Mechanized Methods for Railway Electrification

e-Mobility in Indian Railways

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4th Sept. 2018

ALSTOM
Designing fluidity

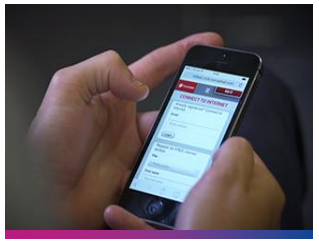
A complete range of transport solutions

ROLLING STOCK

- Tram, metro, suburban/regional, high speed, very high speed, locomotive
- E-bus
- Components: traction, bogie, motor

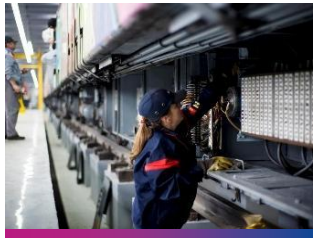
SIGNALLING

- Signalling solutions portfolio for urban, main line, freight and mining and digital mobility
- Sold as products or solutions



SERVICES

- Maintenance
- Modernisation
- Spare parts, repairs & overhaul
- Support services



SYSTEMS

- Integrated solutions
- Infrastructure including Electrification

Capabilities….Systems, Infrastructure & Electrification
A complete offer

R&D

- In-house innovation capabilities for catenary components
- In-house manufacturing of cantilevers, tensioning devices, etc.

ENGINEERING

- Large multi-disciplinary engineering capabilities
- Feeding systems, power supply

PROCUREMENT

- Worldwide suppliers knowledge
- Strong frame agreements

CONSTRUCTION

New-build, renewals, catenary rearrangement

- Worldwide experimented project management teams
- Flexible construction resources
- Heavy plant & tools
- Local partnerships

MAINTENANCE

(through Services platform)

- Predictive and corrective maintenance capabilities
- Modernisation, overhauls, etc.

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Systems Approach on Design Build Basis

Systems Approach is being used increasingly in rail projects, with the aim of creating better systems in better ways, thus generating a return on the effort/money invested. Design to maximize Capacity, Improved Safety

The type of catenary power supply and substations architectures must be determined by analyzing costs and traffic simulations, which require :

- Detailed train schedule, with rolling stock characteristics
- Expected Reliability/Availability of the system
- Available connection points to the electrical network
- Possible future extensions

Design Build Approach

The Dedicated Freight Corporation of India Limited is executing Systems Works (including electrification)on **Design Build** Basis for the first time in India for Bhaupur – Khurja Section.

Sub-Systems:

- OHE Electrification (2x25 kV)
- Power Supply (Sub-Stations) : TSS , SSP, SP
- SCADA – Traction and Non-Traction
- Signalling: Electronic Interlocking (IXL); Digital Axle Counters, Automatic Block Section
- Train Management System (TMS)
- Telecom : GSM-R, OFC system other COM systems
- Operations Control Centre (OCC)
- Associated Infrastructure (S&T Huts, Technical Buildings)

System Design Based on Simulation Studies

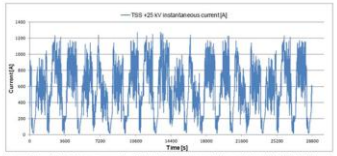
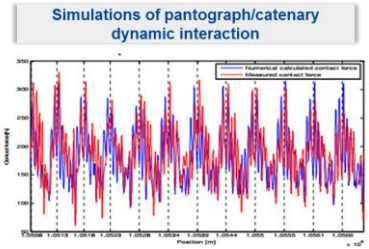


Figure 63: Instantaneous current at the +25 kV busbar of the most loaded TSS for Normal feeding condition (648 A continuous RMS at Birunl TSS Right)

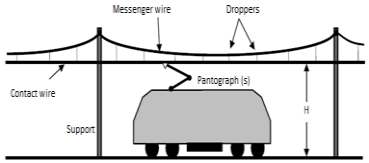
Simulation Studies

- Performed to Comply EN Standards
- Sophisticated Simulations Tools Used
  - i. Enotrac Fabel
  - ii. CDEGS Software
  - iii. CRM
  - iv. FEA



- Simulations Performed
  - i. Power Loading Simulation
  - ii. Earthing & Bonding Simulation
  - iii. Power Quality Simulation
  - iv. EMI-EMC Simulation
  - v. Dynamic Simulation of Interaction between Pantograph and OHE
  - vi. Finite Element Analysis for Cantilever
- STAAD Modelling for Buildings and Structures

