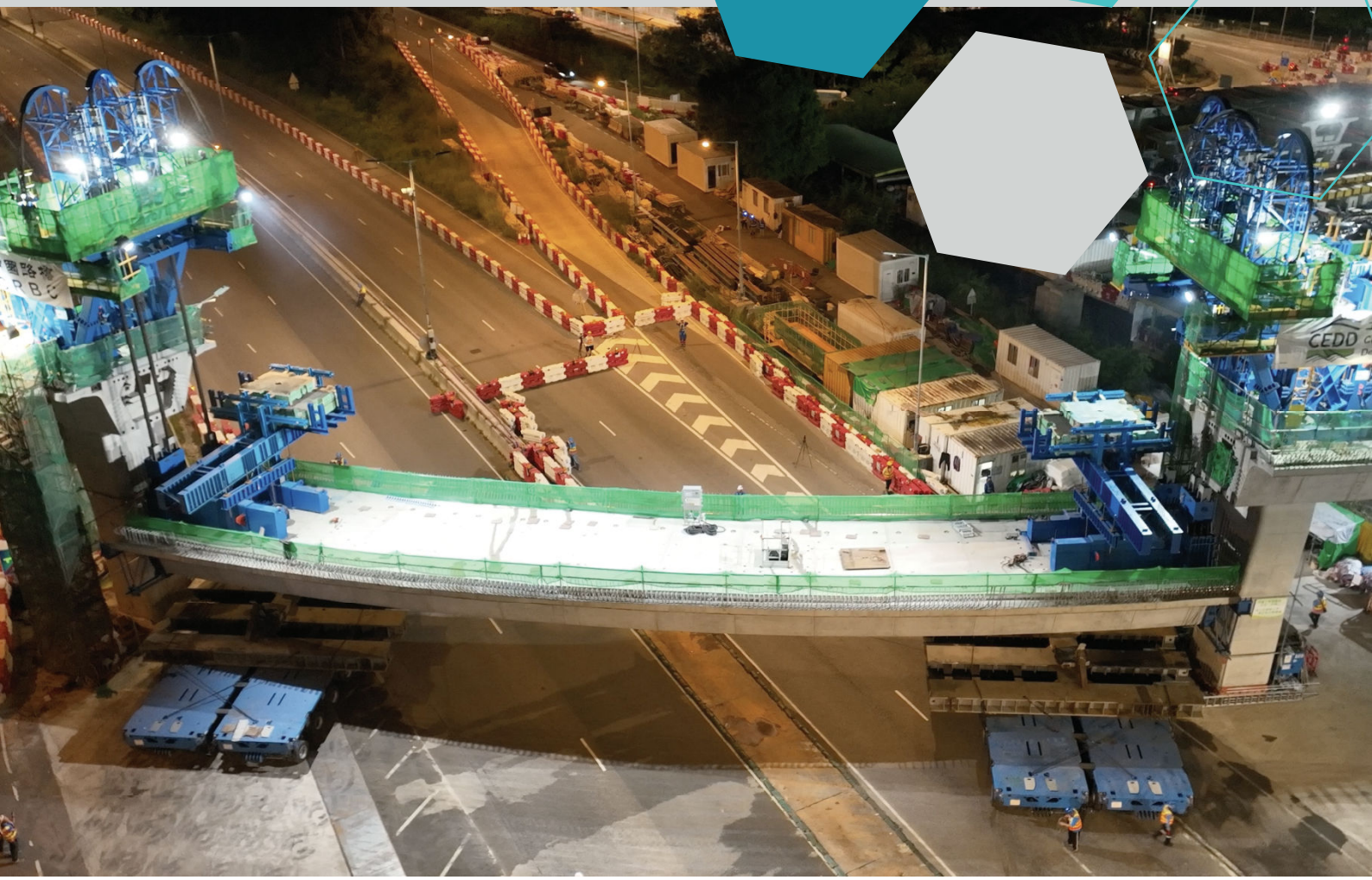
CEDD INNOVATION SERIES



Full-span Deck Erection Method

Foreword

The successful implementation of the innovative Full-span Deck Erection Method along the heavily trafficked Fanling Highway and Castle Peak Road marks a notable advancement in the industralisation of bridge construction within congested urban environments. This achievement exemplifies the core values of engineering excellence, innovation, quality and safety, and sustainability.

