Life First - Walk the Talk

Continuous Promotion of Design for Safety

Innovative Horizontal Bridge Rotation Method (HBRM) over the East Rail Line

Transformative Change for Achieving Railway Operation Safety and Productivity Enhancement

創新橋樑平衡轉體施工橫跨東鐵線

實現鐵路營運安全與提升施工效率

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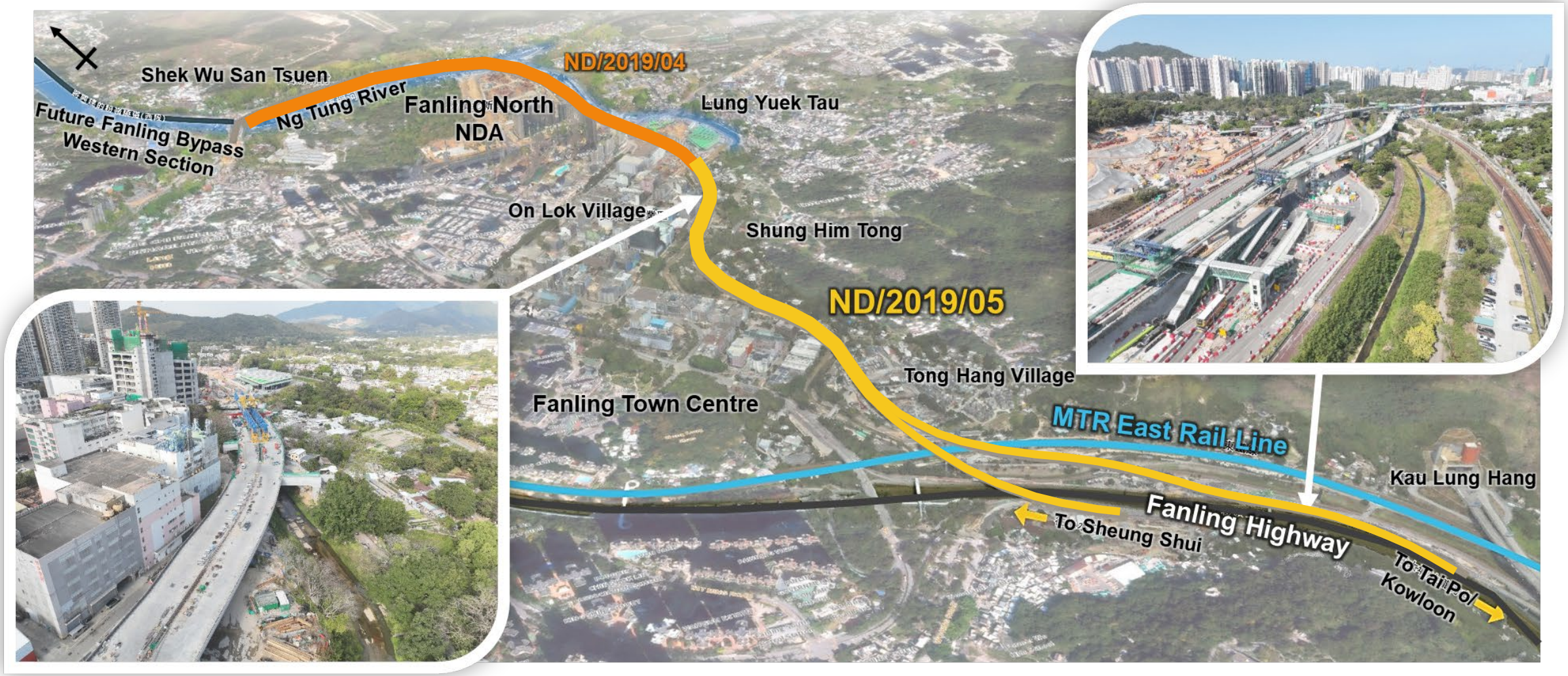
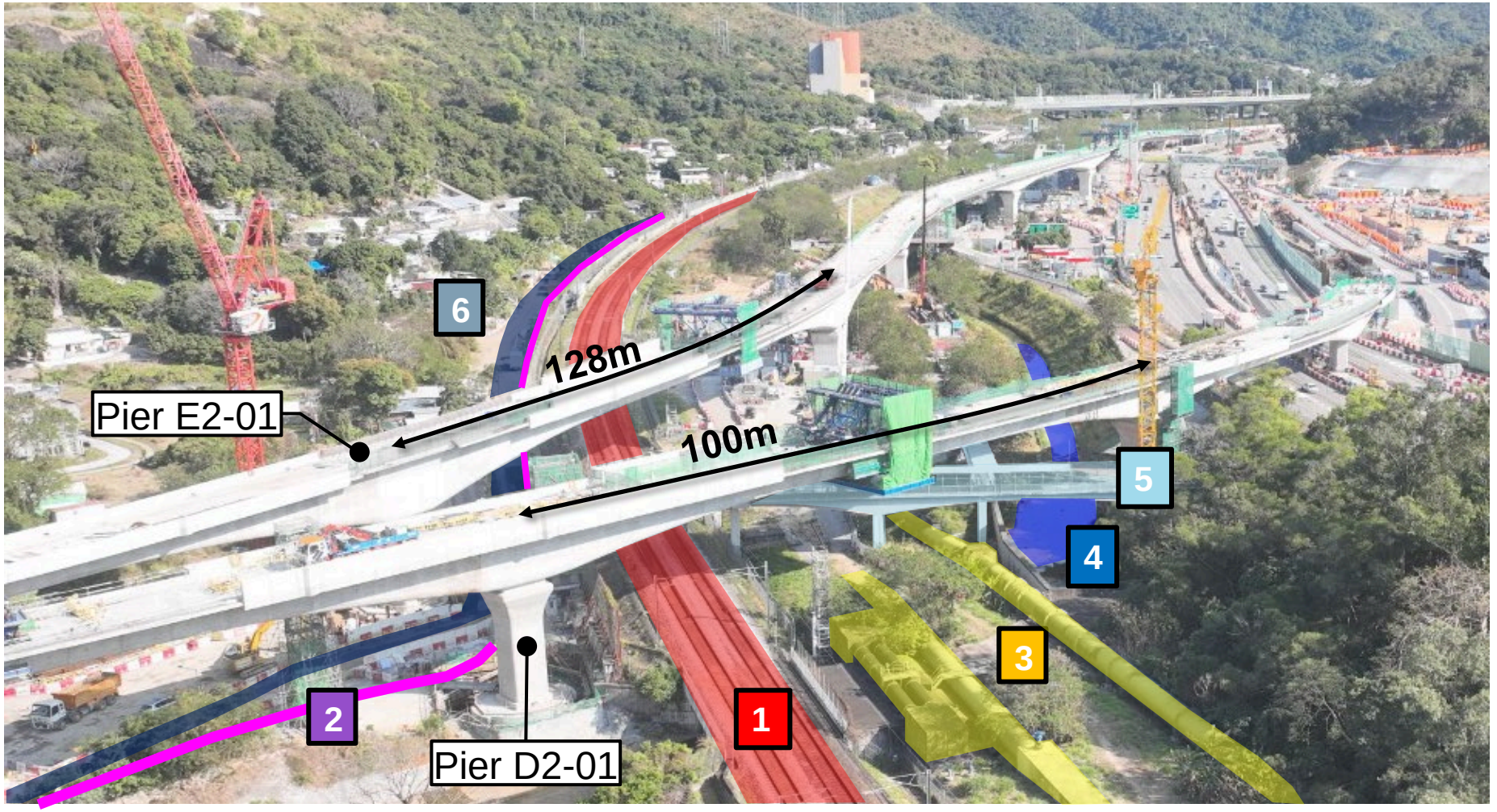
1. Site Constraints & Engineering Solutions

Fanling Bypass Eastern Section – General Layout



1. Site Constraints & Engineering Solutions

Site Constraints of Bridge Construction



Physical Constraints

1	MTR East Rail Line
2	CLP's 132kV Cable
3	Dongjiang Watermain
4	Ma Wat River
5	Footbridge
6	Tong Hang Village Road

Time Constraint

Restricted working timeframe (Allowable working time between 02:00 to 04:00 and 5 nights per month)

Geometry Constraint

Bridge deck in curved shape across railway (Eccentricity problem)

