Nagpur Metro Project

Double Decker Integrated Road Cum Metro Corridor

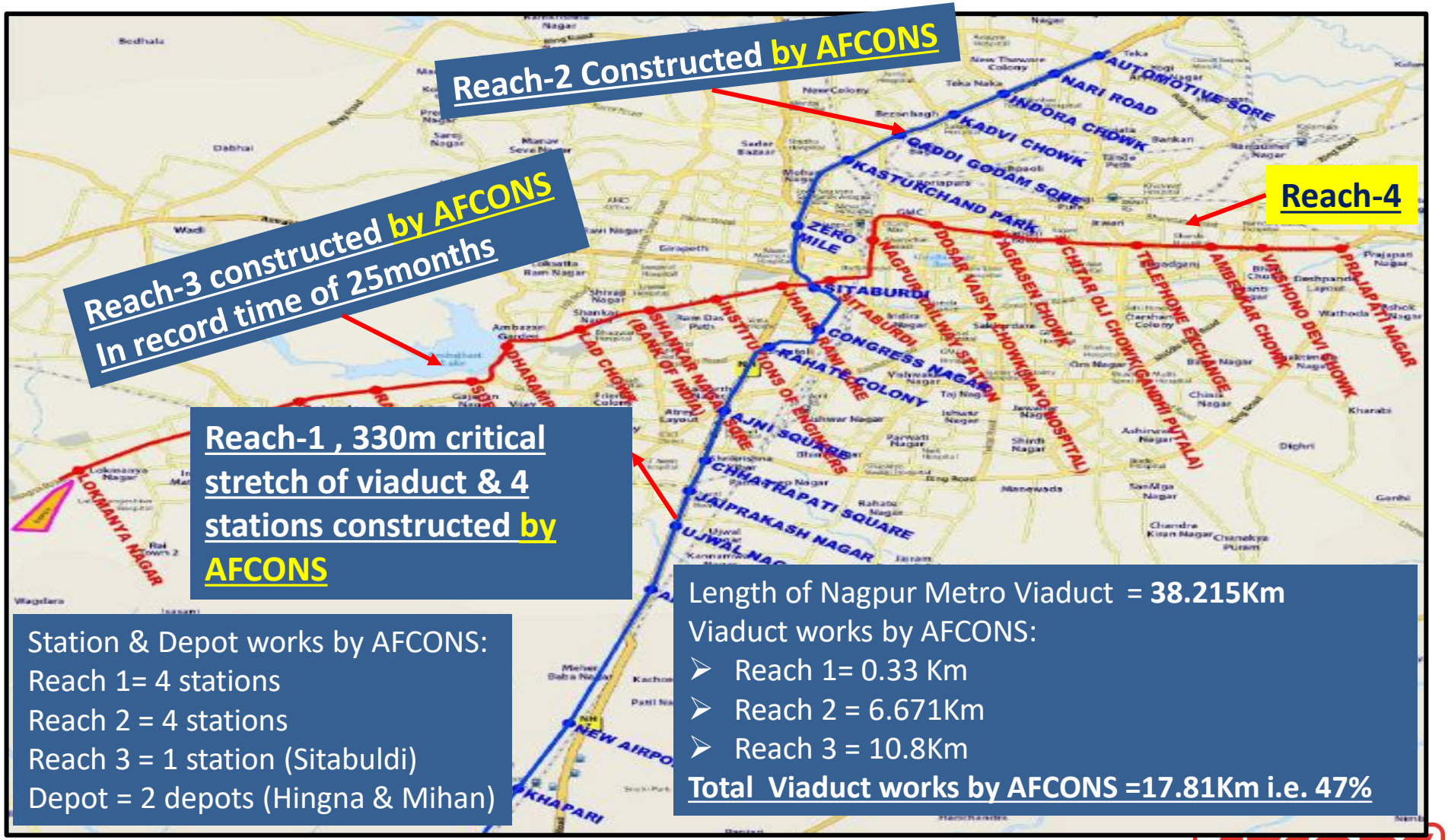
‘Railway span’

05.11.2022

Content

- Nagpur Metro Project Alignment
- Snaps of Works by AFCONS in Reach-03, Reach-01 & Depots
- Brief on Alignment in Reach-02
- Construction Sequence of Double Decker Viaduct
- Snaps of Reach-02 Double Decker Viaduct & Stations
- 80m Railway Span Construction
- Key Highlights & achievements on Railway Span
- Challenges & Solutions during construction of Railway Span

Nagpur Metro Project Alignment



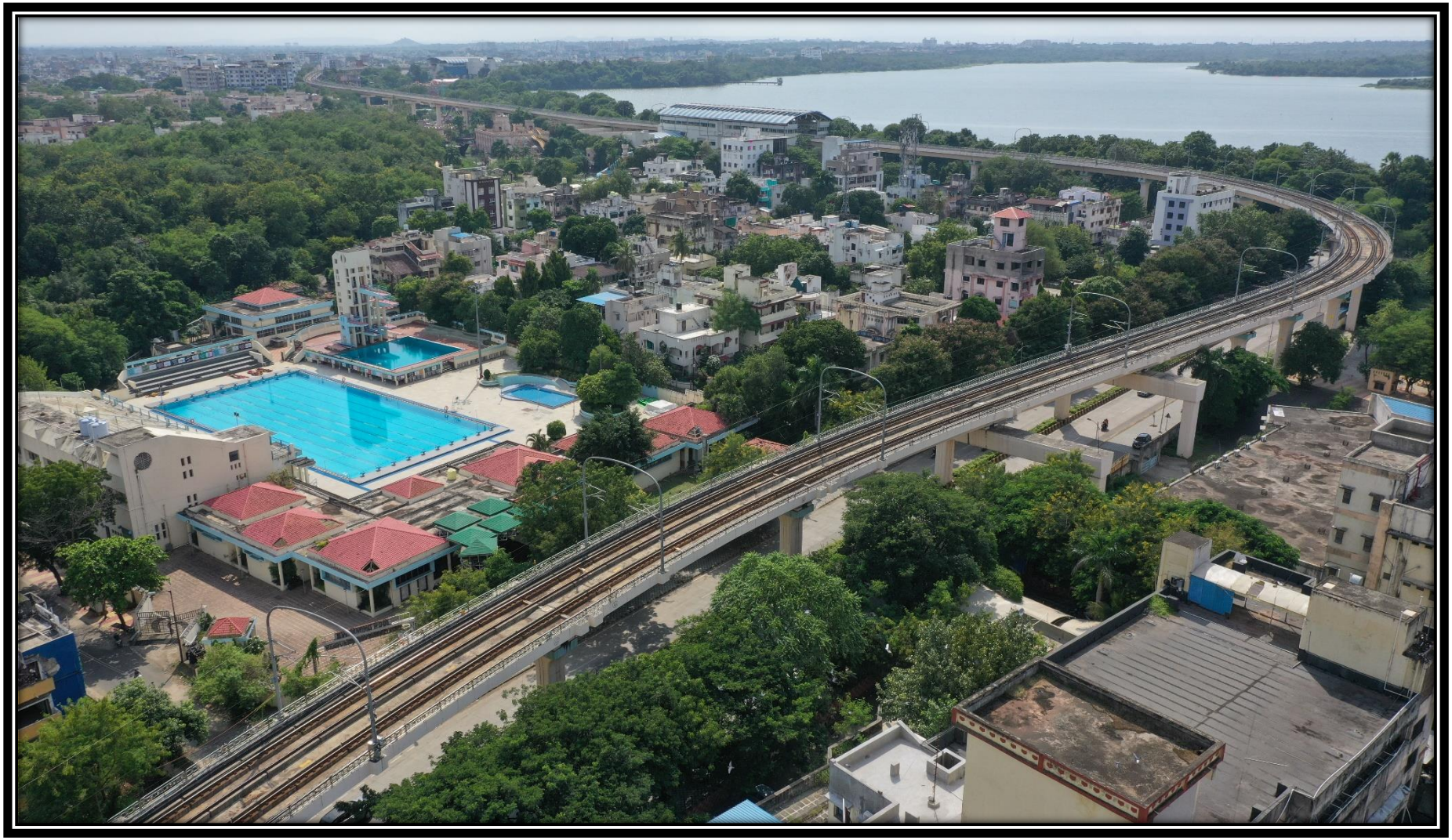
AFCONS executed more than 51% value of Construction works in Nagpur Metro