Conditions



- 13 min headway.
- Single Train to Double Train ratio - 2:1
- UP Track fully loaded and Down Track 30% loaded.
- For Normal, N-1 & N-2 scenarios.
- Impact of Adjacent IR network on DFCCIL network for E&B
- Multiple Pantograph arrangement combinations (C1-C9)
- Speed : 120 Kmph

Simulation Based System Design – First Time in India

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Design / Output Based on Simulation Studies

- TSS – V-Connected
- TSS to TSS : ~ 60km
- Power Supply boosting using SP & SSP
- Power Quality and Unbalance
  i. THD (Both Current & Voltage)
  ii. Voltage Unbalance; < 3% @ PCC
  iii. Power Factor improvement
- Earthing and Bonding Scheme for 12 KA Short Circuit Current
  i. Aerial Earth Wire (AEW)
  ii. Rail
  iii. Cross Bonds and Every Mast earthed
  iv. Rail potential within permissible limits of EN 50121

- Contact, Messenger and Aerial Earth Wire
  i. Contact Wire : 150 mm^2Copper Silver
  ii. Messenger Wire : 120 mm^2Copper Magnesium
- Cantilever Design : EN 50119 and TSI Compliant
  i. Type tested to
  ✓ EN 50119 & EN 10002 for mechanical
  ✓ EN 50151 for Electrical requirements
  ii. Suitable for suitable for high tensioned contact lines
  iii. Registration arm design : Suitable for high radial loads due to sharp curves
- Catenary Span
  i. 58.5 meters (Max.)

Designed for Future

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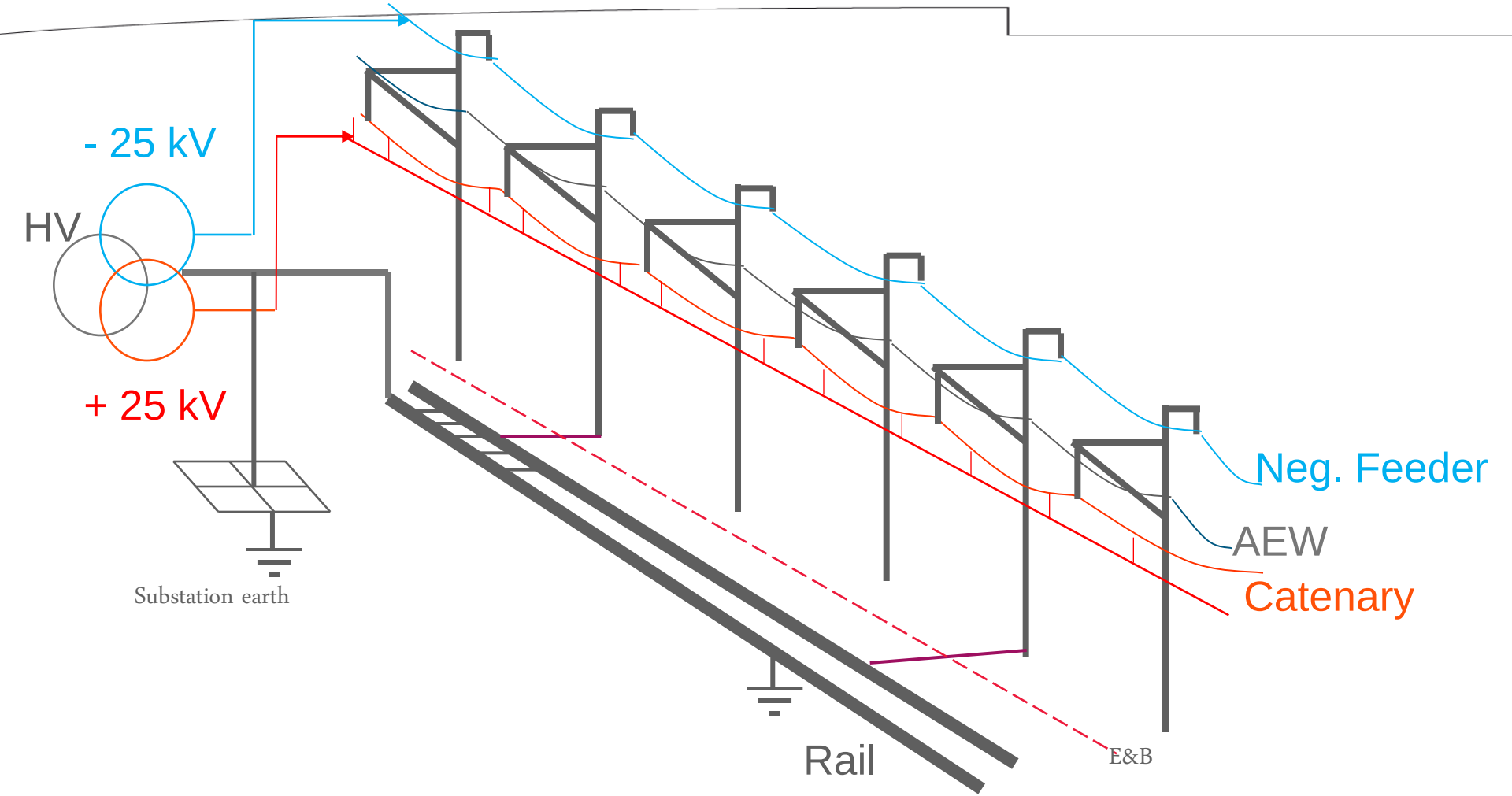
Catenary Power Supply