CEDD AECOM CRCC 中国铁建 Paul Y YWL

1. Site Constraints & Engineering Solutions

Site Constraints of Bridge Construction

Curved bridge deck in close proximity to railway track

1. Site Constraints & Engineering Solutions

Advantages of Bridge Rotation vs. Conventional Segment Erection

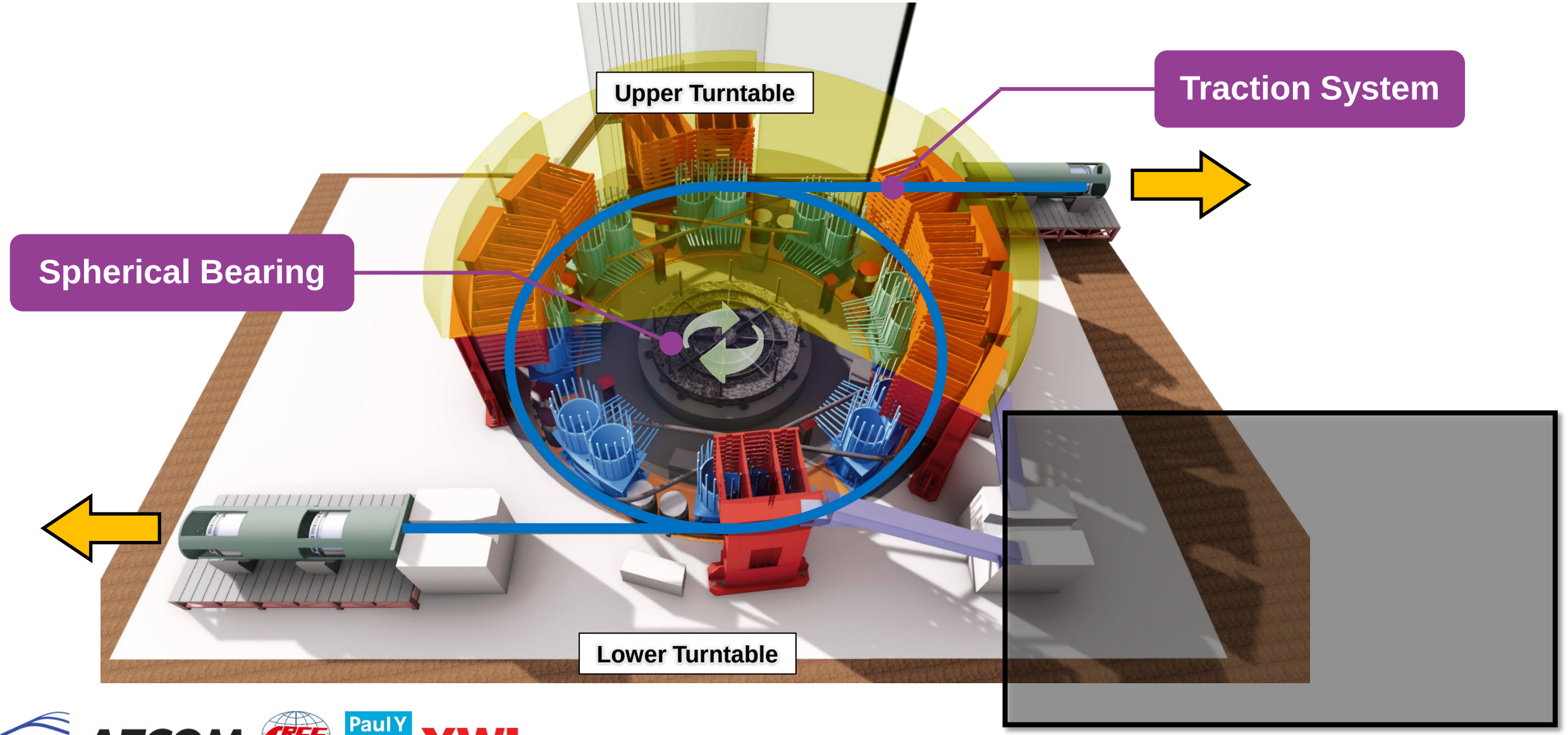
Before Rotation

1st Rotation Completed

2nd Rotation Completed

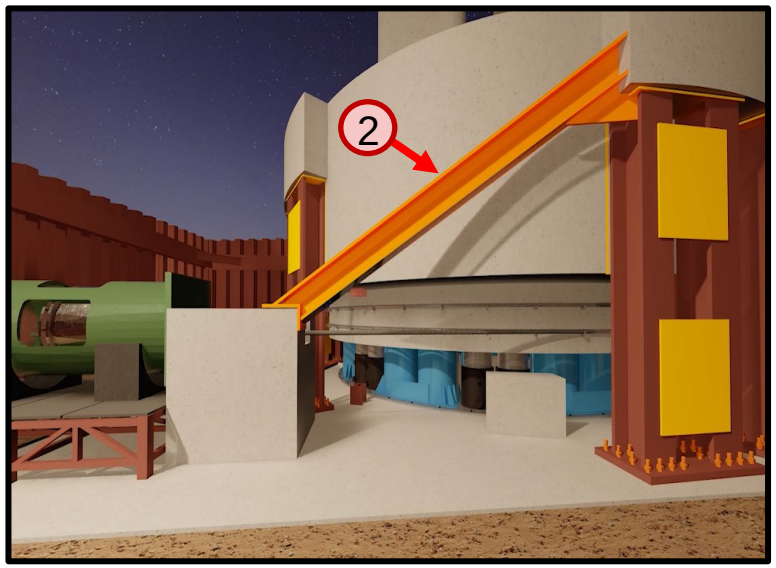
	Conventional segment lifting	Bridge rotation
No. of nightworks above ERL	100 nights	2 nights
Construction period/risks above ERL	2 years	2 nights
Safety and impacts on railway	Works **above** ERL	Works **outside** ERL
Equipment	Heavy lifting frame	Light strand jacks

2. Mechanism of Bridge Rotation

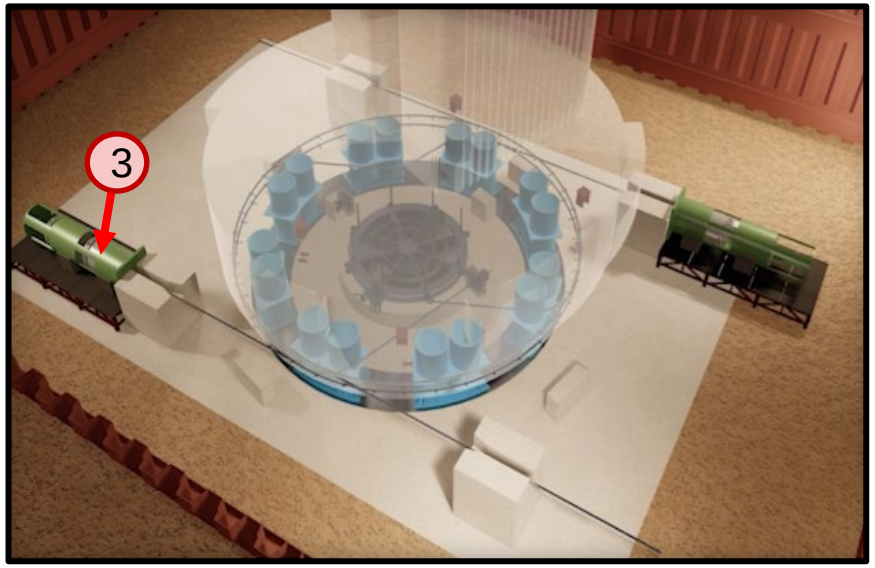


2. Mechanism of Bridge Rotation

Temporary Works Components



1. Stanchion
2. Torsional support
3. Traction system
4. Spherical bearing
5. Outer shear steel support
6. Sliding track



3. Smart Monitoring System

Adoption of Innovative and Smart Initiatives

A. SMART Monitoring System

B. LiDAR Intrusion Detection System

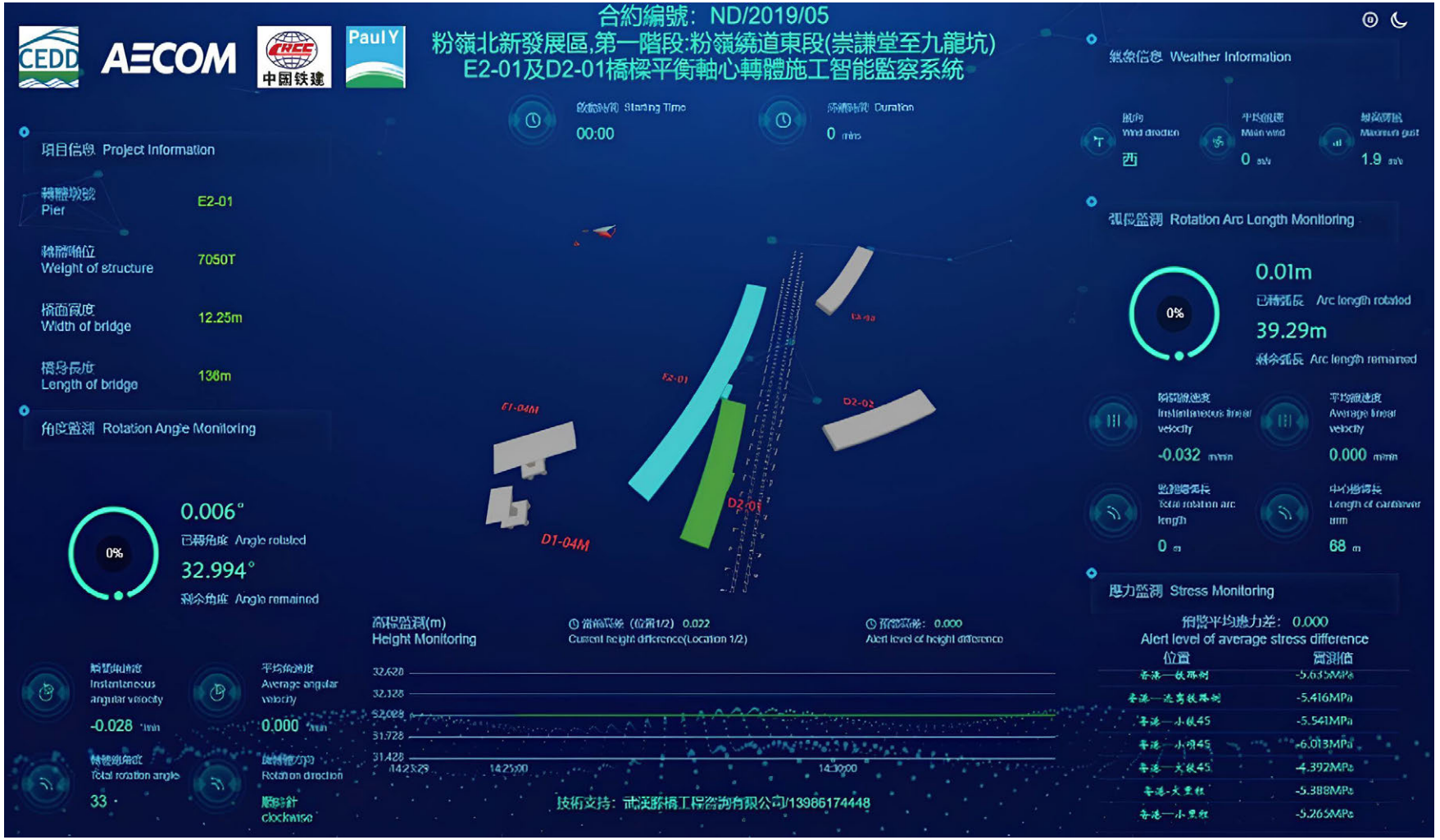
C. AI Camera

D. Strain Gauge

E. Automatic Deformation Monitoring System (ADMS)

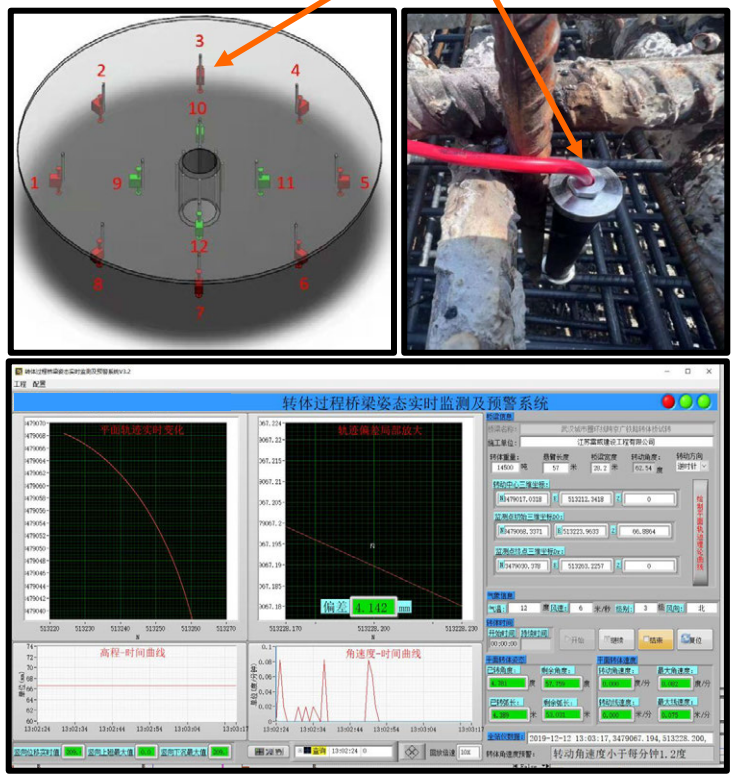
3. Smart Monitoring System

A. SMART Monitoring Systems



Monitoring During Rotation:

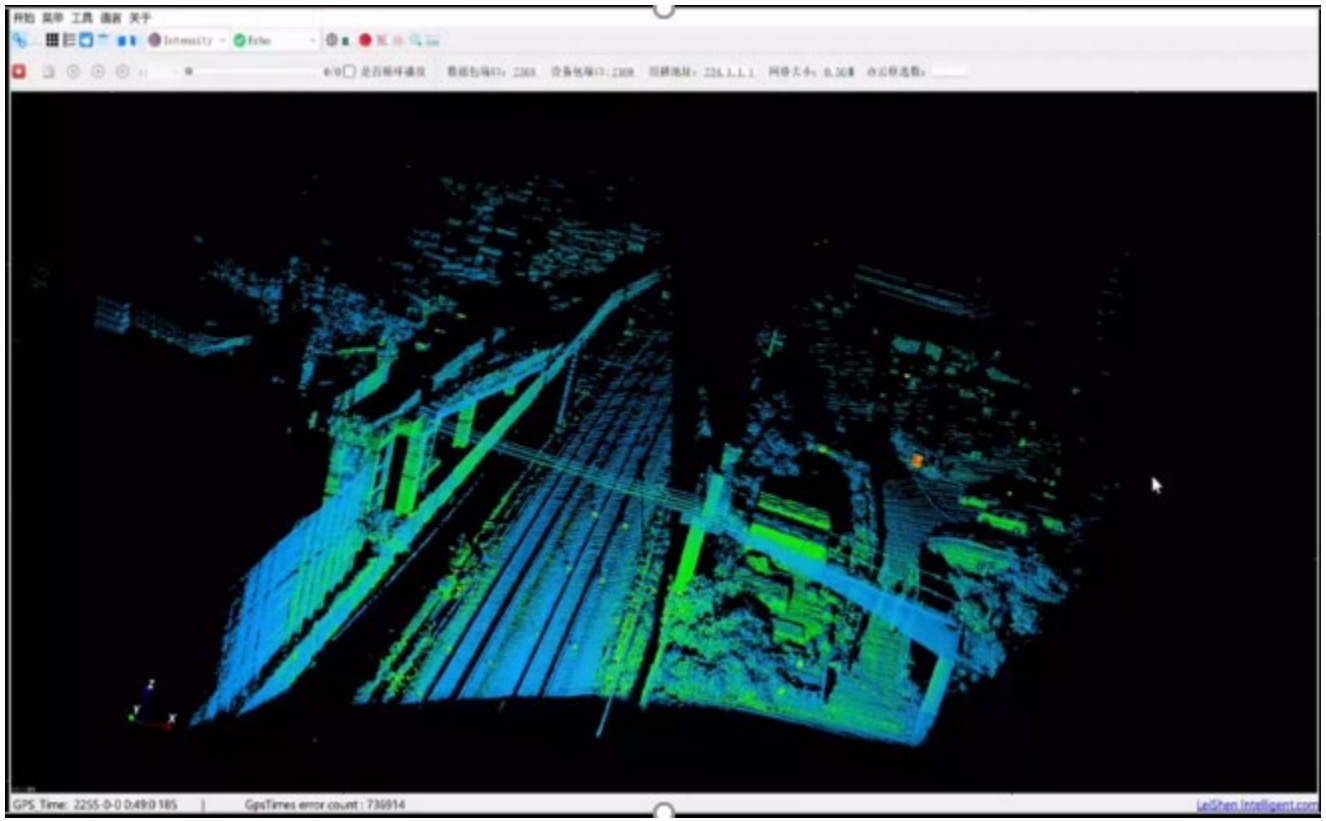
- Geometry
- Rotation speed
- Wind speed
- Concrete stress under spherical bearing

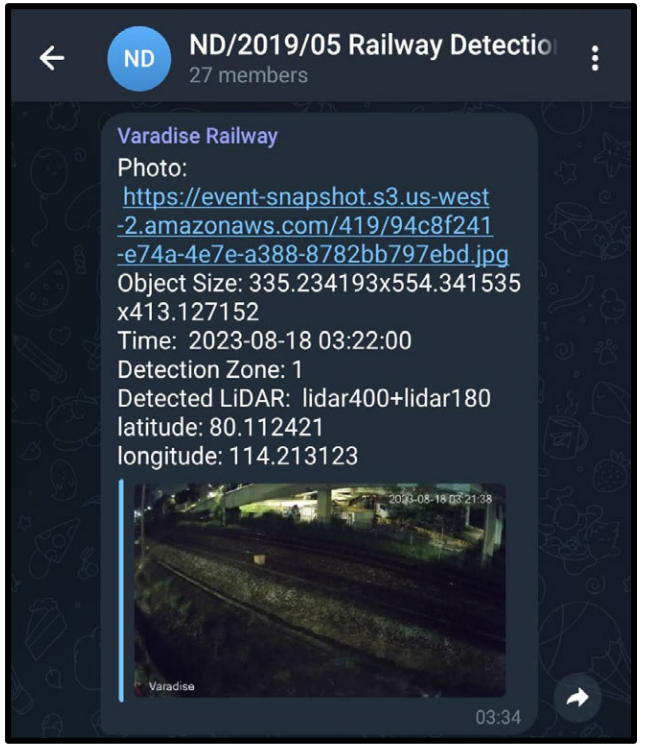


3. Smart Monitoring System

B. LiDAR Intrusion Detection System

- Detect any objects intruding into the railway area
- Trigger alarm upon detecting object





3. Smart Monitoring System

Other Systems

AI Camera

Strain Gauge Monitoring System

ADMS

Design for Safe Rotation: Three Essential Principles

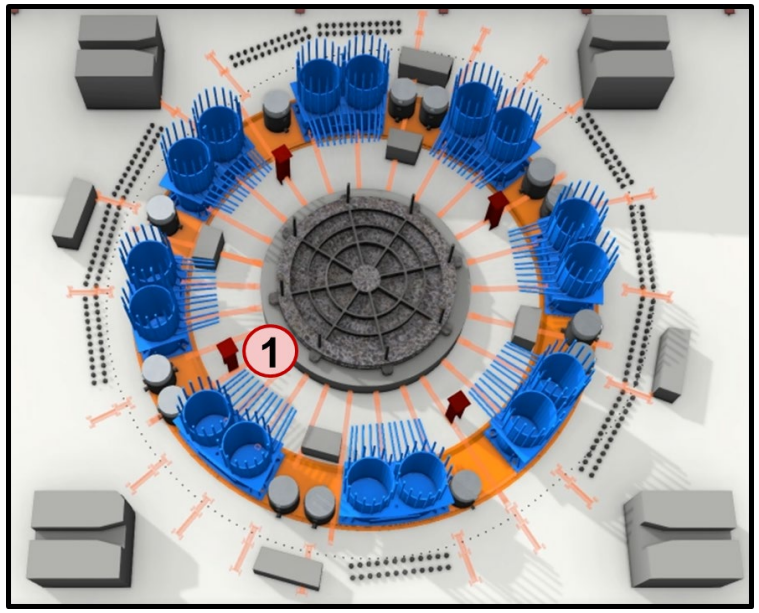
轉得動

轉得穩

轉得準

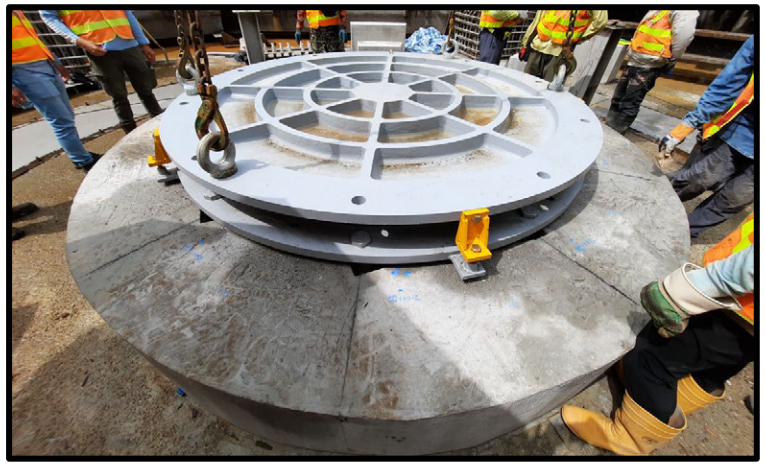
4. Design for Safety – Three Essential Operation Principles

轉得動 – 轉體球骹 (Suitable Material for Effortless Rotation)



Spherical bearing

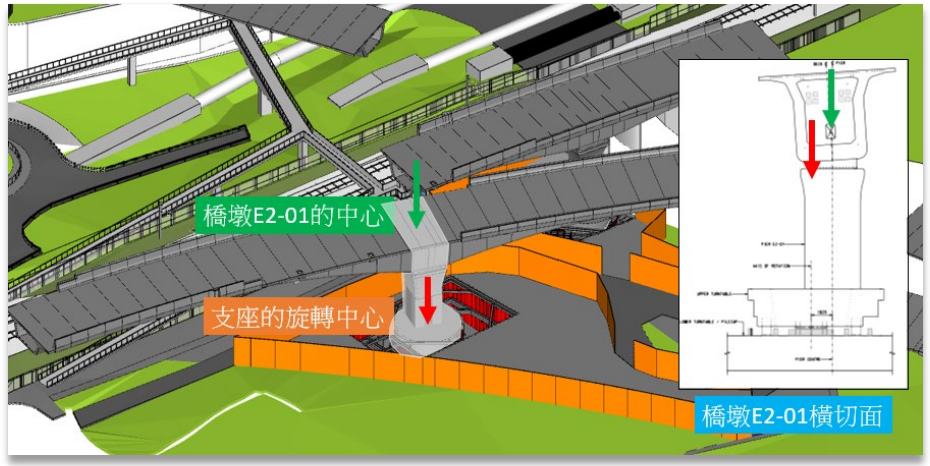
	Pier E2-01
Material	Steel Yield strength: 270MPa [Similar to S275]
Diameter	3.3 m
Loading during rotation	7000T
No. of PTFE pads inside bearing	1056 nr.
Design Friction Coefficient of PTFE	**0.1**
Actual Friction Coefficient of PTFE	**0.015** (6 times better)

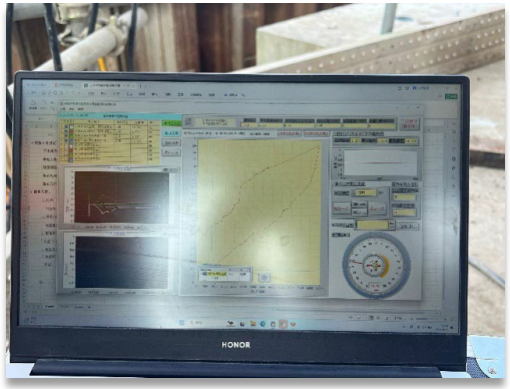


Spherical Bearing is sealed up to prevent leakage of lubricant grease and dirt ingress, the design is proven to be capable to withstand extreme weather conditions (e.g. Typhoon Signal No. 10 on 1 Sep 2023, 16 hrs black rain storm on 8 Sep 2023.

