Advanced Programme - Planning, Design _ Construction of Long Span Bridges- (Batch I) - 22

Quality Control and quality assurance during casting, erection, launching and scaffolding works

National Rural Infrastructure Development Agency

Ministry of Rural Development

Engineering Staff College of India (ESCI)

Hyderabad

Lecture 6

Quality Control and quality assurance during casting, erection, launching and scaffolding works

- Stacking, storage of materials
- Production, placement & compaction operations
- Quality controls during casting of moulds,
- Epoxy jointing, prestressing, grouting,
- Sequence of activities in precast construction,
- Importance of correlation with design
- Permanent works and temporary works
- Scaffolding

Raw Materials used in Bridge Construction

1. Cement
2. Sand
3. Coarse Aggregate (Gravel)
4. Admixtures

Stage 1 – Material testing

- Daily Moisture Correction Checking from Stock Yard

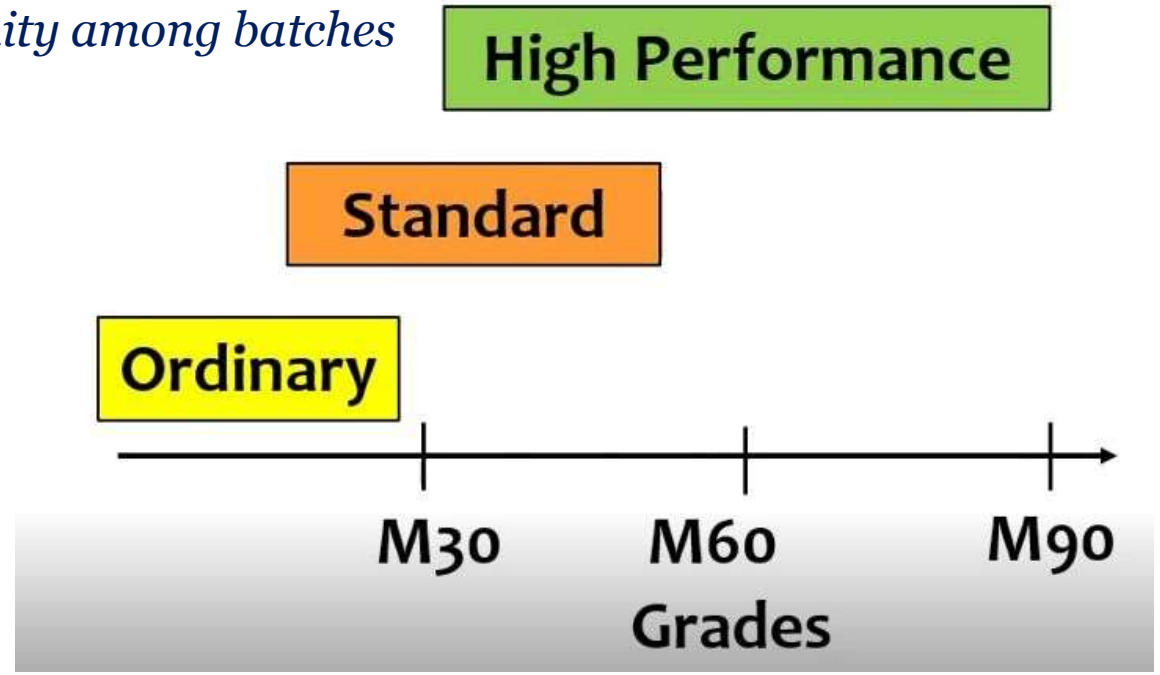
- Grain Size Analysis of Incoming Material

- Aggregate Impact Value Test of Incoming Material

Concrete – Expected Properties

High Performance

- *To meet special performance requirements*
  - **High Strength**
  - **High early strength**
  - **High workability**
  - **High Durability**
  - **Minimum Shrinkage and Creep**
- *Needs high Degree of Uniformity among batches*
- *M30 to M90*