Works by AFCONS

In

Reach -03, Reach-01 & Depots

Reach - 03 : Viaduct



Reach - 03 : Sitabuldi Interchange Metro Station

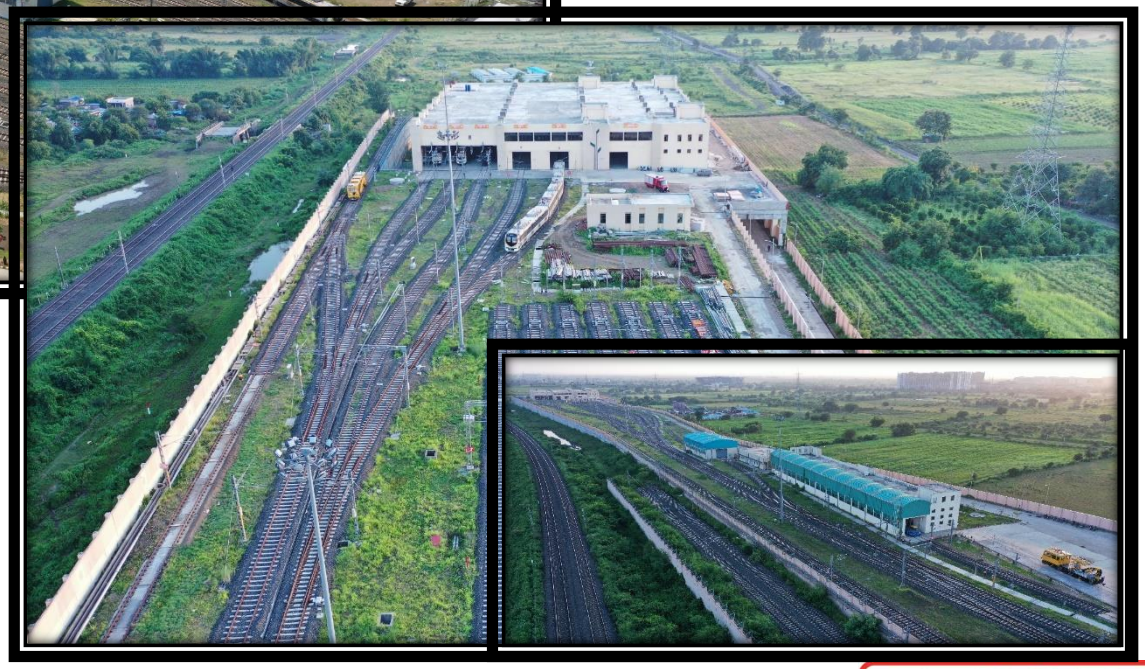
Reach - 01 : Metro Stations

Chattrapati Square Station

J P Nagar Station

Depot works : Hingna & Mihan

Hingna Depot



Mihan Depot

Reach – 02 / Viaduct

India’s longest double decker Metro cum Road Corridor

Reach - 02

Reach-02 - Alignment Brief

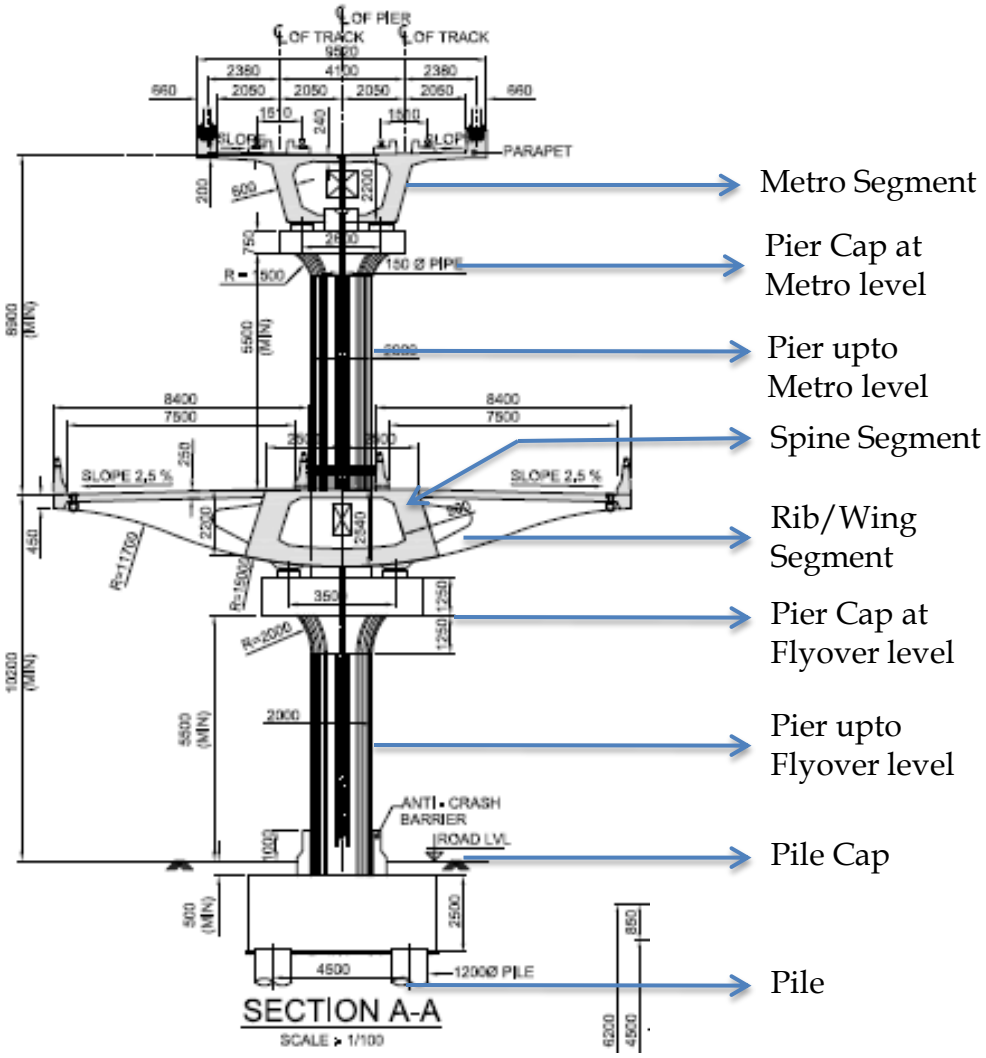
Located on North South Corridor between Sitabuldi Metro Station to Automotive Metro Station on Nagpur – Jabalpur National Highway (NH-07)