2x25kV Power Supply : Used 2nd Time in India

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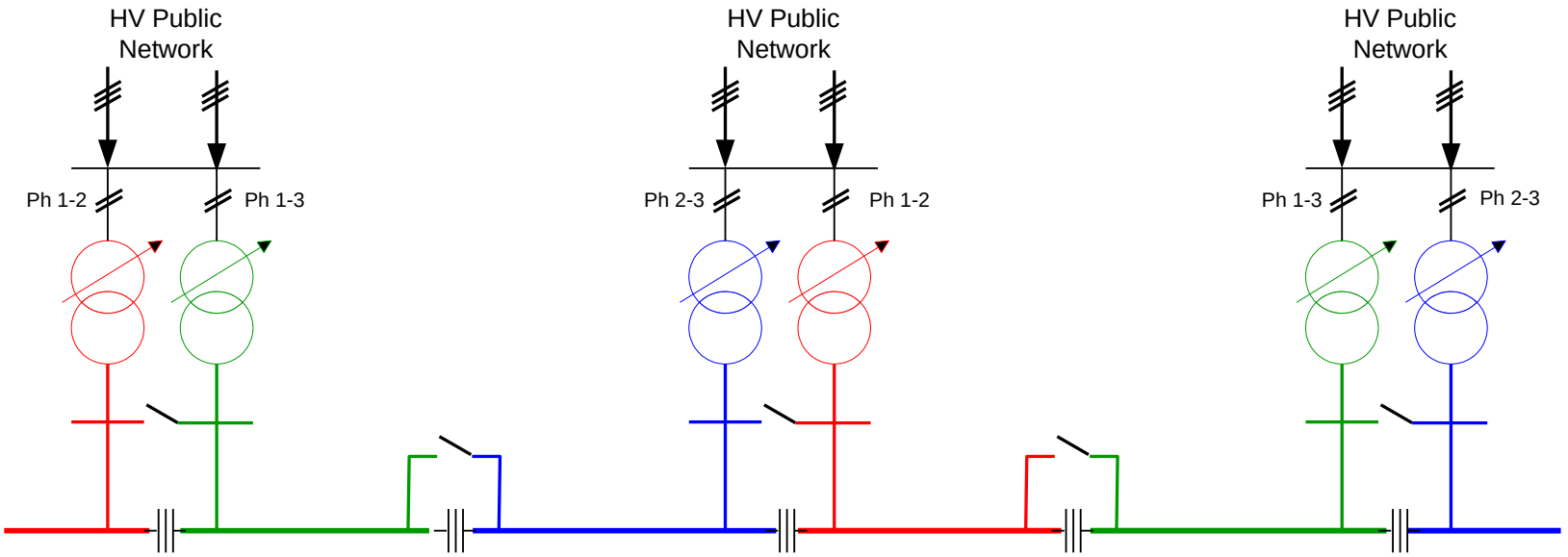
Substation……Classic Architecture Used

- Each substation is equipped with 2 transformers connected to *different* HV phases , in order to reduce unbalance.
- Each transformer supplies a portion of the line.