4. Design for Safety – Three Essential Operation Principles

轉得穩 – 稱重 (Weight Balancing)





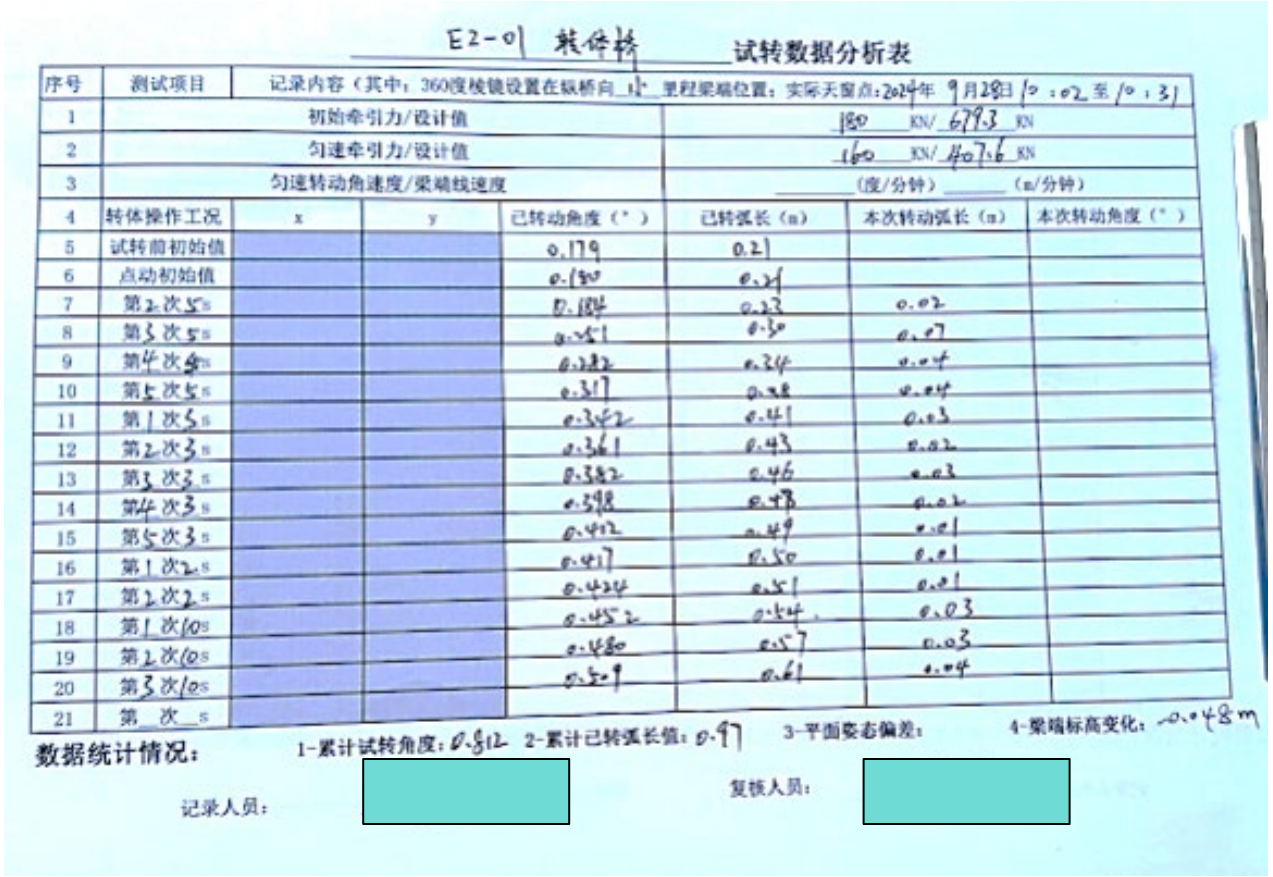
- Close Liaison with HKO
- Pre-rotation eccentricity reduced from 0.282m to 0.01m (away from track)

4. Design for Safety – Three Essential Operation Principles

轉得準 – 點動 (Inching)

1-degree trial rotation to validate functionality and collect data for planning of inching schedule (點動)

Trial Rotation Statistics	T-Span E2-01
Initiation Traction Force	180 kN
Sustained Traction Force	160 kN



E2-01 转体梁 试转数据分析表

序号	测试项目	记录内容（其中：360度棱镜设置在纵桥向 北 里程梁端位置：实际天窗点：2024年 9月28日 10：02 至 10：31					
1	初始牵引力/设计值				180 KN/ 6793 KN		
2	匀速牵引力/设计值				160 KN/ 4076 KN		
3	匀速转动角速度/梁端线速度				（度/分钟） （m/分钟）		
4	转体操作工况	x	y	已转动角度（°）	已转弧长（m）	本次转动弧长（m）	本次转动角度（°）
5	试转前初始值			0.179	0.21		
6	点动初始值			0.180	0.21		
7	第2次5s			0.185	0.23	0.02	
8	第3次5s			0.251	0.30	0.07	
9	第4次5s			0.282	0.34	0.04	
10	第5次5s			0.317	0.38	0.04	
11	第1次5s			0.362	0.41	0.03	
12	第2次3s			0.381	0.43	0.02	
13	第3次3s			0.382	0.46	0.03	
14	第4次3s			0.398	0.48	0.02	
15	第5次3s			0.402	0.49	0.01	
16	第1次2s			0.417	0.50	0.01	
17	第2次2s			0.424	0.51	0.01	
18	第1次10s			0.452	0.54	0.03	
19	第2次10s			0.480	0.57	0.03	
20	第3次10s			0.509	0.61	0.04	
21	第 次 s						

数据统计情况： 1-累计试转角度：0.512 2-累计已转弧长值：0.97 3-平面姿态偏差： 4-梁端标高变化：-0.048m

记录人员： 复核人员：

Record of Trial Rotation

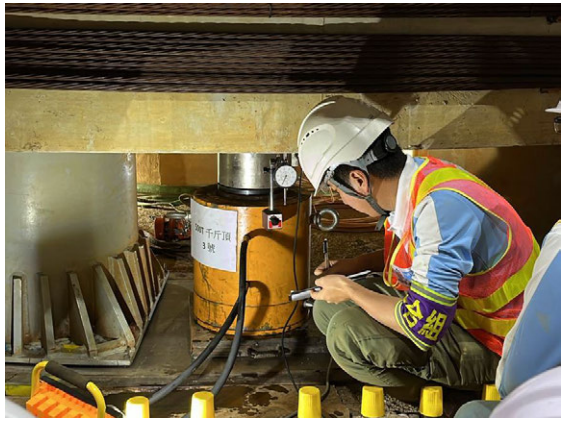
5. Rotation Operation

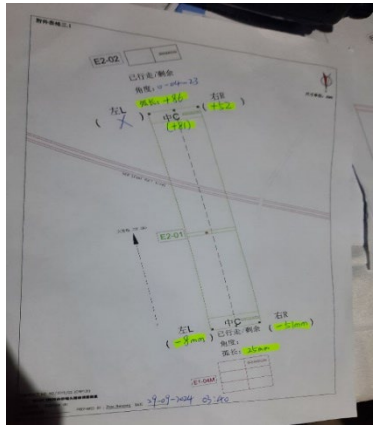
Pre-rotation Rehearsal

An intensive rehearsal brought together over 60 contractor workers, 30 supervisory staff and professional engineers from CEDD, consultants, contractor and MTR to ensure full readiness for this groundbreaking, first-of-its-kind operation in Hong Kong

5. Rotation Operation

Final Geometry Adjustment





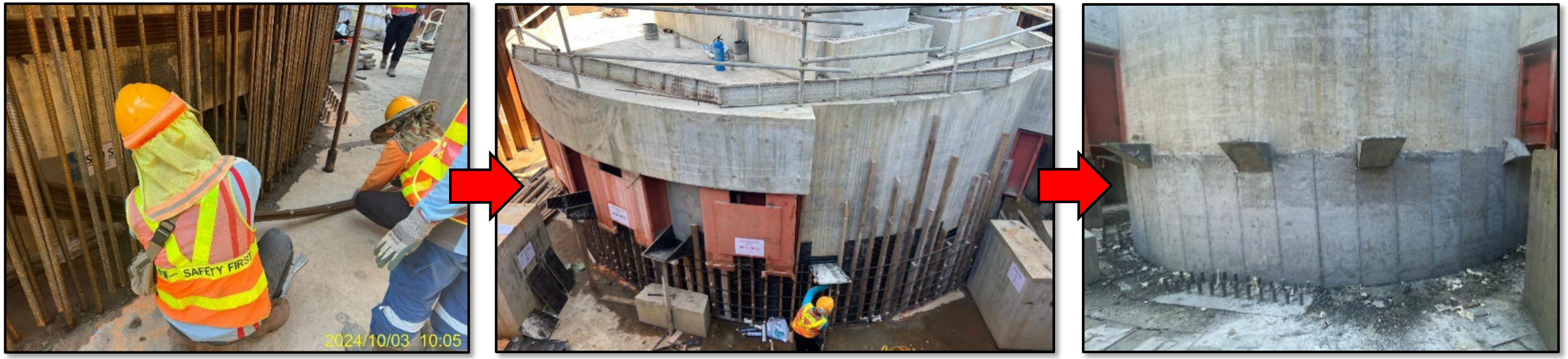
Inching Process → **Final Position Verification** → **Temporary Jack Installation** → **Final Adjustment** → **Temporary Stabilization Measures**

Temporary stabilization works
(shimming and welding of the stanchion and sliding track)