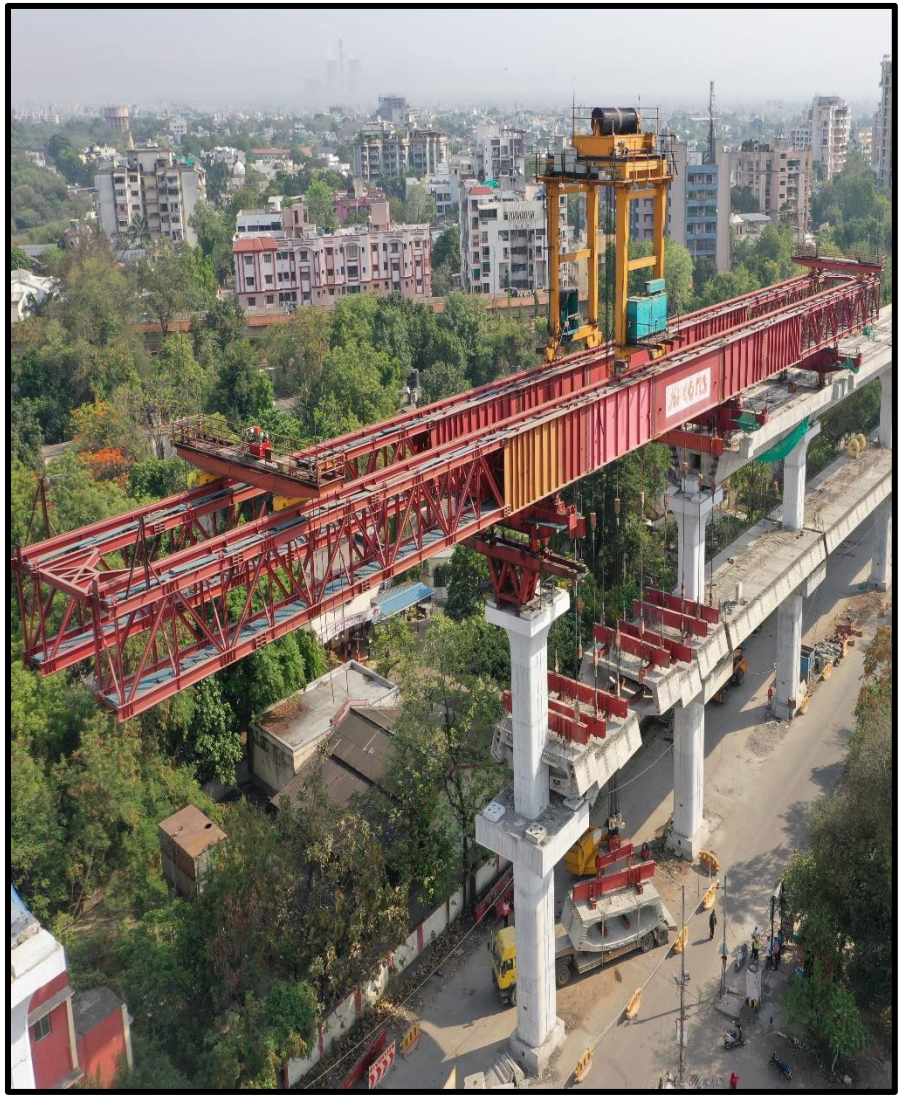
- **Length of alignment : 6.67 km**
  - **Length of double decker Viaduct : 5.06 km**
  - **Length of Metro Viaduct : 1.61 km**
- **Number of Elevated Metro Stations : 6 Nos (4 stations done by AFCONS)**

Viaduct : Scope of work

Sr. No.	Activity	Unit	Total Scope
1	Pile	Nos	1687
2	Pile Cap	Nos	221
3	Pier	Nos	386
4	Pier cap	Nos	380
5	Portal Beam (Railway span)	Nos	6
6	**Pre-casting units :**		**7540**
6.1	Metro : Segment	Nos	2320
6.2	NHAI : Spine	Nos	1740
6.3	NHAI : Wings	Nos	3480
7	**Erection :**		
7.1	Metro : Segment	Spans	220
7.2	NHAI : Spine	Spans	168
7.3	NHAI : Wings	Spans	168
8	Railway span (80m) Fabrication & Erection	MT	1650
9	Obligatory span (44m) - 275 MT	Span	1 No.