“V-connected” transformers…..Mitigating Unbalance

V-Connected Traction Transformer

Control & Relay panel; IEC 61850 Compliant

Light Weight Modular Cantilever

Power Supply

- ✓ **2x25kV system for**
  - Improved voltage regulation
  - Increased Traction Substation spacing; ~ 60 Kms
  - Reduced cross-section of Contact & Catenary wire
  - Lesser inductive effect in the conductor
- ✓ **Power Quality as per IEC 61000-3-13 and CEA**
  - Unbalancing – within 3% @ PCC
  - THD on Voltage – 5%
  - THD on Current – 8%
  - Power Factor – 0.95 (Lag)
  - Statcom : Dynamic Power Factor compensation
- ✓ **Control and Relay Panel**
  - Compliance to IEC 61850
  - Remote Control, Monitoring and Operation through SCADA in OCC
- ✓ **Providing high System Reliability and Maintainability:**
  - System to guarantee normal (N-1) as well as degraded mode (N-2) operation

Single phase Traction Transformer in V-connection : First Time in India

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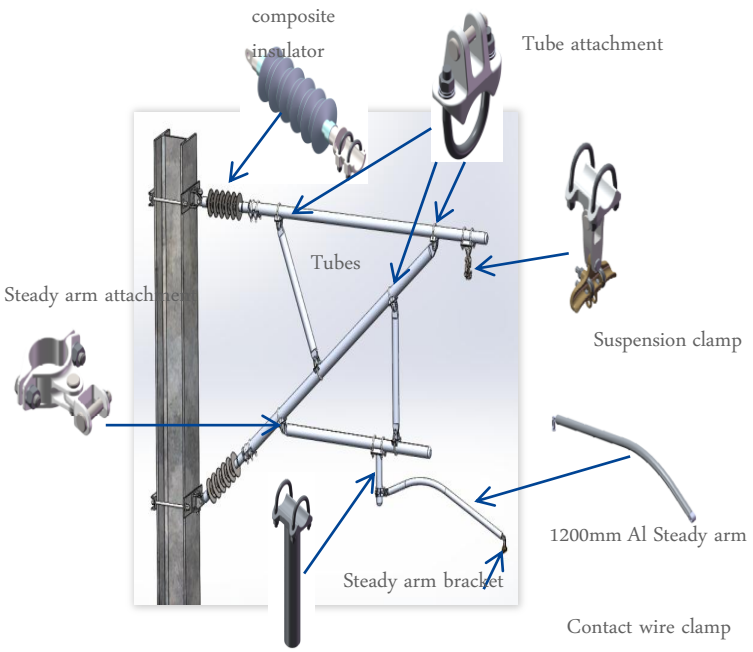
Light Weight Modular Cantilever

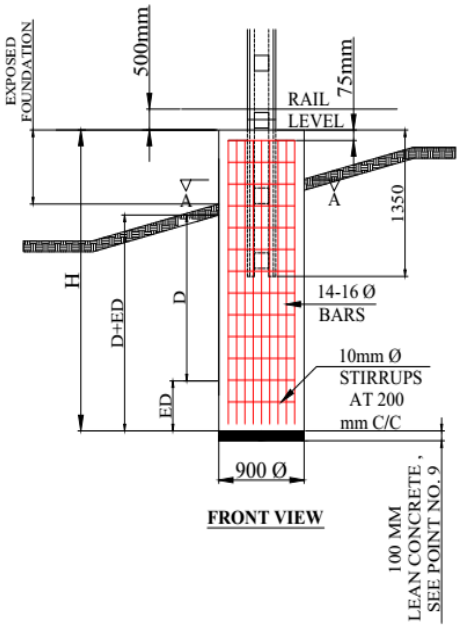
Alstom make OCS 3 Modular Cantilever

- **Light Weight; Aluminium Cantilever**
  - Composite insulators and aluminium tubes
  - Aluminium alloy castings of high strength for Components
  - Bronze Clamps for copper wires
- **Easier adjustments, installation and maintenance**
  - Independent adjustment of Contact and messenger wire staggers.
  - Independent adjustment of height by moving mast attachments on mast
- **Suitable for:**
  - High Tensioned Contact Wires
  - High Radial Load
  - Higher Speeds : 200 Kmph

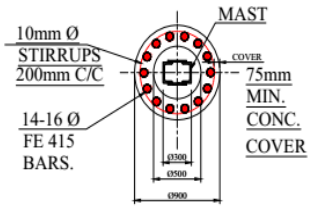


Used for the First Time in India (Mainline)