5. Rotation Operation

Post-rotation Construction Activities

Stitching works between upper and lower turntables



Concreting completed **9 days** after rotation

✓HyD/Chief Engineer inspected and accepted the structure within **2 weeks**

CEDD AECOM CRCC 中国铁建 Paul Y YWL

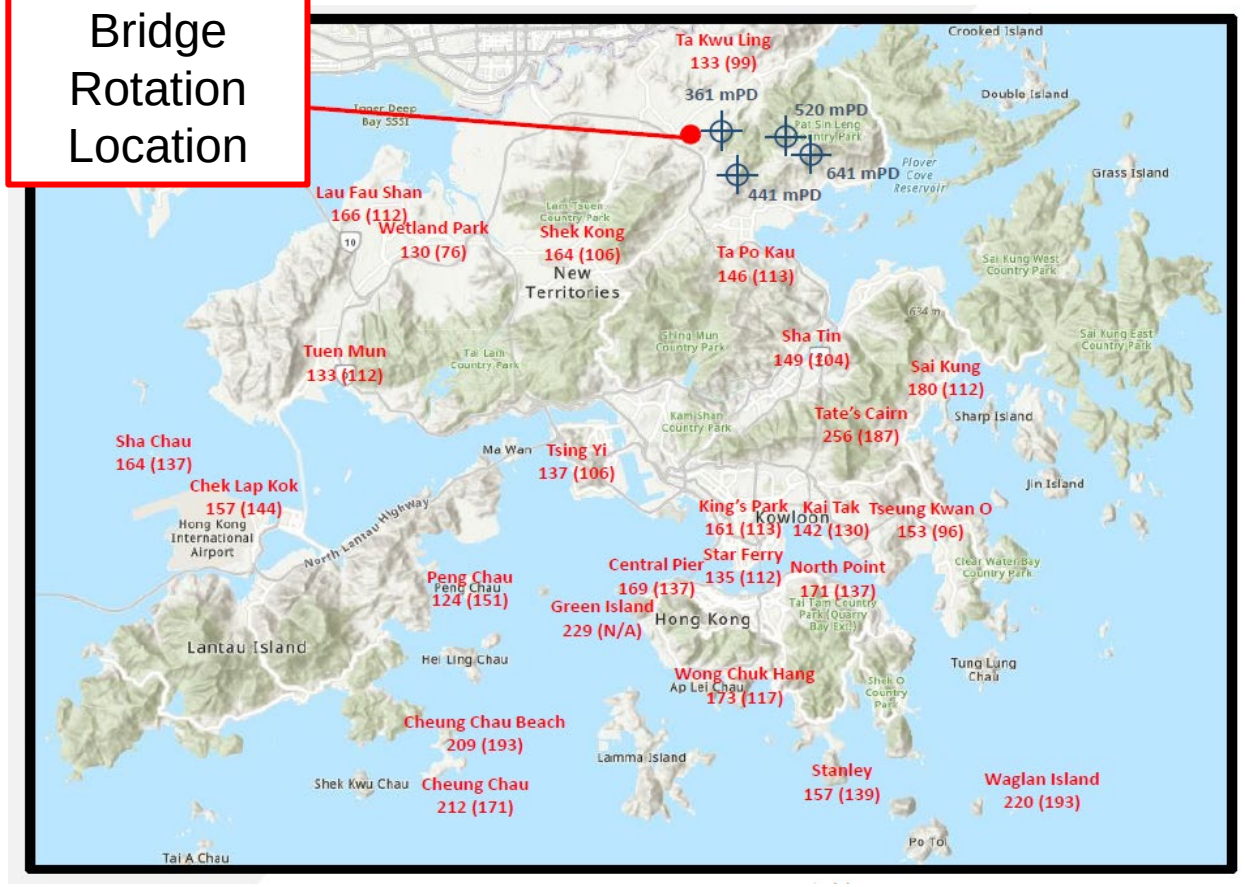
6. Design Robustness & Contingency Plan

Resilient - Design to withstand extreme wind load

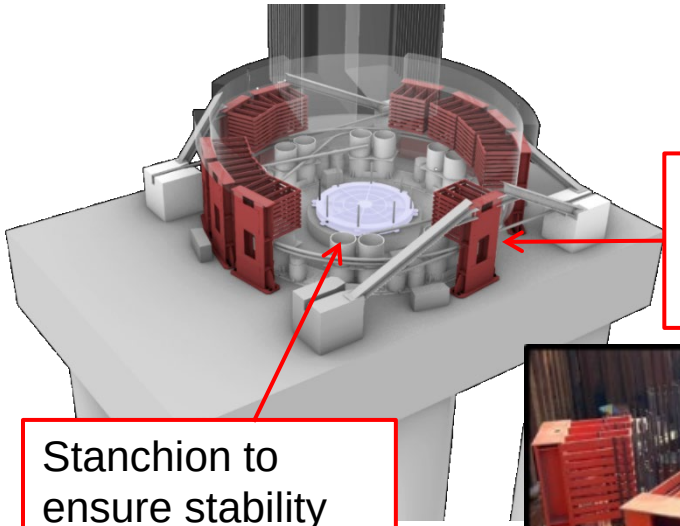
- Design Gust Wind Velocity **before rotation = 183km/hr**
- Design Gust Wind Velocity **during rotation = 159km/hr**

香港天文台
HONG KONG OBSERVATORY
The Government of the Hong Kong Special Administrative Region

Bridge Rotation Location

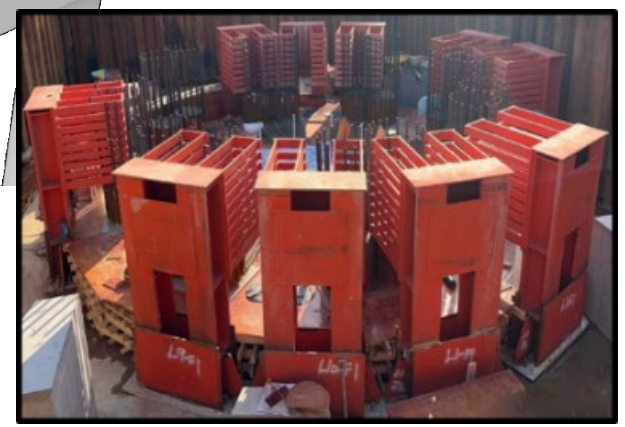


Past Wind Velocity Record



Outer shear steel support to enhance stability before rotation

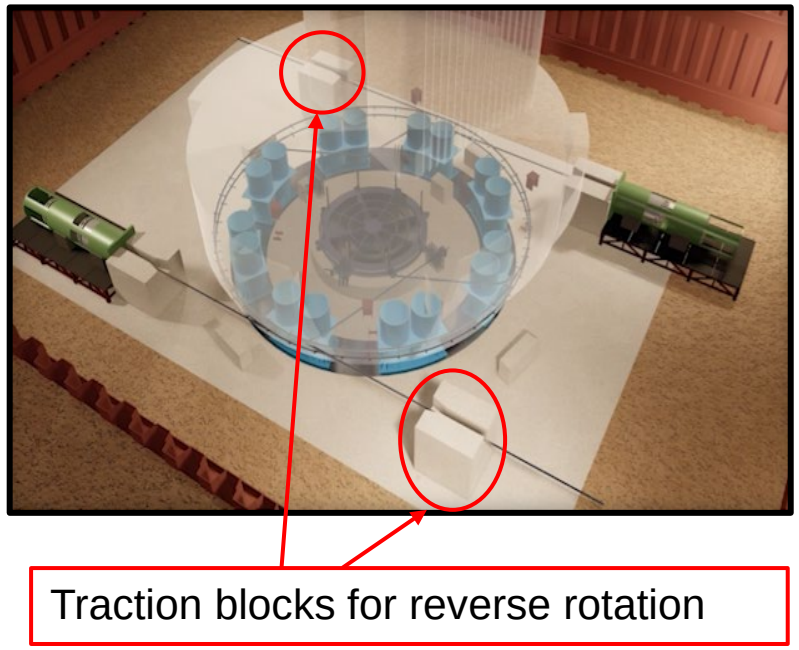
Stanchion to ensure stability during rotation

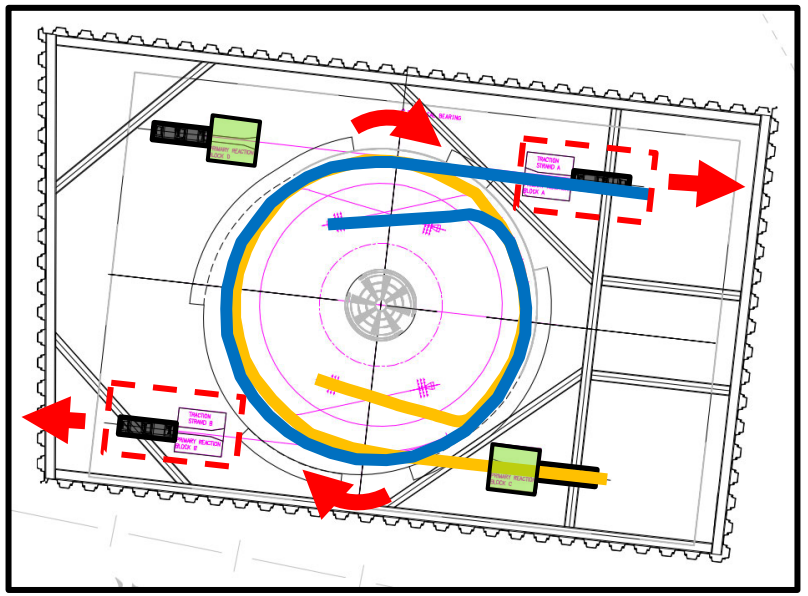


6. Design Robustness & Contingency Plan

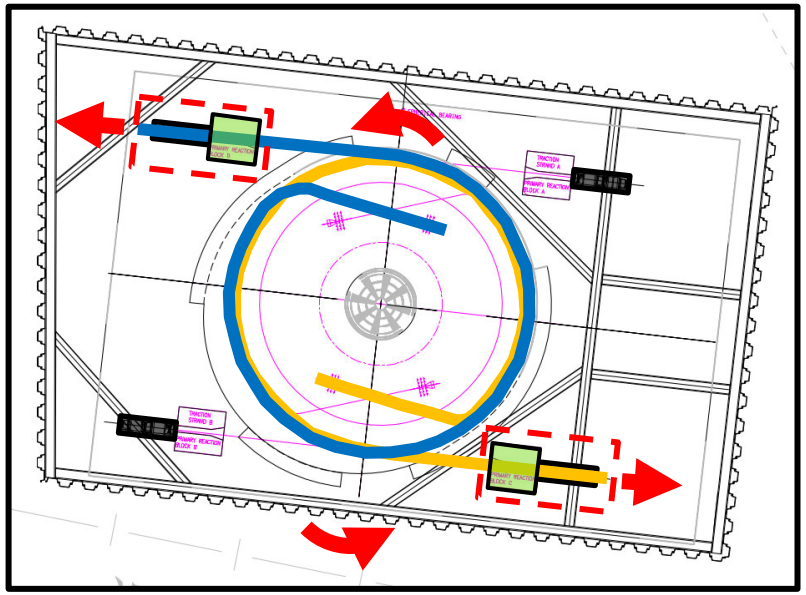
Contingency Planning

Allow Reverse Rotation for Emergency
(e.g. Stuck in half way, incomplete rotation, etc.)





Rotation System (Clockwise)

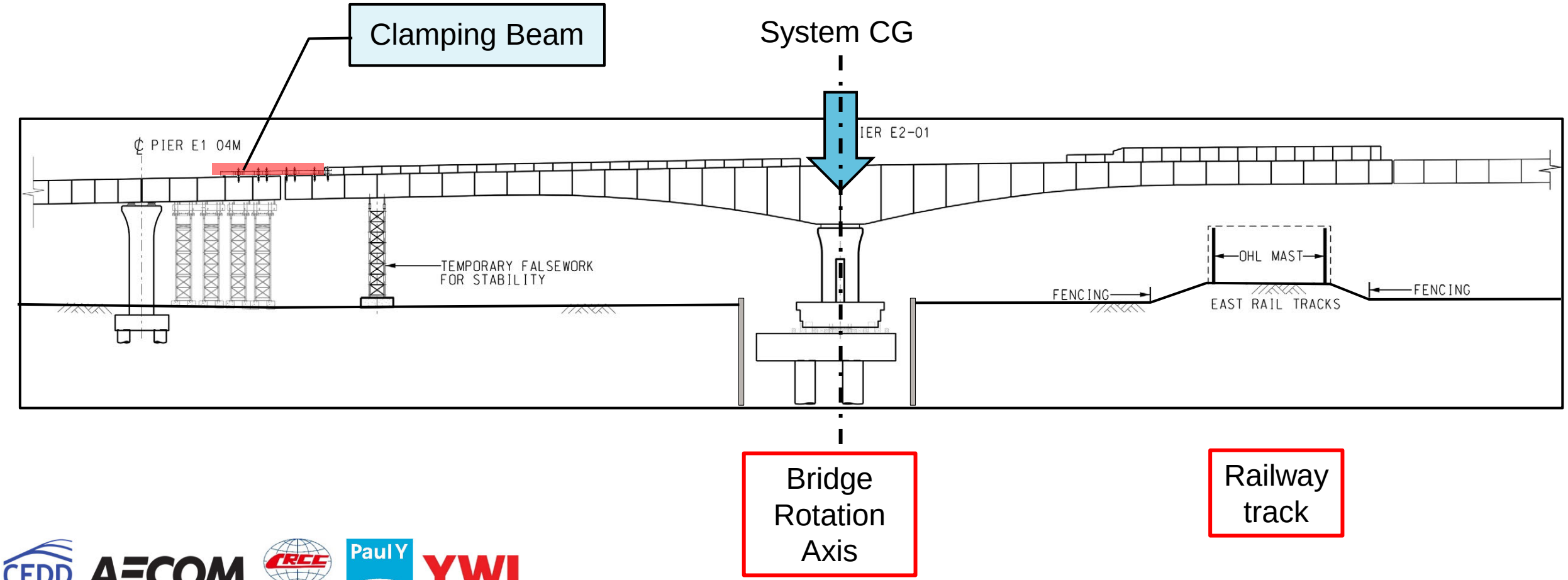


Reverse Rotation System (Anti-clockwise)