Stage 2 – Concrete Production from Batching plant

- Chilling Plant Water Temperature Checking

- Temperature of Water for Concrete production

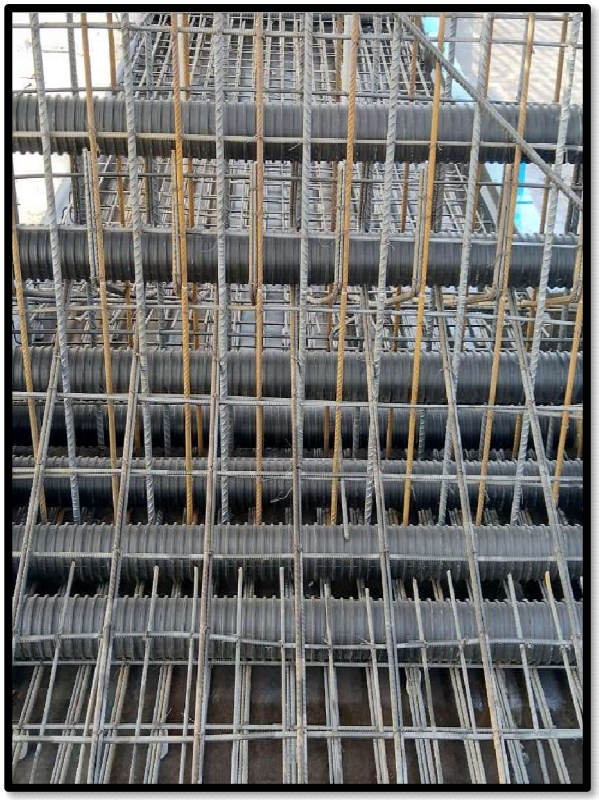
- Slump Checking at Batching Plant

Variable requirement of workability

- Segment requiring higher workability

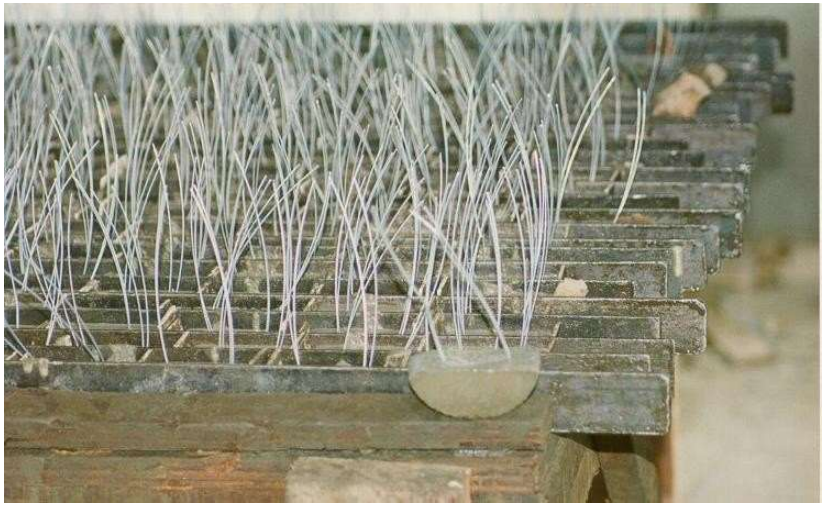
- Segment requiring moderate workability

Stage 3 – Pre-pour check



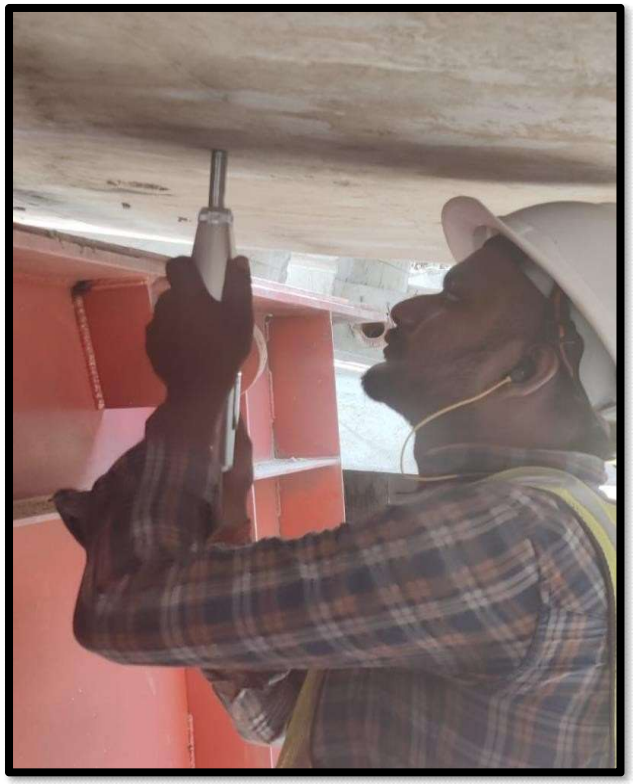
- Reinforcement Checking of Segment
- Checking of Profiling & Cover Block
- Checking of Shuttering before Concreting