OHE Foundation Design : Circular Foundation



FRONT VIEW



SECTION "A-A"

NOTE:-

1. THIS SHEET SHOULD BE READ IN CONJUNCTION WITH DOC. NO. W3PS#5006 & DOC. NO. W3PS#5023 B.
2. ALL DIMENSION ARE IN mm, UNLESS SPECIFIED.
3. D=EFFECTIVE DEPTH OF FPUNDATION, SHOWN IN SHEET 1 .
4. THE MINIMUM DEPTH OF FOUNDATION WITH GROUND SHALL BE MAINTAINED IN ALL CONDITIONS.
5. GRADE OF CONCRETE USED FOR OCS FOUNDATION IS M20 AS PER IS456:2000 FOR GROUTING OF OCS STRUCTURE IF POCKET LEFT DURING CONSTRUCTION SHALL ALSO BE M20 AS PER IS456:2000
6. REFER SHEET 2 FOR STANDARD REINFORCEMENT ARRANGEMENT. FOR ALTERNATIVE ARRANGEMENT REFER SHEET 3 OF THIS DRAWING .
7. H= TOTAL DEPTH OF FOUNDATION .
8. REFER ASPL DOC. NO. W3PS#4052 FOR METHOD STATEMENT OF OHE STRUCTURE FOUNDATION FOR CONSTRUCTION.
9. 100mm LEAN CONCRETE SHOULD BE USED ONLY IF BORE HOLE IS DE-WATERED.
10. 75mm NOMINAL COVER SHOULD BE USED.
11. ED= EXTRA DEPTH ;WHICH WILL BE GIVEN IF DISTANCE OF SLOPE FROM FOUNDATION CENER IS LESS THAN 0.6 M , IN THAT CASE ED= 0.6-X (WHERE X= DISTANCE OF CENTER OF FOUNDATION FROM START OF SLOPE)

Design Considerations

- Designed as per the Union of International Railways report
- Side bearing performance unlike Ground pressure bearing in IR
- Designed to take the maximum cross track bending moment
- Use of Reinforcement steel cages
- Use of high strength concrete; M20 against M15

Advantages over Conventional

- Mechanized Construction / Auguring Possible
- Lesser Concrete
- Occupies Less Space
- Better Service Life of Foundation

“Circular Foundations” for both OHE & Portals…..First Time in India

Construction Methodologies

New Construction Methodologies like Mechanized drilling with Rail road arrangement, Batching plants on rail wagons (concrete train), Wiring kits with automatic tensioning and simultaneous stringing of catenary and contact wires and self-propelled platforms for cantilever fixing, Droppering & Clipping and catenary adjustments are introduced for the first time in India

Mechanized Construction....Circular foundations

Mechanized excavation by Auguring using RRV

- Less Execution Time; Faster Construction
  - ✓ Auguring Time: ~ 25-30 minutes/Foundation
  - ✓ 15-20 foundations per day
- Less Manual; Less Manpower; more Uniformity
- Safer
- Augur mounted on JCB / Excavator for Non-Track Laid area

Used for the First Time in India

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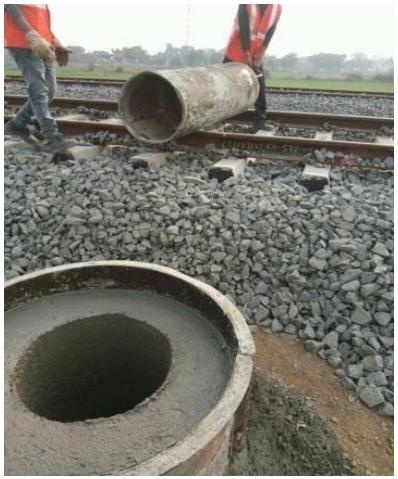
Mechanized Construction....Concrete Train

Batching plant on wagon (Concrete Train) to cast foundations

- Hauled by Loco or UTV
- No manual lifting or shifting of concrete
- Concrete discharging chutes for UP and DN
- Design Mix Concrete
- Better Quality Control; SCADA operated Concrete Train / Batching plants equipped with printable load cells
    i. automatic moisture control
    ii. fully automatic weighing system
    iii. connection for admixture and water
- Cube Test : Every 6 Cum of Concrete
- Faster : ~ 25-30 mins / foundation