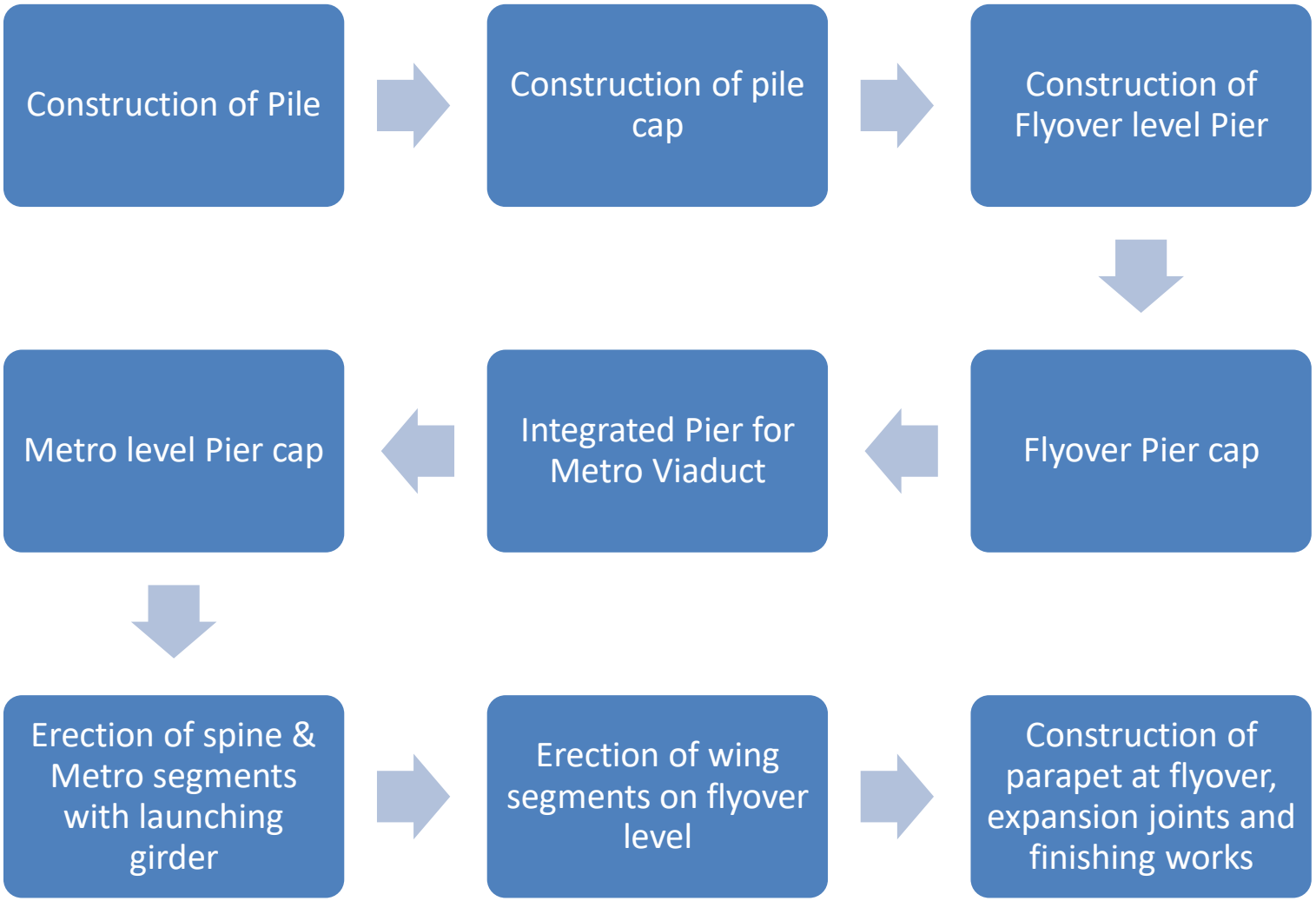
Typical cross section – Double decker



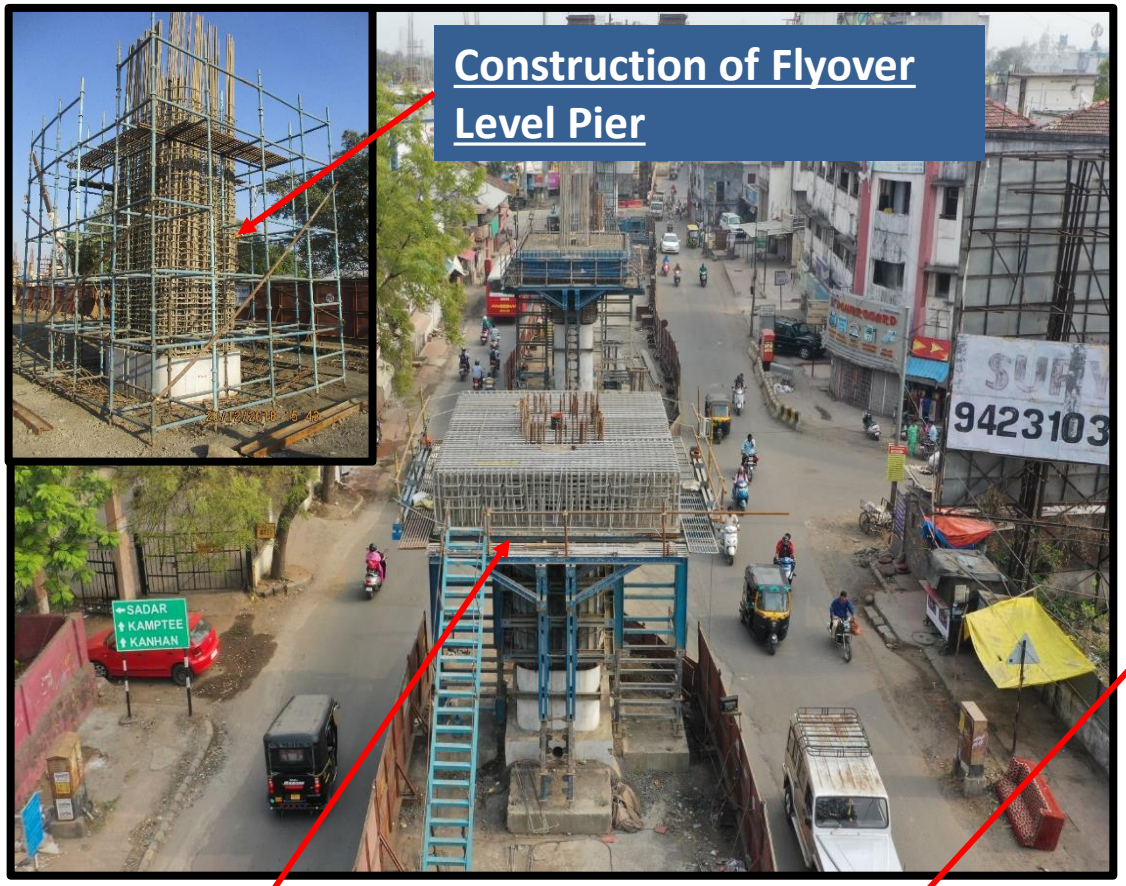


Construction Sequence of Double Decker Viaduct

Construction Sequence of Double Decker Viaduct



Construction Sequence of Double Decker Viaduct



Construction Sequence of Double Decker Viaduct

Construction Sequence of Double Decker Viaduct

Wing Launcher for Rib segments erection

Wing launcher for erection of Flyover wing elements

Reach -02

Double decker Viaduct

& Station

-- Photos --

Reach – 02 : Site Photos

Automotive Ramp –Start of Alignment

Reach – 02 : Site Photos

Automotive Square

Reach – 02 : Site Photos

Nari Road Station

Reach – 02 : Site Photos

Indora Square to Nari Road Station

Reach – 02 : Site Photos

Indora Square Station to Kadvi Chowk Station

Reach – 02 : Site Photos

Kadvi Chowk Station

Reach – 02 : Site Photos

Gaddigodam Station

Reach – 02 : Site Photos

KCP Station

Reach – 02 : Site Photos

44m Obligatory Span over Govari Flyover

Finished structure

Asia Book of Records for Double decker on Wardha Road

ASIA BOOK OF RECORDS

CERTIFICATE

Maharashtra Metro Rail Corporation Limited and National Highways Authority of India set the record for the Longest Viaduct with Highway Flyover and Metro Rail Supported on Single Column Piers at the Nagpur Metro Rail Project, Maharashtra, India. The National