6. Design Robustness & Contingency Plan

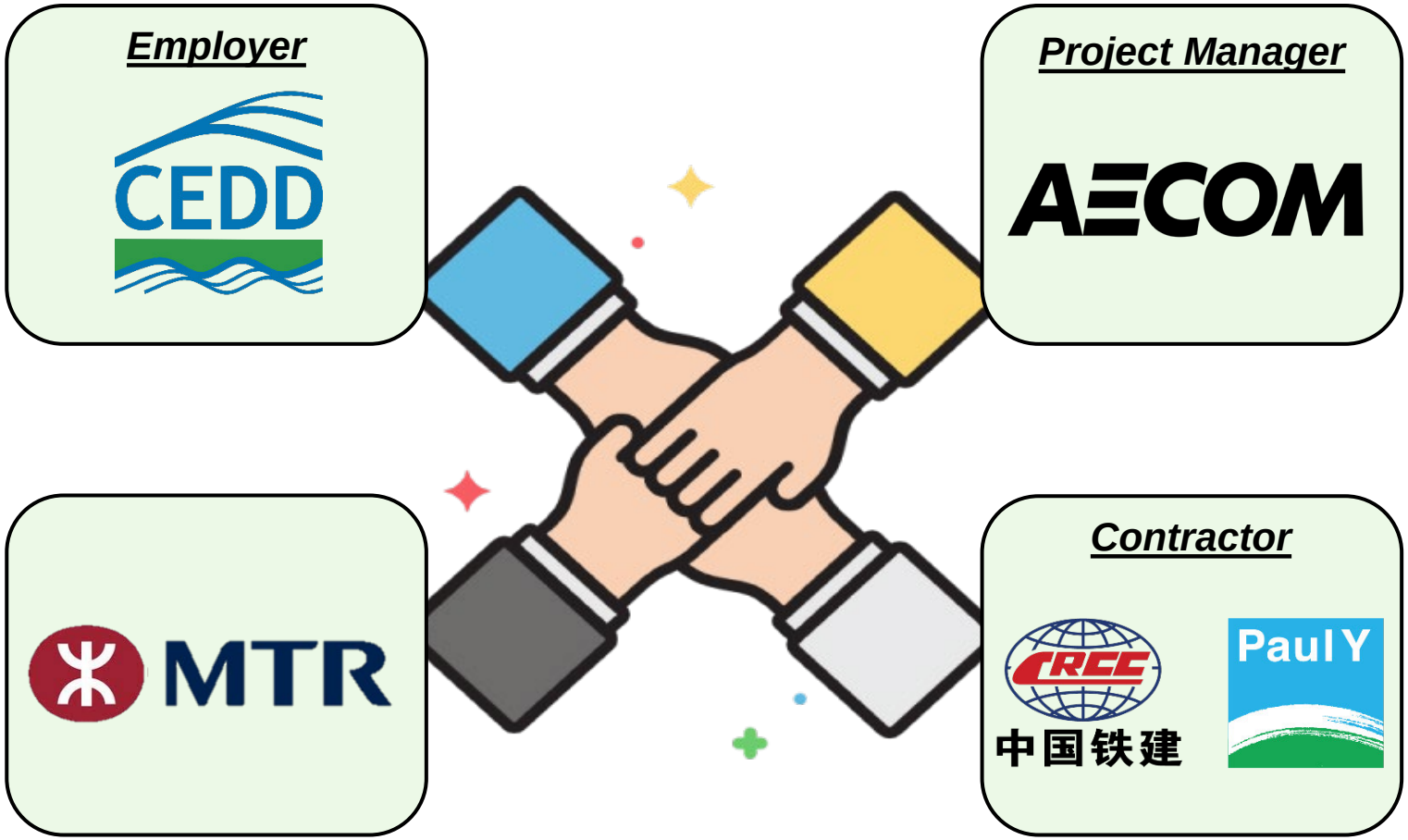
Stability Design Before and After Rotation

- ✓ System Centre of Gravity
- ✓ Clamping beams connected to next T-span structure to enhance stability



7. Collaboration with MTR

Collaboration & Team Work – Core Element for Bridge Rotation Success



7. Collaboration with MTR

Collaboration with MTR – Proposal of HBRM & Develop Project Hazard Log

12/2020	06/2022	03/2023	09/2023	09/2024 & 11/2024
Proposal of Bridge Rotation	Turntable Construction	Pier Construction	Deck Construction	Bridge Rotation

Proposal to MTR on 06/2021

Joint Site Visit to 廣州增城 on 26/06/23

Joint Site Visit to 湖北襄陽 on 30/11/23

- 5nr. Senior management meetings
- Over 30 nr. Progress Meetings and Workshops
- Over 60 nr. Method statements submitted
- Joint site visits with MTR

- Early engagement on rotation scheme's implementation
- Develop methods with minimized risk to railway
- Detailed rotation schedules to suit railway operations
- Timely obtain MTR internal approvals

Hazard Register

Use this register to record and follow up on hazards in your workplace

Brief Description of Hazard	Hazard Status	Complete By
(EXAMPLE) Fire extinguisher in office out of date	Follow Up	23/08/2021
(EXAMPLE) Liquid spilled on kitchen floor	Complete	22/08/2021

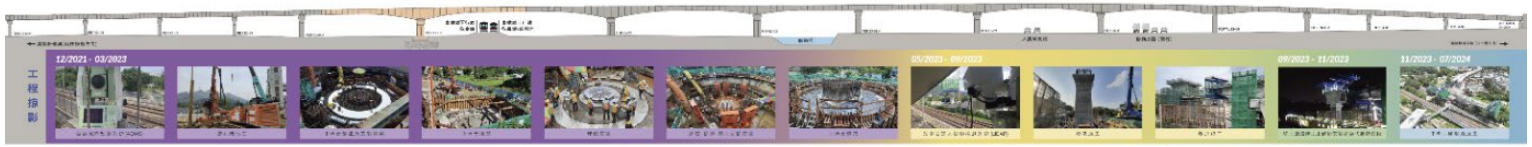
Jointly Develop Project Hazard Log to Identify Hazards Arising from Construction

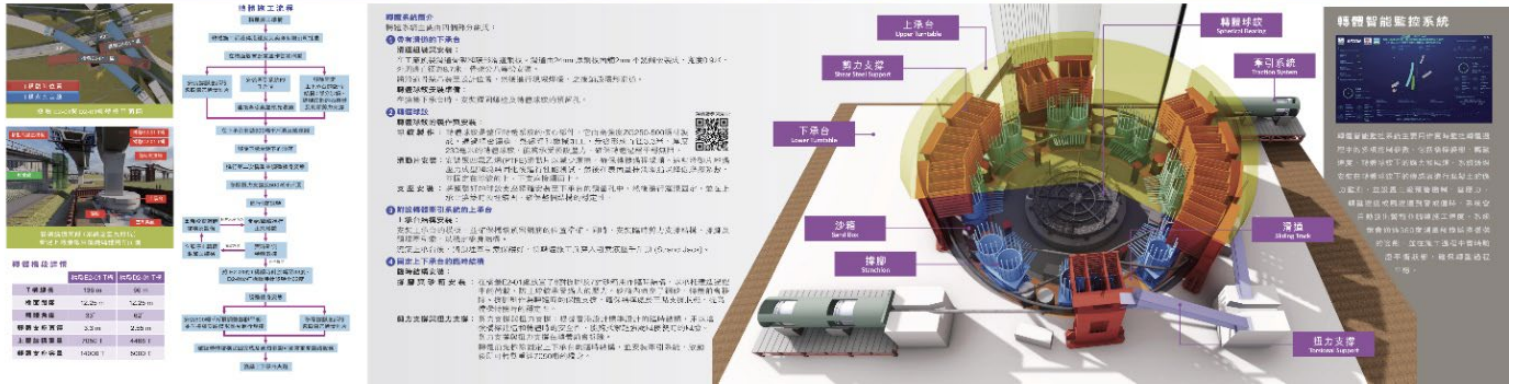
Conduct Dynamic Risk Assessment with MTR during Construction

✓ **Preferred method** for construction of bridge above existing railway now

8. Stakeholder Engagement

Communication with Public





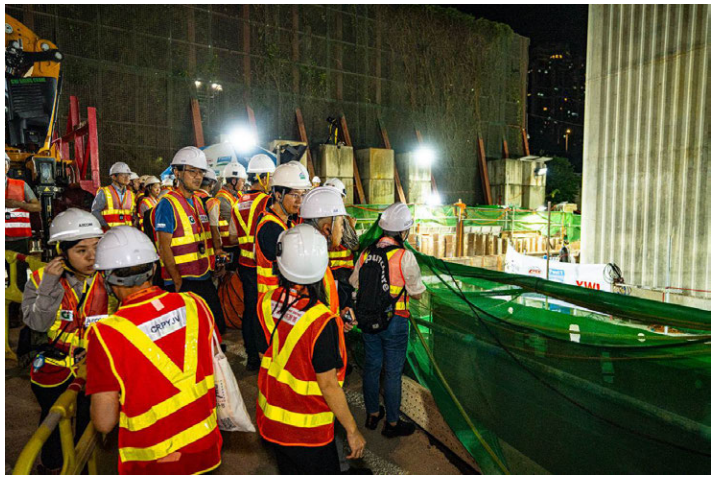
No complaint received from nearby villages

Leaflet to nearby villages before rotation

8. Stakeholder Engagement

Technical Site Visit of Bridge Rotation

Hosting 2 bridge rotation events on the nights of operation to share the innovative construction method, attended by over 200 practitioners



Site Visit before Rotation Operation

Event on 3 November 2024

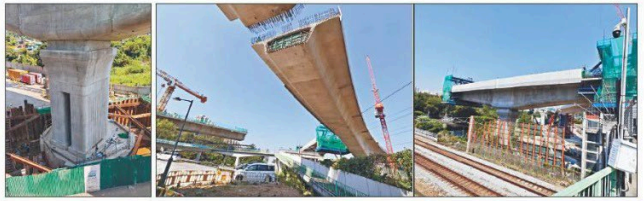
Event on 29 September 2024

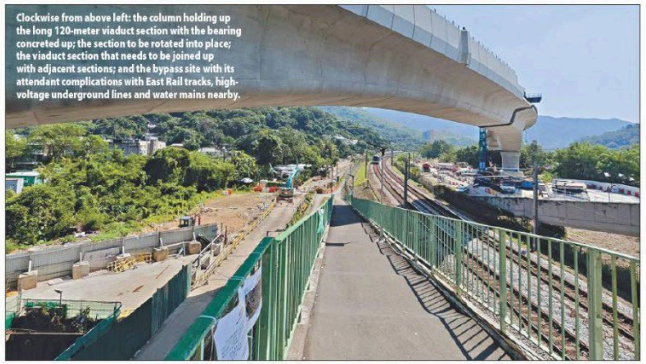
8. Stakeholder Engagement

Experience Sharing with HKIE Past President, Mr. Edmund Leung, along with his Featured Story in the Newspaper

City Talk

Bypass construction shows the expertise has come full circle





Clockwise from above left: the column holding up the long 120-meter viaduct section with the bearing concreted up; the section to be rotated into place; the viaduct section that needs to be joined up with adjacent sections; and the bypass site with its attendant complications with East Rail tracks, high-voltage underground lines and water mains nearby.

Nuts and bolts
Edmund Leung

Hong Kong's construction industry, like almost everything else in life, has its ups and downs, although it is generally buoyant.

Some 40 years ago, well before the Lantau airport core program – dubbed the Rose Garden – and associated works, we regarded ourselves as world leaders in infrastructure construction.

We were able to attract the best talent in the world by offering relatively high salaries.

Our MTR and Rose Garden projects were among the world's best in both construction methods and meeting schedules.

We were able to export our expertise up north, enabling infrastructure projects – highways, tunnels and metro railways.