- **Prefabrication of Reinforcement cages with Cover blocks**



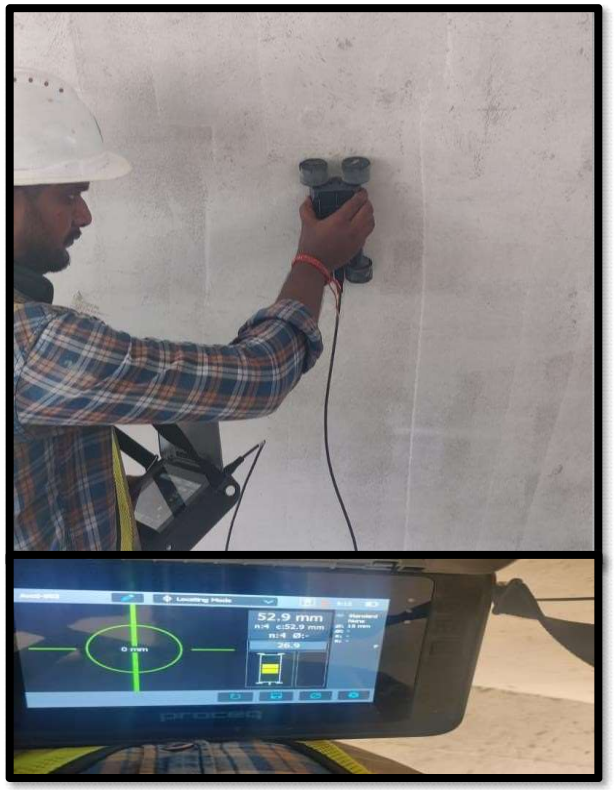
- **Simple way of casting cover blocks in casting yard with same grade of concrete**