Highway Flyover and Metro Rail System were integrated to form Double Decker viaducts and the section runs for 3.14 km on Wardha Road having three metro stations respectively. The viaduct was opened for Metro Rail traffic on March 05, 2019 and for Highway traffic on November 13, 2020 as confirmed on June 20, 2022.

Date: June 20, 2022

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80m Railway Span Construction

India’s Most Iconic Four Layer Multi Transport System

Scope of 80m Railway span - OWG

Salient Features of 80m Railway span	
Type of Truss	Double Decker Open Web Girder
Span Length	80m
Total Weight of Structure	1650MT
Total no. of HSFG bolts	80,000
Grade of Steel	E – 350 B0
Bearing Type	Spherical Bearings
Nos. of bearings	Total = 06nos.
Height of Truss	12.3m
Truss above from ground level	28m
Erection Methodology	Part Pulling and erection with multiple cranes

Construction sequence & erection method

Site Photos – Four Level multi transport crossing

Completed view of Railway Span

DAY 01/22.12.2021

Erection of 1st member (PART-B) Node -6 LHS

DAY 10/31.12.2021

Erection of Node 6 & 7R , 7-6, 6-5 & 5-4 R BC of (PART-B)

DAY 18/08.01.2022

Erection of Flyover Cross girder 5BH & 7-6 RHS diagonal of (PART-B)

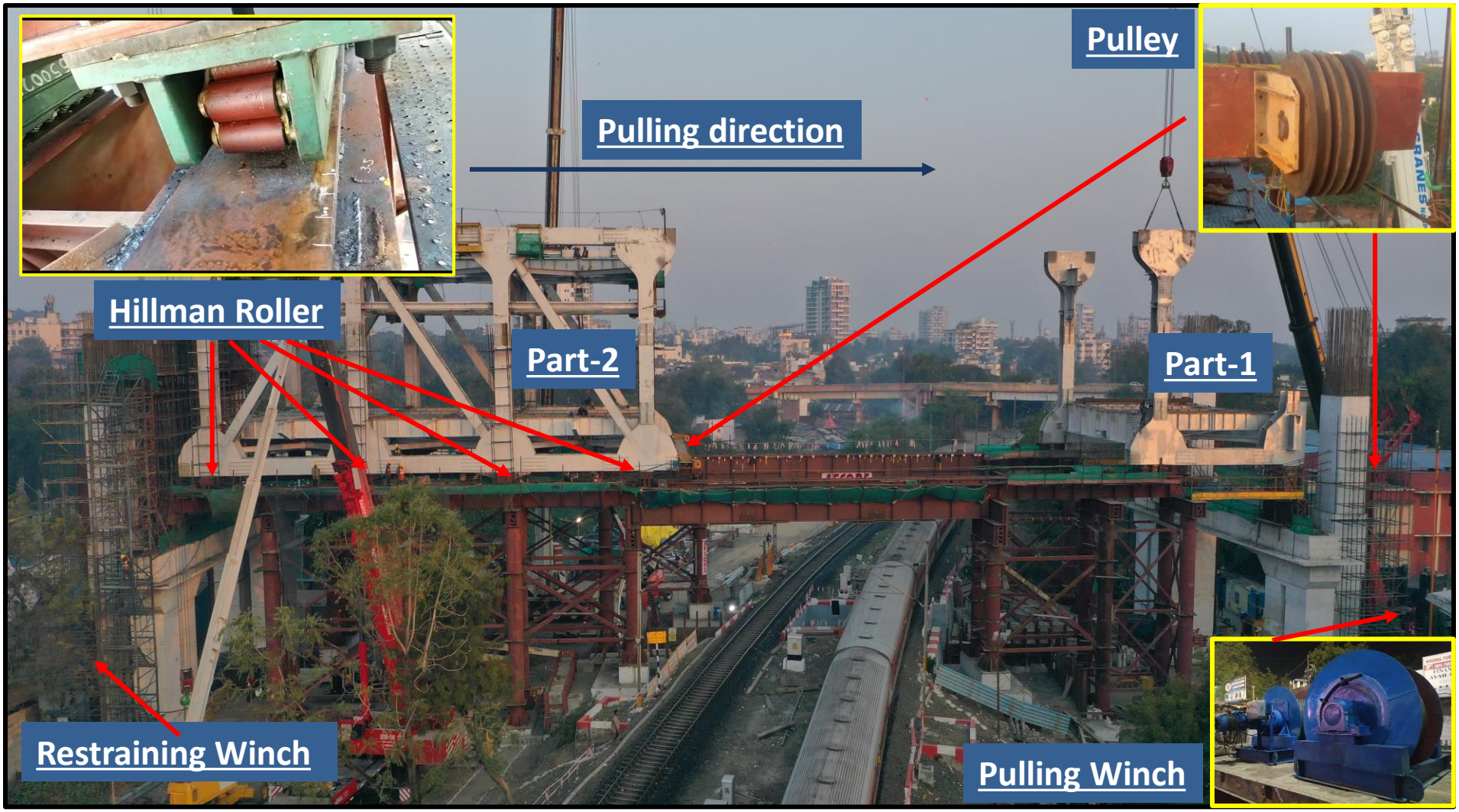
DAY 28/18.01.2022

Erection of 5, 4 TH, 7-4 LHS TC, 5-4 LHS & RHS diagonals, 5-4 BB & FSB of (PART-B)