I would like to commend the project team for tremendous efforts in pioneering novel engineering technologies to effectively address Hong Kong's challenging site constraints during the construction of the major new bridge, including limited working space, stringent temporary traffic management requirements, and restricted time slots on heavily trafficked red-route trunk roads. The team's technical expertise and innovative approaches were pivotal in enhancing construction efficiency, mitigating site safety, and minimising disruption to the public.

I would also like to express my sincere appreciation of the exemplary spirit of collaboration among the project teams and industrial practitioners, which was fundamental to the successful implementation of this innovative methodology. The integration of advanced construction techniques with digital technologies has yielded substantial and quantifiable benefits—notably in improved construction safety, optimised programme scheduling, and enhanced efficiency. These combined outcomes have resulted in significant benefits, while establishing a new benchmark for bridge construction in constrained urban settings.

As always, CEDD is committed to promoting innovation and collaboration in the delivery of resilient, safe, and sustainable infrastructure for Hong Kong. This CEDD Innovation Series publication consolidates our experience with the Full-span Deck Erection Method and is intended to serve as a reference of proven best practices for the local construction industry.



Mr. FONG Hok-shing, Michael, JP.
Director of the Civil Engineering and Development Department

CEDD

Abstract

The Development of the Loop project successfully pioneered the innovative Full-span Deck Erection Method in the construction of Bridge ST01 connecting the Loop to Fanling Highway/San Tin Highway. Bridge ST01 spans over the heavily trafficked Fanling Highway and Castle Peak Road (Chau Tau) that encompass a total of 10 lanes. To overcome the constraints of limited construction timeslots for overnight work over the busy highways, the project team combined the use of Self-propelled Modular Transporters and strand-jack lifting system to erect a full span bridge deck in just one night, enabling faster construction and minimising public disruption, with significantly fewer road closures required.

To optimize the operation of this innovation, the project team fully leveraged the use of digital technologies, including LiDAR scanning, drone-based photogrammetry, comprehensive BIM modelling and augmented reality, etc. These technologies helped streamline construction activities and avoid abortive works, thus enhancing construction efficiency.

The Bridge ST01 was successfully and safely completed in October 2025 with “zero” construction incidents. With the adoption of this innovation, it greatly reduced construction time, enhanced site safety (through reducing work-at-height activities), minimized public disturbance (through reducing road closures) and reduced carbon emissions. The entire setup can be easily replicated for application in other bridge construction having similar constraints.

CEDD hopes that the innovations under the Development of the Loop project can enhance the efficiency and safety of future bridge construction in Hong Kong as well as the Greater Bay Area, strengthening Hong Kong’s role as a super-connector and super-value adder in the region.

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1 Project Overview

1.1. Project Background

The Development of the Loop project supports Hong Kong's development into an international innovation and technology (I&T) centre. In order to establish the Hong Kong–Shenzhen Innovation and Technology Park (HSITP) in the Loop (Figure 1), the Hong Kong Special Administrative Region (HKSAR) Government and Shenzhen Municipal People's Government agreed to develop the Loop jointly, formalised via a Memorandum of Understanding signed on 3 January 2017.

The HSITP is located in the Loop, adjacent to the Shenzhen River, leveraging its strategic location, creating one river two banks, one zone two parks, which forms part of the development plan for Shenzhen Park of Hetao Shenzhen–Hong Kong Science and Technology Innovation Co-operation Zone. The Development of the Loop project is undertaken by the Civil Engineering and Development Department (CEDD) to facilitate such development. It includes site formation and infrastructure works within the Loop, construction of Western Connection Road, viaducts to Fanling/San Tin Highway and Mass Transit Railway (MTR) Lok Ma Chau Station, and establishment of an ecological area.



Figure 1 – Artistic impression of the Hong Kong-Shenzhen and Technology Park (HSITP)

The key scope of works includes a vital new single-lane carriageway viaduct (Bridge ST01) connecting Lok Ma Chau Road and Fanling Highway/San Tin Highway, which is an important road for cross-boundary traffic. The bridge features prestressed concrete box girder decks, with most spans situated in highly constrained areas containing multiple sensitive receivers. These constraints posed significant construction challenges, especially in maintaining productivity with minimal disruption to the public.

1.2 Need Innovations

In addition to the site constraints mentioned above, this project commenced during the Covid-19 pandemic, introducing further challenges in meeting deadlines and budgets. The project team recognised early that leveraging innovative solutions to enhance productivity would be essential.