Innovation in Construction of Railway Electrification

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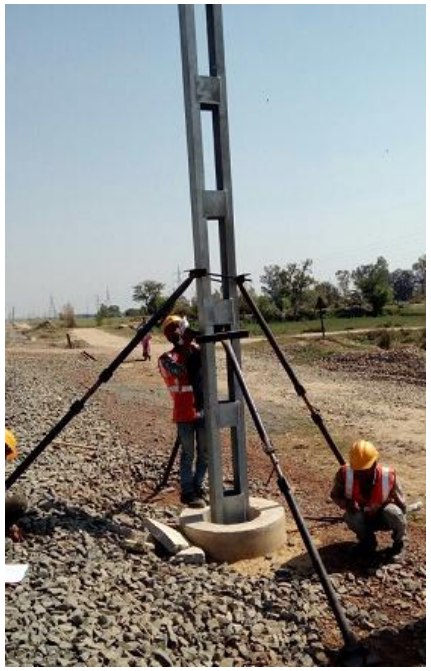
Mechanized Construction.....Mast Erection

Mast Erection with pole grappler fitted to crane on UTV

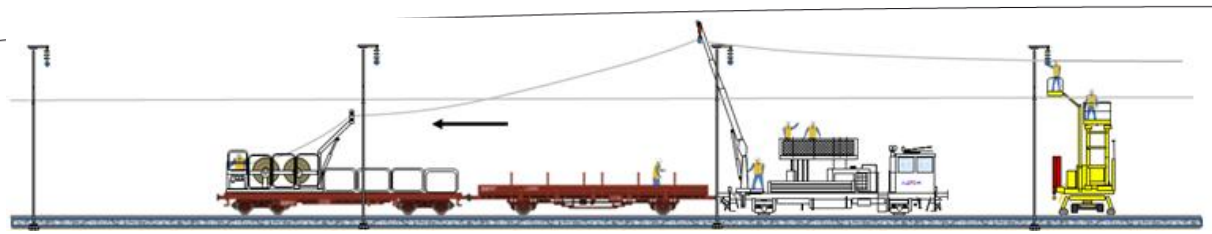
wagons loaded with steel masts

- UTV : A rail vehicle mounted with a crane capable of lifting and placing mast into the foundation
- The approximate weight of each mast is around 500kg
- Capable of pulling up to 2 wagons
- Maximum of 60 masts / Wagon
- Fast progress
- No damages to galvanization coat



Mast Stabilizing Jig

Mechanized Construction.....Stringing of AEW and Negative Feeder



PT 500 & Spazio

- Aerial Earth wire stringing is done by auto tension unwinding kit placed on wagon hauled by loco/ UTV.
- Positioning of Aerial Earth wire to back side of mast at clamp will be done with the help of self propelled machine (PT500 & Spazio)
- Clamping of wires will be done by Self propelled platforms (RSM 12)

RSM 12

Used for the First Time in India

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Mechanized Construction.....Cantilever Erection

Cantilever fixing with self propelled platform (RSM 12)

- The cantilevers are properly stored in order of erection on a wagon pulled behind the RSM 12 or UTV vehicle with elevating platform.
- The cantilevers are transported by rail to the locations and the crane arm will lift them to the required position.
- It then is fixed by workers seated on the elevated platform.
- Usually done after the Feeder and AEW conductors Stringing
- Safe and Efficient way of working; double production (~ 25/day) and less than half resources (4)

Used for the First Time in India

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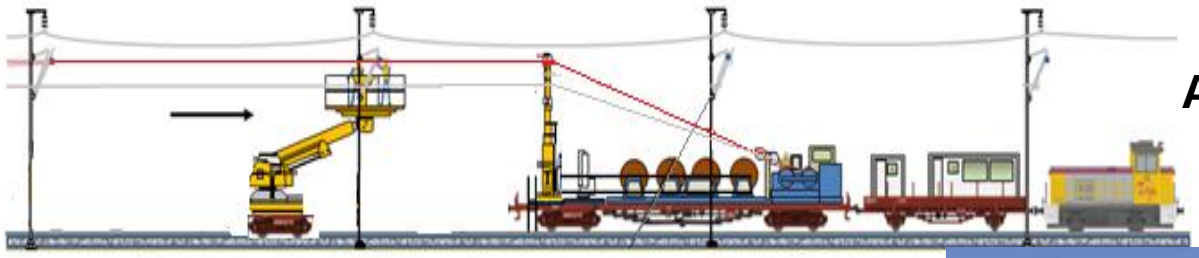
Mechanized Construction.....Stringing of Catenary and Contact Wire