DAY 34/24.01.2022

Erection of PART – A & PART – B in progress

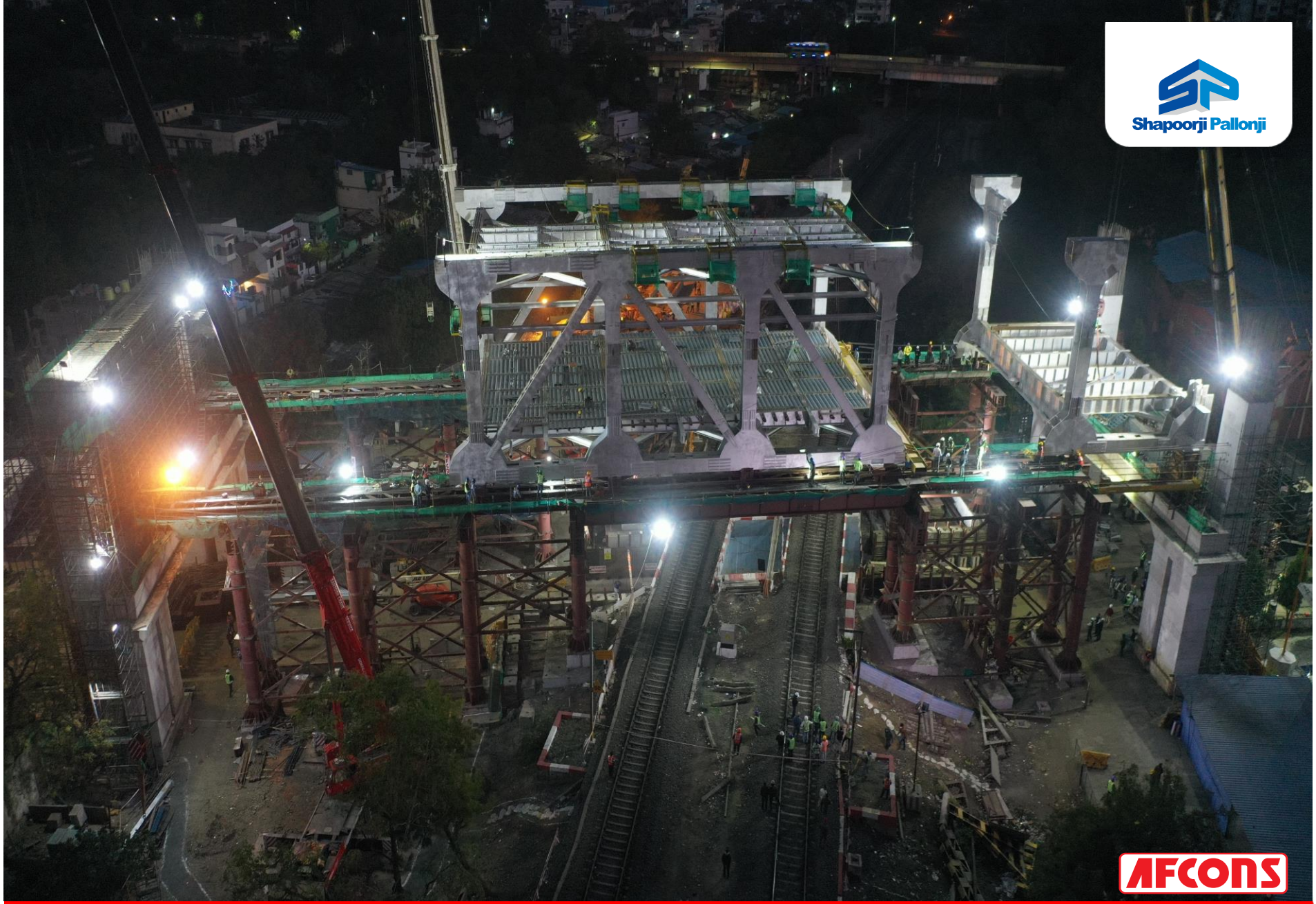
Construction of 80m Railway span - OWG



Part erection of Steel truss Part 1 (Right of Rail Track), Part – 2 on Left

DAY 44/ 03.02.2022

Erection of PART – A & PART – B



DAY 44/03.02.2022

Erection of PART – A & PULLING OF PART – B

DAY 47/06.02.2022

Erection of PART – A & PART – C

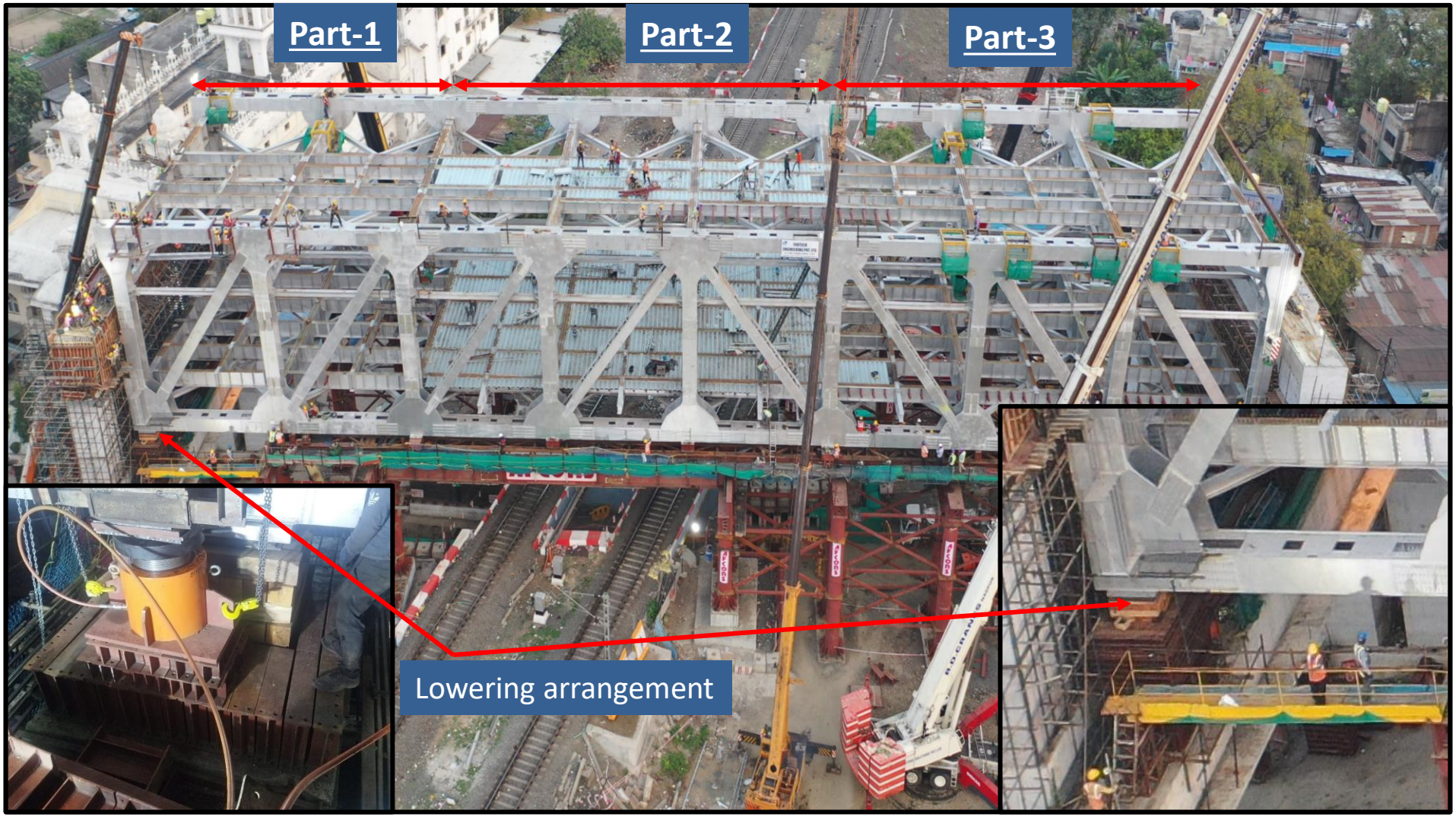
DAY 55/14.02.2022

Erection of PART – A & PART – C

DAY 63/22.02.2022

Complete erection of PART – A & PART – C

Construction of 80m Railway span - OWG



Completion of member erection of Steel Truss

Construction of 80m Railway span - OWG

Deck Slab Construction of Steel Truss

Construction of 2nd level Portal of 80m Railway span - OWG

Prefab cage placing over shutters

Balance reinf. Fixing and side shuttering

Completion of portal

Key Features of Portal

1. Reinf. Quantity = 40T
2. Concrete volume = 190cum
3. Grade of concrete = M60
4. Clear height above ground = 24m
5. Time duration to complete = 11days

Construction of 80m Railway span - OWG

Test load for NH level = 443.62T
Test load for Metro level = 464.6T
Total test load = **908.22T**

Material used for test load
1. Concrete blocks
2. Sand bags
3. Metro bogie

Span load test at 80m Railway span

Site Photos

80m Railway Span

Key Highlights & achievements during construction of Railway Span

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Asia Book of Records for Railway Span

ASIA BOOK OF RECORDS

CERTIFICATE

Maharashtra Metro Rail Corporation Limited set the record for *Heaviest Single Span Double Decker Steel Bridge Truss over Railway Tracks in an Urban Area* at the Nagpur Metro Rail Project, Maharashtra, India. The Double Decker Steel Bridge Truss is of 80 m span and 18.9 m width weighed 1670 mt. The N-type configuration supported on RCC portal piers, with High Strength E350-B0 grade Structural Steel, connections of High Strength Friction Grip Bolts of 10.8 grade, along-with Shear Studs of yield strength 385 MPa and tensile strength of 495 MPa were used for Truss building, as confirmed on June 20, 2022.

Date: June 23, 2022

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- Record Titles approved by Limca Book of Records and **expected to be awarded shortly**
- Record Titles approved by Guinness World Records and **expected to be awarded shortly**

Key Highlights & achievements of Railway Span

Located at Railway crossing where average train movement is 5 numbers per hour and peak movement is 8 numbers per hour

- Railway span facilitates Four Level multi-transport junction
- Fabrication completed in 80 days (Total 9140 members & 2700 splice plates)
- Trial assembly of entire span completed in 48 days
- Transportation of all the members sequentially done in 96 trailer trips
- Erection done in 3 parts due to area/location constraints. Erection done with 3 erection work fronts and completed in 63 days.
- Pulling of truss across Railway line done in 3.5 hours, distance travelled is 27m. Accuracy of joining Part 2 with Part 1 was within +/- 3 mm.

Key Highlights & achievements of Railway Span

- Total erection done in 436 lifts (Average weight of each lift – 24 T and maximum weight was 42 T)