New approach for constructing the major bridge structure was developed and implemented, marking significant advancements in bridge construction. As the benefits were validated, the team sought to promote this innovation for wider industry adoption.

1.3. Strategic Significance of the Innovations

The project's innovative approaches align with 'Construction 2.0', which highlights innovation as key to industry advancement. The innovative technologies and method employed in the construction of Bridge ST01 is not limited to specific site conditions but can be widely adopted as standard solutions for building other urban viaducts in congested areas and over existing roads. This solution incorporates mechanised bridge erection technique with extensive pre-assembly, thereby reducing manual labour, minimising work at height, and limiting activities over live traffic. This approach effectively addresses common challenges faced by the construction industry in Hong Kong, such as the undesirable incidence of accidents and the shortage of the skilled workforce.

2. Background of Full-Span Deck Erection Method

2.1. Challenging Site Constraints and Limitations

Bridge ST01 is situated near the San Tin Interchange, spanning over the heavily trafficked Fanling Highway and Castle Peak Road (Chau Tau), which are essential for connectivity to the boundary control points at Lok Ma Chau and Huanggang (Figure 2). In recent years, there has been a significant increase in cross-boundary commuters, facilitating the integration, exchange, and collaboration within the development of the Greater Bay Area. Thus, it is imperative that the construction of Bridge ST01 be executed efficiently to minimise traffic disruptions that might adversely affect cross boundary traffic the Hong Kong–Shenzhen boundary.



Figure 2 – Overview of Bridge ST01

2.2. Conventional Solutions and their Limitations

The implementation of the conventional balanced cantilever method for Bridge ST01's deck erection would require the lifting of individual segments. With 10 existing road lanes beneath the bridge, this would necessitate multiple phases of temporary traffic arrangements (TTAs), involving complex lane closures and diversions, resulting in significant traffic disruption. The method's continuously advancing construction front would demand frequent lane reconfigurations, potentially confusing motorists and raising safety concerns. Moreover, segment-by-segment erection is inherently slow. Given the multiple spans to be constructed and the inability to undertake concurrent works due to TTA constraints, overall construction productivity would be severely limited. Accordingly, the conventional balanced cantilever method was deemed unfavourable for Bridge ST01.

2.3. Development of the Innovative Solution

In response to these challenges, the project team developed a novel solution of the innovative Full-span Deck Erection Method, leveraging Design for Manufacturing and Assembly (DfMA) principles to fundamentally transform bridge deck erection practices. The concept was initially conceived in 2021 and refined into the final design by 2022.

This method enables span-by-span construction, delivering substantially higher productivity than the traditional balanced cantilever approach, which requires the erection of individual segments. For Bridge ST01, comprising ten spans in total, five spans located over and adjacent to the existing roads were specifically selected for the implementation of this innovative solution. The advantages of this method relative to the conventional approach are summarised in Figure 3 below.



Figure 3 – Key features of 'Full-span Deck Erection Method' and its advantages

2.4. Implementation of the Innovative Solution

The bridge design, segmentation, and prestressing were optimised for Full-span Deck Erection, supported by comprehensive structural analysis for all loading conditions. The deck comprised precast segments up to 3m long, enabling offsite prefabrication and land-based delivery. An assembly yard, located away from existing highways and equipped with a custom gantry crane, facilitated ground-level daytime assembly of segments into full-span units with epoxy joints and first-stage prestressing, enhancing safety by minimising work at height and night-time operations.

During scheduled nighttime shifts, each full-span unit (maximum weight approximately 900-tonne) was transported by Self-propelled Modular Transporters (SPMTs) to its final position between piers. TTAs were implemented in advance where SPMTs traversed existing roads. A strand-jacking system at the pier-heads lifted each full-span unit to the required elevation within a single nighttime operation, followed by geometrical surveys and adjustments to achieve high-precision positioning. Strand jacks were locked off and telescopic hanger beams were extended to provide additional support.

All activities were completed within one nighttime shift, with roads reopened before 5:30 AM. Daytime in-situ stitch concreting and second-stage prestressing connected each span to the pier heads, ensuring self-supporting conditions prior to adjacent span erection. This process was replicated for all spans, as illustrated in Figure 4.