Fast forward to the 2020s, and we are seeing a complete reversal.

The latest technology, expertise and construction facilities are all from up north.

Whether it is in modular construction, high tensile steel and concrete, new technologies or speed of construction, we are now far behind our motherland.

A recent example worth noting is the construction of viaducts for the Fanling Bypass Eastern Section.

At one point of the alignment, the highway viaduct crosses East Rail, a group of 132kV underground high voltage transmission lines and Hong Kong's main water supply pipes from Dongjiang.

All of these, as we know, are essential utilities and there is no way the services that they normally provide can be interrupted, even if it is to construct new highways.

East Rail has particularly stringent requirements with regard to clearance protection and service interruptions that leave only four hours each night for the work at hand.

In addition, all construction machinery and paraphernalia must be cleared away from the area reserved for the railway so that no unforeseen incidents will affect its operation.

Similar restrictions apply to high-voltage cables and water pipes.

This poses serious challenges for constructing the bypass.

Fortunately, we were able to use methods pioneered by our mainland peers, who succeeded under similar restrictions by forming sections of viaduct nearby and rotating them before placing them in their final positions.

Such innovative construction methods have now become commonplace in the mainland, earning it the somewhat grudging but ultimately crowning nickname of "infrastructure monster."

The Fanling bypass alignment consists of two parallel viaduct sections for road traffic.

Most sections of the viaduct are constructed using proven methods, such as lifting precast segments into place, launching girders for sections crossing other restrictions and using form-travelers to allow in-situ casting of concrete overhead without affecting existing structures at the ground level.

Both precast segments and launching girder construction methods are good only for building sections shorter than 70 meters.

For this particular section, the length of the viaduct is around 120 meters, making these methods no longer feasible, severely affecting other operations and requiring a construction program that would have taken at least two years.

That is obviously not acceptable.

Thus, the Civil Engineering and Development Department together with consultant AECOM entered into a contract with China Railway Construction Corp to build, in a joint venture with Paul Y Engineering, this highway link with long viaducts over the railway line.

The project team was comprised of government engineers, consultants and the contractor.

Given the restrictions, they got two viaduct sections to be cast on a site immediately adjacent and parallel to the railway but some distance away from power lines and water mains.

To allow the longer section to be rotated into its final position, a substantial pillar on the mid span of the section was constructed with a rotatable base. After the 7,000-tonne section of reinforced concrete was completed, the entire rotation process took just one night.

The actual rotation itself took only 30 minutes at a speed of about one degree per minute.

This gave ample time in the unlikely event of delays to other parts of the operation.

Planning this construction process took more than two years.

This was to ensure it met the usual high standards mandated by authorities here, whose confidence was given a strong boost by the fact that the operation was performed using proven methods and thoroughly tested to eliminate all known errors and mishaps.

MTR Corp engineers were invited to visit mainland sites to see for themselves how safe and effective such placements can be accomplished with total confidence.

All stakeholders were then convinced by the high safety standards and minimal inconvenience involved.

They were happy to see the potentially troublesome viaduct section constructed and rotated into the final position last month.

There is still a lot of work to be done in joining this section with adjacent ones but it will be done, as in other viaduct construction, with proven methods.

The other viaduct section will go through a similar process on Sunday but is a shorter and lighter section.

The CEDD, benefiting from success with the more difficult section, does not anticipate any issues with what is essentially a repeat activity.

I shall describe further technical details of the viaduct construction in my article next week, but we have to marvel at the high competence of our mainland peers in supporting us in this innovative construction operation.

The operation may be the first of its kind in Hong Kong but its methodology can be applied all over the world for construction efficiency.

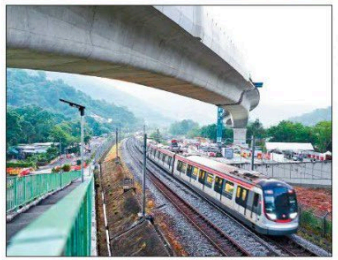
So I am pleased to see new technology applied in our city to make our construction processes more efficient and safe.

Veteran engineer Edmund Leung Kwong-ho casts an expert eye over features of modern life

City Talk

Bypass placement was a class above in precision planning

It's celebration time for the team behind the construction and rotation of the viaduct section, with the magnitude of the job shown by, below, drone views of the area before and after one of the rotations is made and an East Rail train services running as usual.



Nuts and bolts
Edmund Leung

My article last week described the innovation involved in the construction of two viaduct sections of the Fanling Bypass Eastern Section by placing them through rotation.

As I said, there were a lot of technical details involved to make this work.

First, the alignment of the viaduct section had to be carefully planned so that its construction alongside East Rail railway tracks and other utilities would not affect their reliable and continuous operation.

Second, as the viaduct section is curved, its center of gravity does not align with the geometrical center.

Careful calculations were needed to determine the center of rotation to ensure that the section was stable when rotated, to prevent it exerting excessive lateral load and toppling over due to an imbalance in weight.

Third, the mammoth weight of the viaduct section, 7,000 tonnes, and its length, 136 meters, meant a huge column was needed not just for support but also to withstand possible additional lateral loads during the rotation.

Fourth and most importantly, the pillar column needed a smooth bearing to facilitate the rotation while being robust enough to support the heavy viaduct section.

Allowances also had to be made to ensure that should typhoon-strength or other extraneous forces be exerted on the section, the column could support it without any risks of failure or falling.

The viaduct section is a balanced T-shape rotated about its pier.

With reinforced concrete and large depth, the whole piece could be safely supported at midspan without any worries.

Two parts enabled the rotation, namely the upper turntable and lower pilecap, which were connected by a spherical bearing rotating about a central steel plinth with bearing surfaces.

The upper turntable facilitated the smooth rotation and the bottom pilecap ensured stability throughout various construction activities.

Instead of using steel balls as for a normal ball-bearing, thousands of pads with a polytetrafluoroethylene coating ensured minimum friction, allowing the turn to be made with the application of just a little force.

Two hydraulic winches were used, pulling in opposite directions, to ensure the rotational movement could be accurately controlled by counterbalancing forces to prevent an overrun.

These winches can pull up to 60 tonnes but the actual pulling force needed was only a fraction of that.

Along the outer circumference of the pillar column bearing was a set of 16 stanchions.

They were there to support the viaduct section during construction and also to provide support in the unlikely event the piece moved out of position during the rotation, which could cause additional lateral loads to be put on the bearing.

Strain gauges were installed below the bearing and stanchions to monitor vertical and lateral loads and to ensure they were within design limits.

The heavy viaduct section was jacked up at the time of rotation to clear the stanchions and, as planned, at no time were they required to serve as backup support.

After the section had been rotated to its final position, the upper and lower turntables, including the stanchions and bearings, were then concreted up to form the final column.

The ends of the section were then joined up with adjacent sections through the conventional method of formwork-travelers.

The whole process, including the rotation of the section, went smoothly as planned.

At no time were the continuous operation of the railway or the integrity of the power lines and water mains put at risk.

This confirms the adequacy of the planning process and expertise of the construction team. The mainland-based contractor has performed similar rotations dozens of times before, all without mishap.

The second viaduct section was rotated into place on Sunday with similar success.

This process saved at least two years of construction time over conventional methods.

It is gratifying to see innovative methods used in building our transport infrastructure.

Engineers continuously revolutionize construction processes and seek new methods for more efficiency and safety.

Careful design and thorough planning ensure they all work to plan, providing safe and efficient construction activities.

As we enjoy the use of new transport infrastructure, we should be thankful to engineers and construction workers for their hard work and dedication.

Veteran engineer Edmund Leung Kwong-ho casts an expert eye over the features of modern life

Media Coverage by the Standard on 30 October 2024 and 6 November 2024

8. Stakeholder Engagement

Publicity of Bridge Rotation – CEDD Facebook

Scan the QR code for details

土木工程拓展署 Civil Engineering and Development Department
29 September 2024 ·

【一分半鐘睇晒全港首次「行車天橋轉體施工」過程！】

粉嶺繞道(東段)橫跨港鐵東鐵線的行車天橋，於9月29日凌晨順利華麗「轉」身!

我小編工程獅收到勁料，粉嶺公路(近和合石段)旁邊起咗一截行車天橋，長約140米，重超過7000噸，大約等於470部雙層巴士嘅重量。小編聽工程團隊講，佢地起呢段天橋面對好多限制，令到使用傳統建橋方法非常困難：

‼ 橫越東鐵線路軌
‼ 東江水輸水管
‼ 地下高壓電纜

我地工程師梗係多計仔，即刻發揮創意小宇宙，採用咗香港首次創新應用嘅橋樑轉體施工方法，即先係唔影響東鐵線路軌嘅旁邊興建橋身，然後利用東鐵線晚上收車時間，將橋樑水平旋轉，令橋身瞬間跨越鐵路，唔單止成功慳咗3個月工期，又大大減低施工風險同對鐵路嘅影響👏。

透過呢次施工，展示咗工程部門努力嘗試採用創新嘅施工方法，成功剋服香港擠迫城市環境下嘅施工困難，為日後應用呢個技術於其他基建項目提供咗寶貴經驗👍。

工程由土木工程拓展署CEDD主導，顧問公司艾奕康有限公司（AECOM）及承建商中國鐵建十五局—保華聯營（CRCC-PY JV）共同推展，仲得到港鐵公司全力配合和支持。小編都好心急想睇吓七千幾噸嘅行車天橋點樣華麗「轉」身，我哋即刻去片！

粉嶺繞道(東段)項目旨在提升粉嶺北新發展區的交通基建，支持北部都會區發展。項目於2020年3月動工，現已進入工程最後階段，預期2025年通車。

#土木工程拓展署 #CEDD #工程獅 #IrLeo #創新 #香港基建新里程 #粉嶺繞道 #橋樑轉體技術 #發展局 #北部都會區 #港鐵 #東鐵線 #AECOM #中國鐵建十五局 #保華

23,000 Views
480 Like

CEDD's Facebook Post on 29 Sep 2024 Sharing Success of Bridge Rotation

8. Stakeholder Engagement

Scan the QR code for details

Publicity of Bridge Rotation – SDEV Blog

SDEV Blog on 16 March 2025

採用新物料、新技術 降低建造成本 提升效益

橫跨東鐵綫行車橋成功轉體接駁 新技術令工期縮短一年

就應用創新施工方法，土木工程拓展署工程師梁文懿及高級工程師譚建生介紹了粉嶺北新發展區－粉嶺繞道東段項目的兩條行車橋建造工程。行車橋橫跨現有東鐵線鐵路，其中一條長約140米，重逾7000噸，受現場環境所限，使用傳統建橋方法非常困難。工程團隊勇於求變，以突破思維採用了全港首次應用的橋樑轉體施工方法，不單令工期縮短一年，更大大減低了施工風險及對鐵路的影響。

若採用傳統建橋方法，以架橋機在路軌上空吊運預製組件以組裝巨型橋面，未完成的橋段便要懸吊在鐵路上空達兩年之久，不僅對鐵路營運造成重大安全風險，更只可以在深夜港鐵非行車時段進行裝嵌工程，工期較長且風險亦高。