Auto-Tension unwinding kit

- The stringing of Catenary and contact wire can be done simultaneously followed by self propelled lifting platforms for clamping of wires.
- Saves time and increase productivity. 4 cable drums can be mounted on the wiring kit; 1.5 Kms in 2 Hours
- RSMs behind the wiring kit used for droppering in turn reduce the chances theft of wires

Used for the First Time in India

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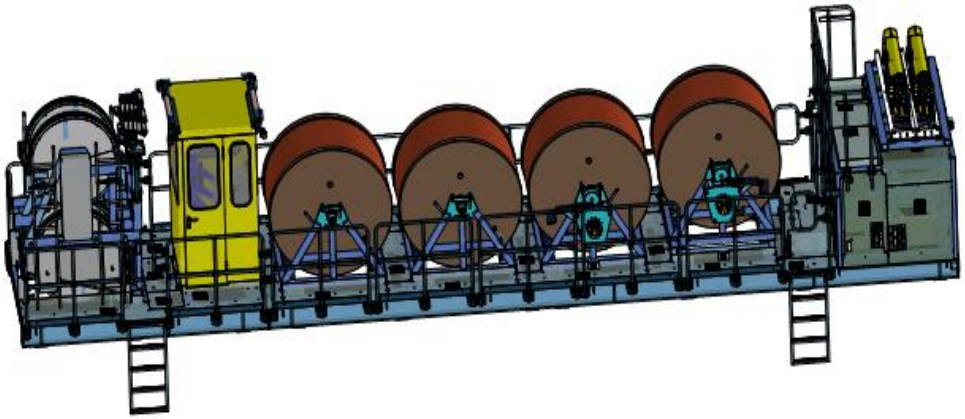
Mechanized Construction.....Wiring Trains



Used for the First Time in India

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Mechanized Construction.....Wiring Trains

Electrically Controlled Wiring Trains:

- Wire Guide System with Two Hydraulic Arms; individually controlled. Wireless Control
- Can Control the tensional force in the cables
- A stringing data record system with USB interface available
- Automatic Tensioning System (ATS)
- Overload protection system

Mechanized Construction of Buildings....Associated Works

Pre-Cast Buildings

- Pre-Cast Panels manufactured in Factory
- Better Quality Control
- Green concept: Minimize wastage generated in plant
- Mechanized and Accelerated construction
- Aesthetically better finish
- Reduced cost of maintenance
- Geo-Web Technology for Slope reinforcement
  - Long Life
  - Easy to Install
  - Low Maintenance
  - Occupies Less Space
  - Better Load Bearing Capacity

Pre-Cast Building

Geo-Web Technology

Pre-Cast and Geo-Web ……Used for the First time in Indian Railways

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Construction....Operation Control Centre (OCC)

State of the Art Operation Control Centre

- > 13500 Sq. meters; 1500 Sq. meter of Theatre, ~ 80 meter video wall (3 Rows)
- Equipped with TMS and SCADA
- GRIHA 4 rated Green Building
- Gas Suppression System for Theatre Fire Safety
- Columnless Theatre
- State of the Art Interiors
  - Metal acoustic cladding for wall & ceiling with LED lighting
  - Best in class consoles

Biggest OCC in India; will control longest line Globally (Ex-China)

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ETCS L2 Ready……All Building Blocks Being Provided

Many Firsts and ETCS L2 Ready

- World Class Electronic Interlocking (EI); Alstom SmartLock 400
  - **ETCS L2 Compatible**
  - High calculation capacity; Support > 1,80,000 equations
  - SIL 4 IXL and MMI
  - Object Controllers at Remote unmanned Locations
  - JR
- State of the Art **Traffic Management System** (**TMS**)
  - Based on Alstom ICONIS platform
  - Integrated Platform
  - **Compatible with ETCS L2**
- **GSM-R Communication Network for ETCS**
- State of the Art Digital Axle Counter; FAdc
  - Axle counter based Automatic Block Section working
  - Fail Safe Ethernet Interface with EI
- OFC Network with Latest Technologies
  - Interface with IR existing GSM-R of NCR / NR
  - Master Clock
  - Two communication backbones OFC and DNS
  - SDH

Opportunity to Implement ETCS L2 for the first time in India

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Project Monitoring.....Drone Survey at Regular Intervals

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Designing fluidity