On-site pre-assembly of precast deck segments at ground level

Transportation of full-span bridge deck unit (800 tons) to the erection position by SPMTs

Lifting and precise positioning by the Strand-Jack Lifting System

Completion of full-span deck erection (operation completed within a single night)

Figure 4 – Key steps for 'Full-span Deck Erection Method' for Bridge ST01

2.5. Features of SPMTs and Strand-Jack Lifting System

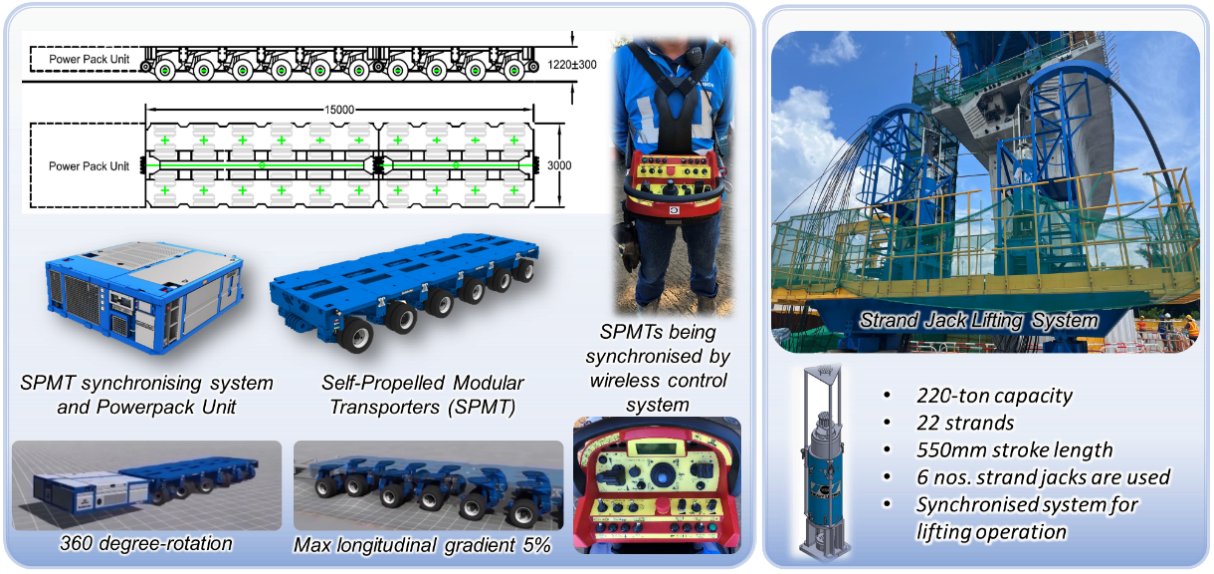


Figure 5 – Feature of SPMTs and Strand-jack Lifting System

The SPMTs, equipped with a wireless control system, enabled synchronized movement for precise maneuvering of the entire bridge deck in multiple directions, allowing navigation through complex site environments, including varying ground gradients and tight spaces. The strand-jack lifting system, utilizing six 220-tonne strand jacks, provided efficient and precise installation of the bridge deck, Figure 5. This deployment reduced risks associated with lifting and assembling precast deck segments at height, enhancing both site safety and construction efficiency.

3. Innovative Use of Digitalisation Technologies

3.1. Innovative Digital Solutions

The construction site of Bridge ST01 exhibited significant congestion due to its proximity to existing roads, structures, and sensitive receivers such as constraining equipment manoeuvring space while the innovative method required larger prefabricated elements and high-precision installation.

To facilitate effective planning, the team implemented advanced digital solutions from 2023 (refer to Figure 6), including photogrammetry and LiDAR scanning to generate accurate digital representations of existing site conditions. Building Information Modelling (BIM) served as the central platform to integrate all project data, including on-site survey data and modelled elements of proposed permanent works and planned equipment. This enabled accurate planning and examination of construction sequences, allowing all stakeholders to visualise activities and identify potential issues at an early stage.