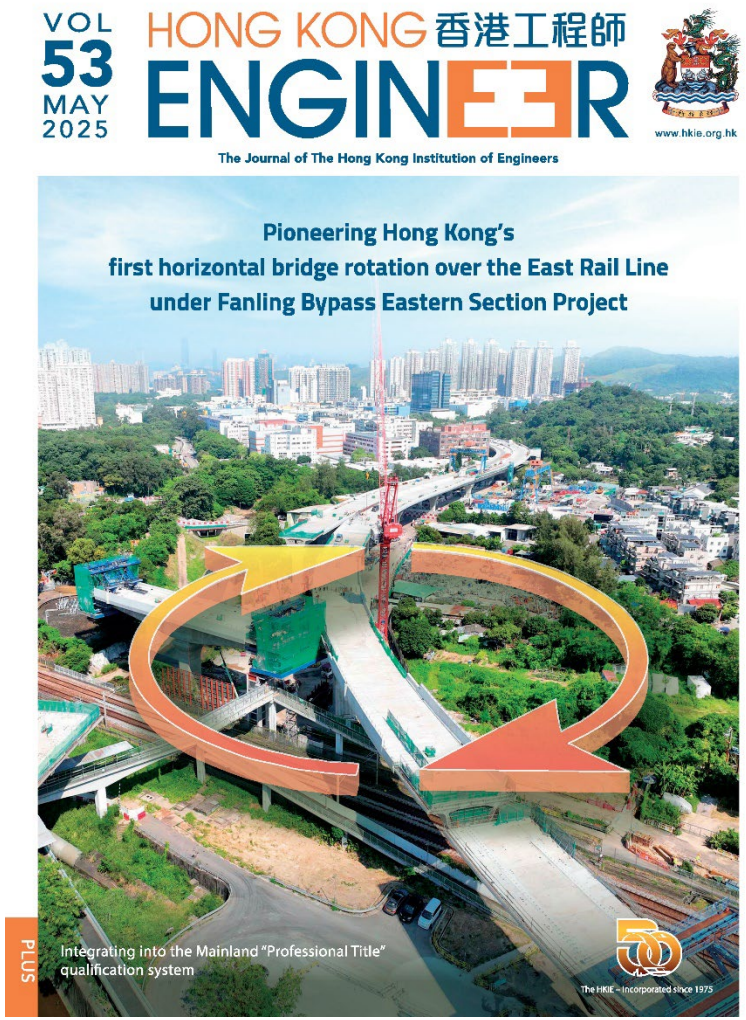
採用創新且高效的橋樑轉體方案，則可先在鐵路旁邊建造完成整個橋段，然後於一晚內進行橋樑轉體工序，將橋樑水平旋轉，令橋身瞬間跨越鐵路，大幅縮短工期約一年，不但節省工程開支，同時減少施工對鐵路服務的影響。兩條行車橋分別於去年9月和11月凌晨順利完成橋樑轉體，大大改善粉嶺北新發展區的交通連接，並為北部都會區的整體規劃提供重要支持。

發展局轄下部門積極採用新材料及新技術，為日後應用於其他基建項目提供寶貴經驗。未來政府會在更多工程項目中應用，降低成本，提高建造業生產力。

8. Stakeholder Engagement

Scan the QR code for details

Publicity of Bridge Rotation – HKIE Journal Cover Story




COVER STORY

Pioneering Hong Kong's first horizontal bridge rotation over the East Rail Line under Fanling Bypass Eastern Section Project

By the Civil Engineering and Development Department

The Fanling Bypass Eastern Section (FLBP(E)) is one of the major road infrastructures connecting Fanling North New Development Area (FLN NDA). This dual two-lane carriageway, approximately four kilometres long, provides a direct link with the existing highway network to cope with the anticipated traffic demand arising from FLN NDA.

Figure 1: Artistic impression of the Fanling Bypass Eastern Section
(Source: Public Works Subcommittee (PWSC) Paper PWSC(2018-19)41 Annex I)

The Civil Engineering and Development Department (CEDD) plays a pivotal role in the development of FLN NDA. AECOM Asia Co. Ltd. was employed as the project manager for the first phase development, including the site formation and engineering infrastructure works commenced in 2019. The FLBP(E) is part of the major works under the first phase development of FLN NDA (Figure 2).

Figure 2: Artistic impression of the FLN NDA
(Source: https://www.landsd.gov.hk/tc/2-1-4-about-project.php)

Innovative construction methods to overcome difficult site constraints

The entire FLBP(E) comprises 3.3-km long viaduct and 0.7-km long underpass. CEDD Contract ND/2019/05 involves the construction of 2-km long viaduct between Shung Him Tong and Kau Lung Hang. The alignment of the viaduct meanders across Ma Wat River and runs through the industrial zones and low-density village residential areas. It spans over the MTR East Rail Line (EAL) and connects to the existing Fanling Highway. The bridgeworks were carried out within a limited working space congested with major underground utilities, including high voltage power cables, large diameter above-ground

8 May 2025 I **Hong Kong Engineer**

HKIE "Hong Kong Engineer" Journal on May 2025

8. Stakeholder Engagement

ICE Technical Seminar on 20 Mar 2025

9. Successful Bridge Rotation

9. Successful Bridge Rotation

Outcome of Bridge Rotation

Complete rotation in **2** nights

Preferred construction method across railway track

Reduce **5%** cost

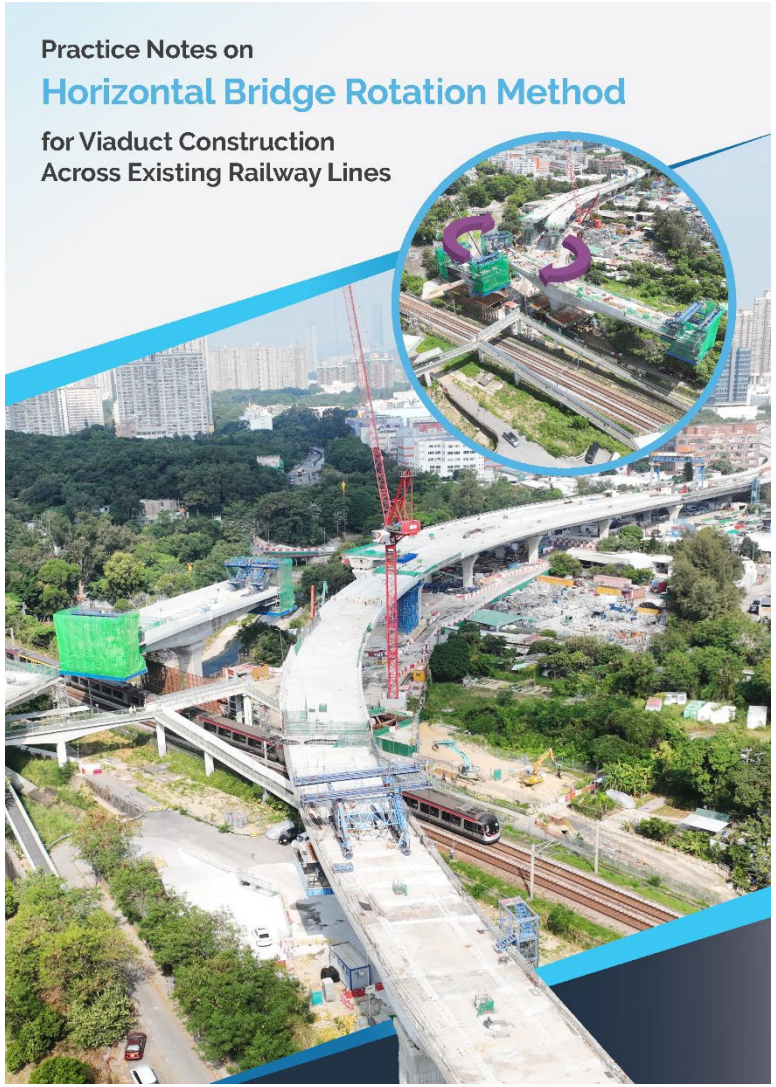
Save **1 year** of construction time

Reduce **99%** of works over railway track

CEDD AECOM 中国铁建 Paul Y YWL

10. Leaving a legacy

Practice Notes on Application of Horizontal Bridge Rotation Method for Viaduct Construction Across Existing Railway Lines



Joint Preparation of Practice Notes with MTR

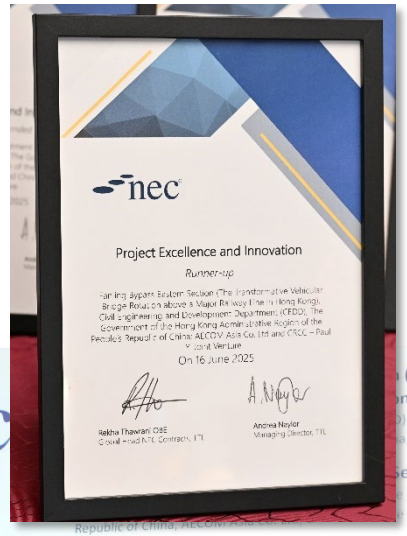
- Promoting bridge rotation method
- Establishing a standard for planning, design, execution for bridge rotation over existing railway
- Highlighting the key challenges and specific requirements on railway safety

10. Leaving a legacy

HKIE – Safety Specialist Committee
Design for Safety Excellence Award 2025 - Gold Award

10. Leaving a legacy

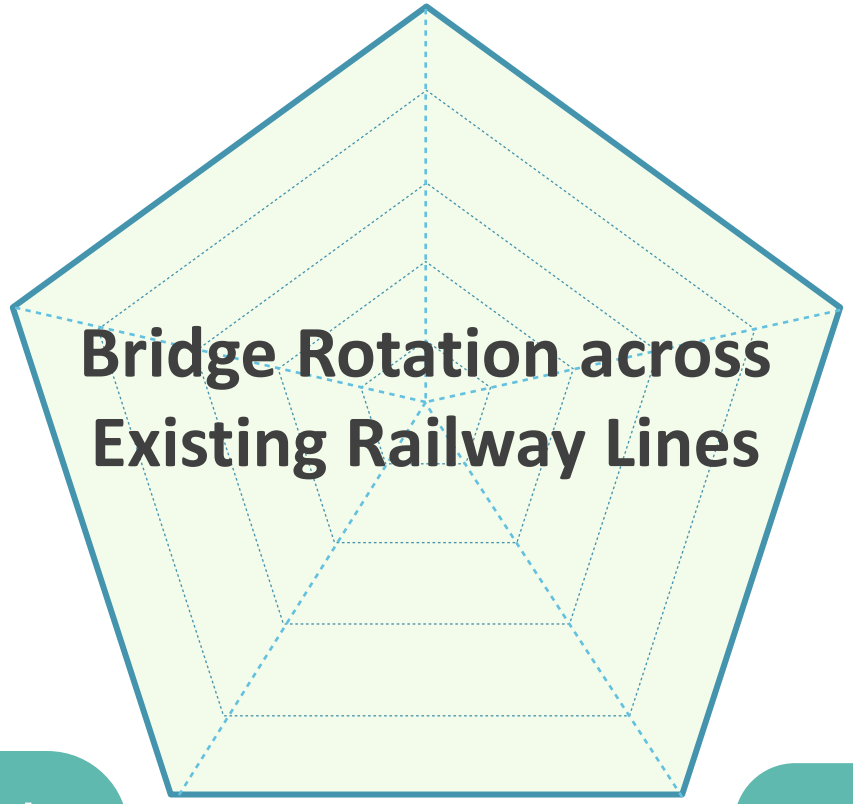
ICE NEC Martin Barnes Award 2025
Project Excellence and Innovation – Runner-up



Conclusion

2. Design for Safety

1. Scalable Safety Element



3. Engineering Elements

5. Designer & Contractor Design Improvement

4. Engineer Input

Thank you