- 300 number of workforce worked round the clock, 80,000 HSFG bolts fixed with 28 number of torque wrenches
- Dismantling of Temporary Structure completed in 5 days
- Lowering of entire span (4.5m height) done in 2.5 days, 8 number of Single acting hydraulic jacks used for lowering. Lowering done with each layer of 150mm (Lowering rate – 15 minutes per layer)
- Camber was measured upon lowering the span duly resting on four points. Theoretical camber at the centre of span was 83mm and actual value observed was 86mm
- Adjacent spans completed within 19 days after completion of 2nd Level portals of Railway Span

Challenges & Solutions during construction of Railway Span

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Challenges & Solutions

***FINALISATION OF METHOD STATEMENT OF ERECTION* :**

- Presence of Railway hospital, Railway workshop, School, Gurudwara on one side of Railway boundary and on other side residential zone, workshops, garages, shops, curved alignment etc. Narrow road width near Railway boundary.

- Erection of full span on any of the side of Railway track was not possible due to above constraints. Using nose for erection of the span was also examined but was not possible due to space constraint

Challenges & Solutions

***FINALISATION OF METHOD STATEMENT OF ERECTION* : …..Contd**

- To overcome above constraints, method of erection of entire span in 3 parts over temporary support system was explored and finallised.

- Part-2 structure erected on other side of railway track to pull across the tracks to match with erected part – 1 structure followed by erection of balance part - 3 structure.
- **The method was deliberated at various levels at AFCONS, GC, Maha metro, Railways,CRS and advisory technical experts and frozen.**

- **Design of all temporary structures were reviewed and approved by DDC and 3rd party of Mahametro, Railways and CRS including construction stage**

Challenges & Solutions

TEMPORARY FOOTING & STRUCTURE OVER RAILWAY EMBANKMENT:

- Temporary footings & supports were required to rest over Railway embankment to reduce the weight of temporary track beams due to radius & space constraint. The span of temporary structure was 25m

- Joint discussions with Railway officials for finallisation of method with full support & active involvement of Maha Metro, Railways gave permission to rest foundations over embankment with strengthening of embankment toes, additional temporary supports for retaining walls of RUB

- Plate load tests were conducted at all 14 temp foundation locations to ensure SBC.

- Method adopted was 1m X 1m X 1m concrete blocks along with structural steel structure retaining walls was adopted to retain embankment slopes.

TEMPORARY FOOTING & STRUCTURE OVER RAILWAY EMBANKMENT:

TEMPORARY FOOTING & STRUCTURE OVER RAILWAY EMBANKMENT :

Challenges & Solutions

PULLING OF 'PART – B' OVER RAILWAY TRACKS:

- Entire pulling operation across Railway tracks under one block of four hours, maintaining the alignment to mm accuracy was **most critical**

- Most sophisticated & safe Hillman rollers, each of capacity 350T, (8 numbers) were used for pulling of truss in place of conventional wheel & trolly system.