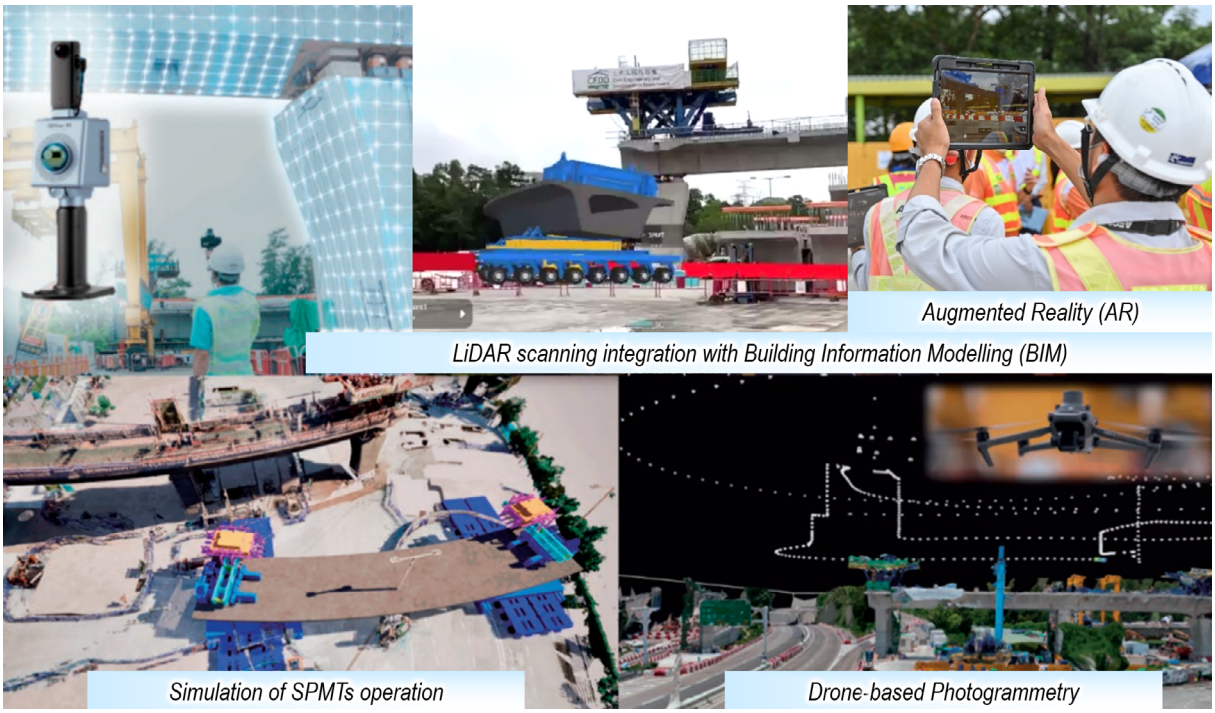


Figure 6 – Digital technologies facilitating effective planning of construction works

Augmented Reality (AR) technology was employed for on-site verification, overlaying BIM data onto the physical environment via tablets. This enabled real-time visualisation of equipment movements and verification of the accuracy of the plans. For Bridge ST01's Full-span Deck Erection, AR facilitated virtual walkthroughs and swept path analysis, ensuring SPMTs could navigate through clearances as tight as 800mm (refer to Figure 7), thereby supporting effective construction planning and implementation.

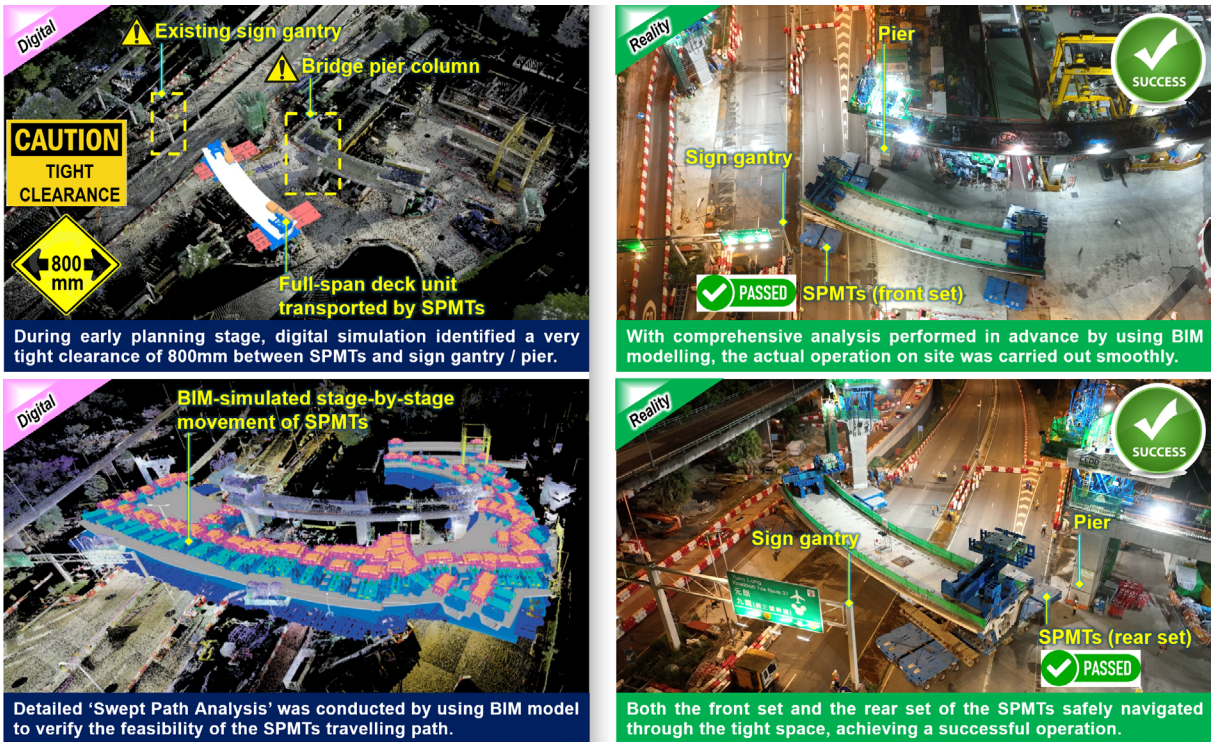


Figure 7 – Digital technologies safeguarding innovative erection solutions at Bridge ST01

4. Design for Safety

Through collaboration among the client, consultant, contractor and subcontractors, design-for-safety measures were fully implemented to enhance the safety margin for the innovative Full-span Deck Erection Method.

4.1. Adoption of Gantry Crane



Figure 8 – Adoption of gantry crane for precast deck segment lifting

Precast deck segments were cast in the Mainland, delivered to Hong Kong by vessel, and unloaded at Tuen Mun Public Cargo Working Area for subsequent land transportation to the on-site assembly yard. The use of a gantry crane at the assembly yard provided much greater stability during lifting compared to traditional mobile cranes, Figure 8.

4.2. Low-Level Transportation

The original plan was to transport the full-span bridge deck at a high level by SPMTs. However, after assessing the complex site conditions, especially tight spaces and sharp turns for the SPMTs, the project team adopted a much safer method of low-level transportation combined with lifting using the strand-jack lifting system (Figure 9) to minimize construction risks.



Figure 9: Adoption of low-level transportation by SPMTs

4.3. Telescopic Supporting Beam System



Figure 10: Temporary support lifting system

Since the full-span bridge deck needed to be temporarily supported over existing busy roads before being permanently connected to the columns, the project team implemented an additional telescopic supporting beam system on top of the strand-jack lifting system, Figure 10. This resulted in two separate temporary supporting systems, each structurally adequate to support the full-span bridge deck. These two independent supporting systems provided a double guarantee, which greatly enhanced site safety and prevented potential failures over busy roads.

5. Construction Challenge

The innovative Full-span Deck Erection Method faced various challenges including (i) complex temporary traffic arrangements for road closures; (ii) complicated site conditions for using the SPMTs; (iii) eccentric loads on the SPMTs due to the curved bridge deck; and (iv) tight construction timelines for night-time work on major highways. As this was the first implementation of the Full-span Deck Erection Method in Hong Kong, the project team began with the erection of the first and second full-span bridge decks located within the site area to gain experience. For the third full-span bridge deck which spans the Fanling Highway, the project team conducted an on-site trial run to identify and rectify potential issues before proceeding.

5.1. First Full-span Deck Erection (Daytime Operation)



Figure 11: First Full-Span Deck Erection

The first Full-span Deck Erection was completed on 2 February 2024 during the day (Figure 11), without the need for road closures, given that this section of the bridge was within the site area. For this first erection, the actual operation time exceeded the original planned time, prompting the construction team to explore ways to streamline the process, particularly surveying, to improve efficiency in subsequent operations.