- Guide rollers & full proof pulling arrangement with synchronised electric winches were deployed including stand by winches/guide rollers.

Challenges & Solutions

OBTAINING RAILWAY TRAFFIC BLOCKS:

- The entire construction was completed with minimum of 5 Railway traffic blocks

- Total 4 traffic blocks, each of 1 hour, was taken during erection of temporary track girders across railway line & the removal of the same.

- **One large time traffic block, 4 hours, was taken during pulling operations of truss across Railway line**

- Maha Metro continuously was engaging even with Railway Board for obtaining timely traffic blocks

Challenges & Solutions

SAFE LOWERING OPERATION OF ENTIRE TRUSS FOR 4.5MTS:

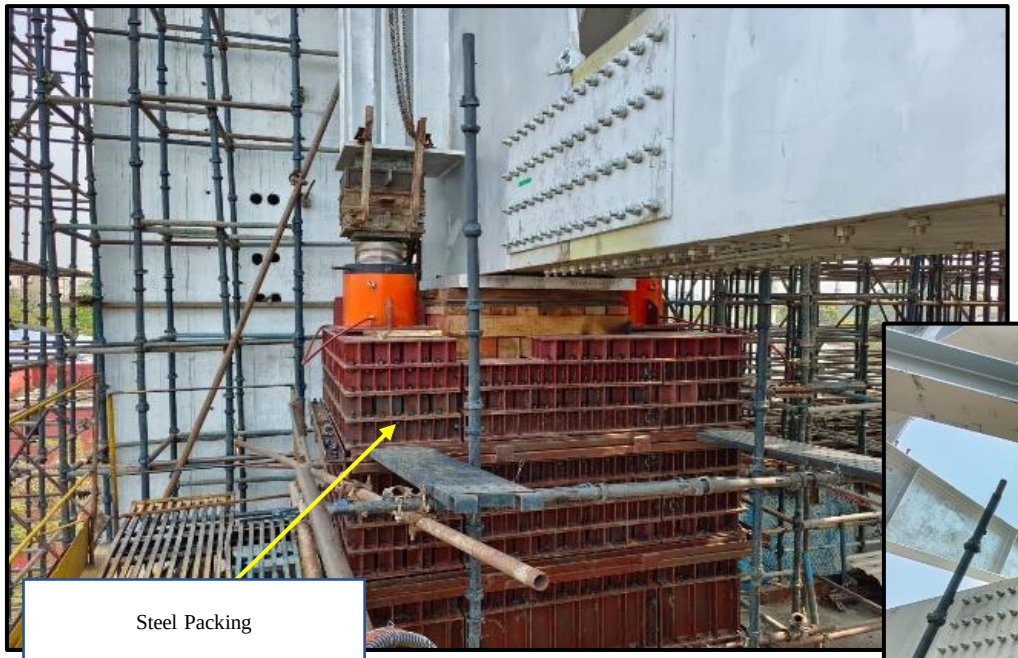
- Safe Lowering of the assembled truss on to temporary bearings from a height of 4.5m was most critical

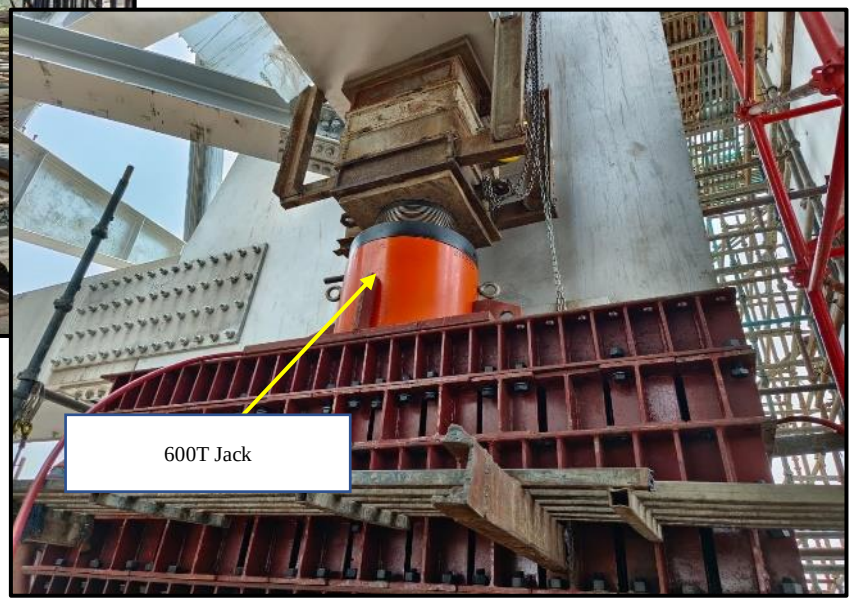
- 8nos of 600T hydraulic jacks were used for lowering operation at the initial stage, 2 nos. at each corner bearing points.

- It was lowered in 30 increments of 150mm each and was completed in 2.5 days as against envisaged 6days.

- 1200T hydraulic jacks were used for final lowering after deck slab construction and bearing installation works.

SAFE LOWERING OPERATION OF ENTIRE TRUSS FOR 4.5MTS:





Challenges & Solutions

CREATION OF MULTIPLE ERECTION WORK FRONTS:

- 3 work fronts were created for erection of structural members. 1st from Gurudwara side, 2nd from Itarasi end of Railway line, 3rd from Nagpur end of Railway line
- Approach road of 250m constructed in 5 days time
- Assembly area developed for daily stacking & assembly of elements.Two locations developed for day to day assembly of elements.
- 12 Trailers used to transport fabricated materials from 40 km away fabrication shop. Entire transportation done in the night between 11:00 pm to 06;00 am
- 28 torque wrenches used to cater torquing requirement of average 2200 number of HSFG bolts per day

Challenges & Solutions

COLLABORATIVE & SYNCHRONISED WORKING BY STAKEHOLDERS:

- Various Task Force were formed from AFCONS, GC & Maha Metro for various activities and stringent deadlines were given to respective Task Leaders.
- Daily tele conferences were held chaired by MD/Maha Metro without singly break during entire completion period.
- Round the clock monitoring was done by at the Level of Directors of Maha Metro, GC and AFCONS
- Detailed macro level transportation and erection sequence was prepared in advance and monitored continuously.
- Successful Liasoning with all stakeholders such Traffic Police, Railway Authorities, Local Authorities, Gurudwara Committee, Schools etc by Maha Metro & AFCONS was most crucial & critical for smooth execution under most stringent time lines


Thank You…!
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& HYGIENIC