5.2. Second Full-span Deck Erection (Night-time Operation)

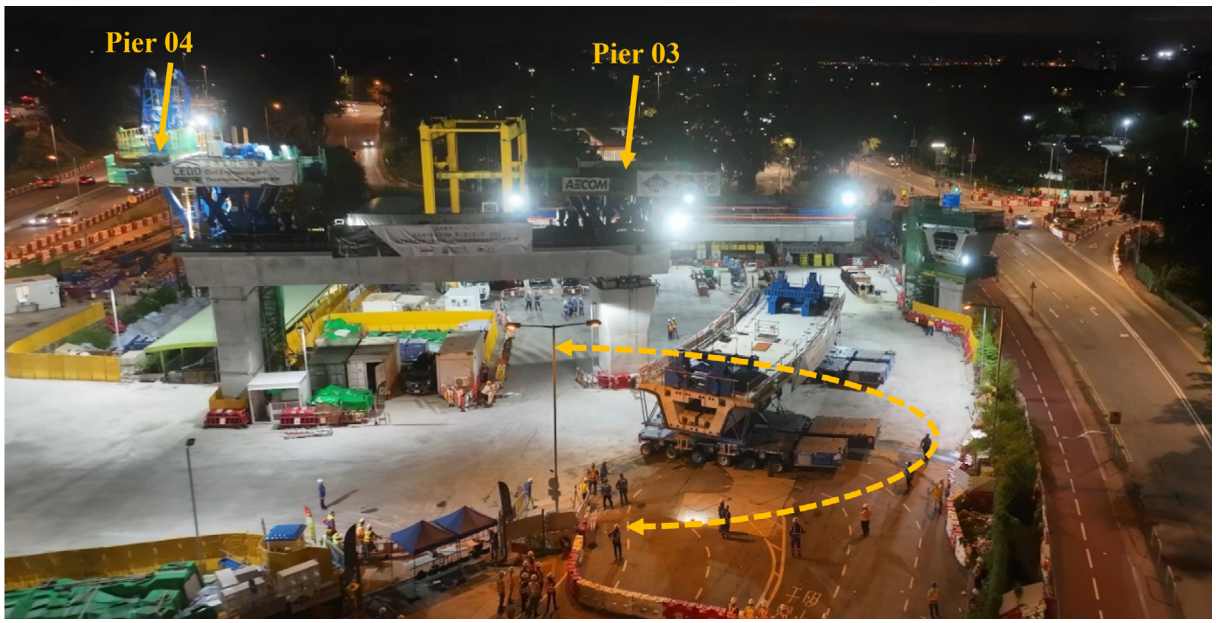


Figure 12: Second Full-Span Deck Erection

The second Full-span Deck Erection was completed at night on 11 July 2024, under similar arrangements (Figure 12) as the first operation but with a curved transportation path for the SPMTs. This erection aimed to determine whether the SPMTs could transport a 420-tonne bridge deck through a tight space and within the allocated night-time window. It was observed that the SPMTs took significantly more time than anticipated due to difficulties with sharp turns and uneven ground surfaces. The construction team conducted a thorough review before the upcoming third full-span erection, which was the most challenging operation.

5.3. Third Full-span Deck Erection – Trial Run for the SPMT Swept Path across Fanling Highway

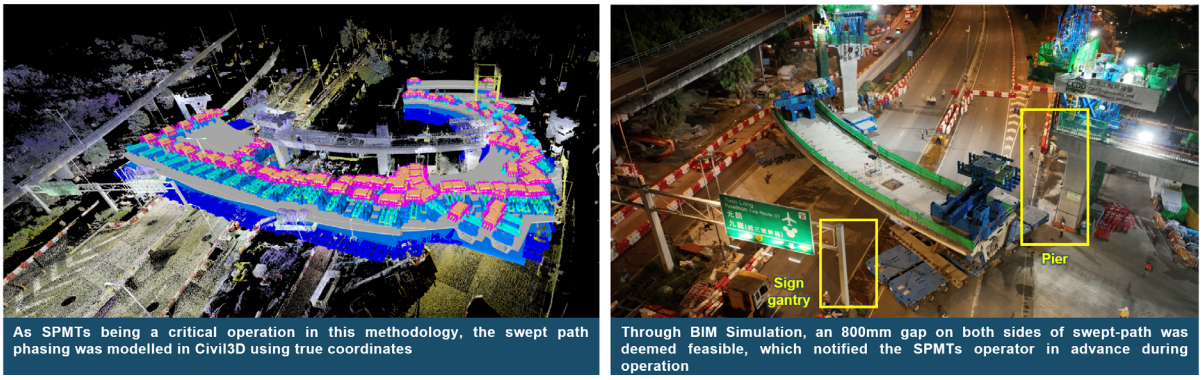


Figure 13: A Trial Run for the SPMTs across Fanling Highway

A trial run for the SPMTs transporting an approximately 800-tonne bridge deck across Fanling Highway was conducted before the actual implementation. This trial validated improvements from the first and second Full-span Deck Erections, verified counterweights for stability, and confirmed the digital simulation path for the SPMTs, Figure 13. In the trial run, the SPMTs navigated tight spaces with the most critical location having only about 800 mm clearances to existing structures and reached the designated erection point at Fanling Highway. Reference points for the SPMTs swept path were recorded and marked, allowing the actual transportation of the third Full-span Deck Erection to be completed smoothly on 28 August 2024.

6. Outcome and Benefits

The Full-span Deck Erection Method enabled entire spans to be erected in a single five-hour operation, far surpassing traditional segmental erection methods. It allowed most of the work to be completed at ground level in the assembly yard, away from traffic. This approach enhanced safety and minimised construction impacts on the surroundings. Performing the work in a controlled environment in the assembly yard also resulted in more consistent and better quality. This innovative approach enabled the bridge structure of Bridge ST01 to be completed efficiently on 28 June 2025 (Figure 14).



Figure 14: Ceremony Marking the Completion of the Bridge Structure of Bridge ST01

In terms of measurable outcome, this innovative construction method underpinned by digital technologies, has delivered quantitative and qualitative benefits to the project.

- **Health and Safety** – The Full-span Deck Erection Method eliminated 80% of work-at-height activities by performing assembly at ground level. Zero safety incident was achieved during all lifting operations.

- **Productivity** – The innovative method enabled the daytime work for the assembly and erection of precast deck segments, unlike the conventional methods, which require significant night work. This increased productivity, resulting in 3-month saving in deck installation.

- **User Experience and Sustainability** – The innovative method reduced night works and road closures by 90%. Minimizing night-time work and disruptions contributed to reduced light and noise pollution for the surrounding community. Shorter durations for road closures and heavy lifting operations also led to a 30% reduction in carbon emissions.

The Full-span Deck Erection Method utilized well-proven plant and equipment readily available in the industry, making the method easily replicable for other projects. Its success in the Development of the Loop project has led to growing adoption in other projects.

7. Recognition

7.1. Local and International Awards

The project team is fully committed to advancing innovative and sustainable infrastructure developments that better serve the community. This innovative Full-span Deck Erection Method, coupled with digitalisation, enables faster and safer construction, reduces carbon emissions, and minimizes public disturbance. It sets a benchmark for future bridge construction in Hong Kong.

This innovative bridge construction method has received recognition internationally and locally, earning a number of awards as listed in Figure 15 below.



1. NEC Martin Barnes Award 2024: Leading the Future through Best Practice and Collaboration (Runner-up)
2. The 9th International BIM Award (Gold)
3. CIC Construction Digitalisation Award 2024 – Project Category (Bronze)
4. HKICBIM Award 2025 (Diamond)
5. The Lighthouse Club 7th International Design for Safety Award (Merit)
6. HKIE Civil Division Civil Engineering Excellence Award 2024/2025 (Platinum)
7. CIC Construction Innovation Award 2025 (1st Prize)
8. The HKIE Grand Award 2026 (Bronze)
9. HKIE Design for Safety Excellence Award 2026 (Silver)
10. HKBIM BIM Award 2026 (Bronze)
11. CIC AI Award 2026 (Gold)

Figure 15: Awards for the implementation of "Full-Span Deck Erection Method"

7.2. Recommendation for Future Applications

The smart and innovative approach adopted for this project has significantly enhanced construction efficiency while reducing carbon emissions from construction activities. By employing the innovative Full-span Deck Erection Method, the project aligns with the principles of Construction 2.0 and establishes a new benchmark for future bridge construction. More importantly, it represents a major advancement in the industralisation of bridge construction in congested environments.

The successful delivery of this innovative construction method has been recognised through multiple industry awards. The pioneering construction solution is expected to be applied in future projects locally and internationally, generating wider benefits for the construction industry and society. This is particularly relevant to the development in the Northern Metropolis and the Greater Bay Area, strengthening Hong Kong's role as a super-connector and super-value adder in the region.

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