Stage 4 – Post-pour check



- **Re-Bound Hammer Testing before Dispatching**

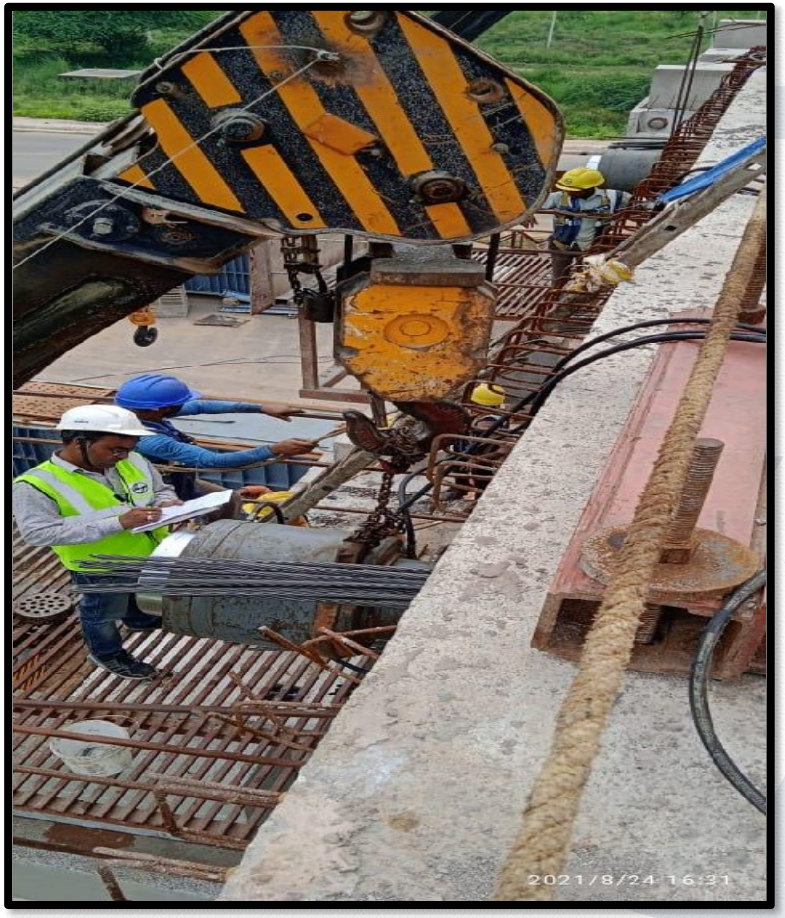
- **UPV Testing before Dispatching**

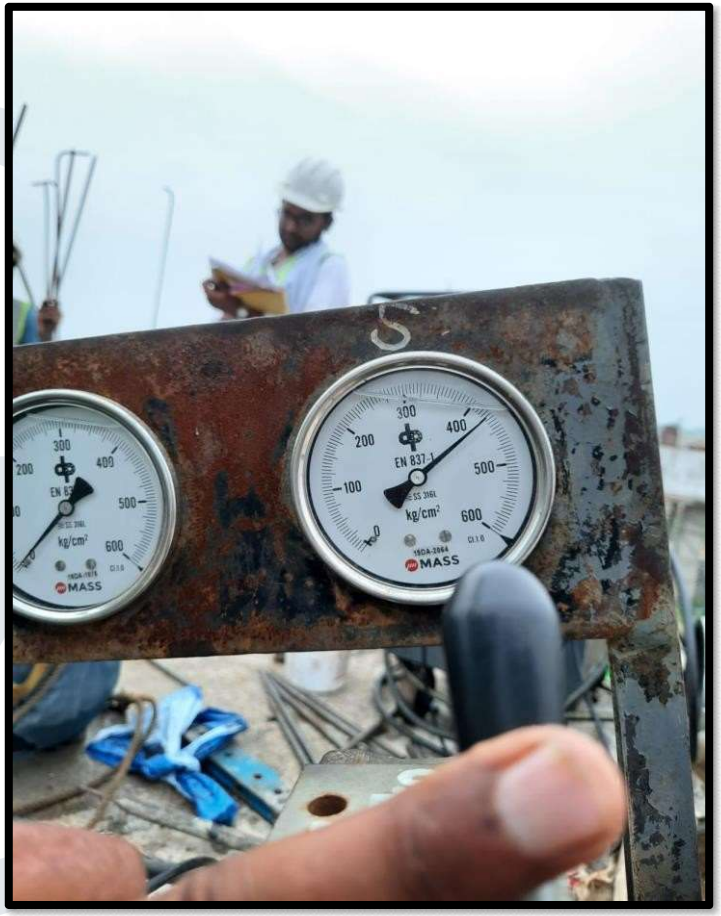


- **Cover meter Testing before Dispatching**

Stage 5 – Jack efficiency testing

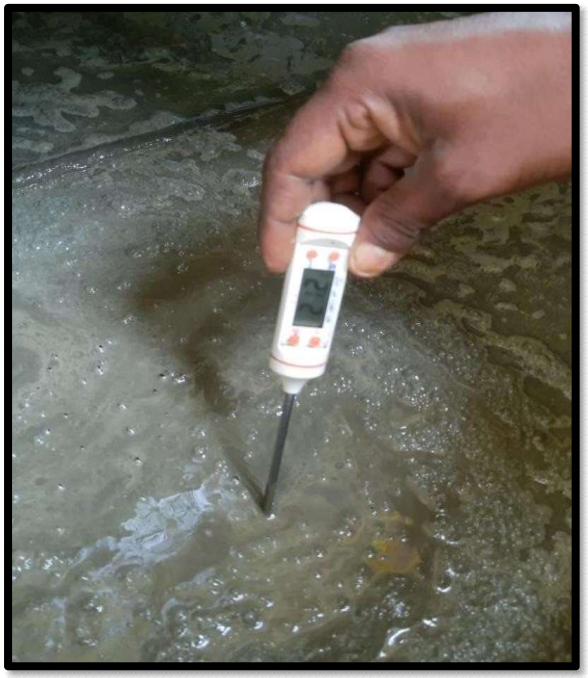
Stage 6 – Stressing and Stressing parameters checking





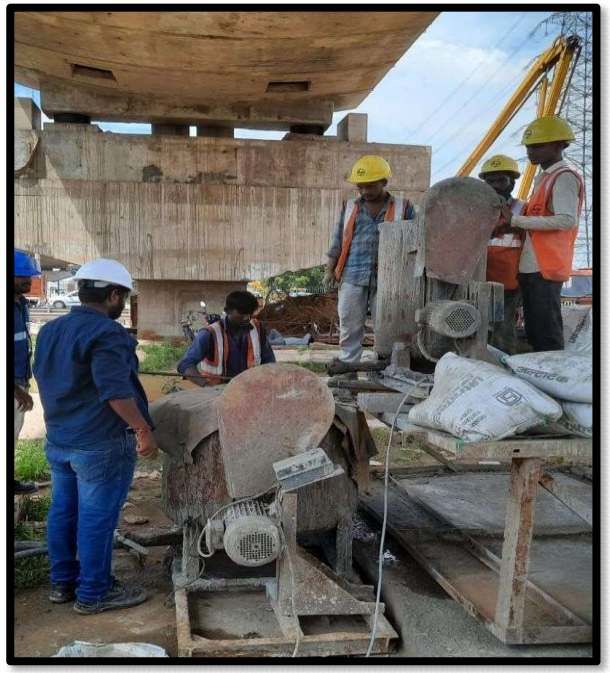
- Span Stressing after verifying the calculation
- Dial Gauge Reading & Observation

Stage 7 – Checks during grouting



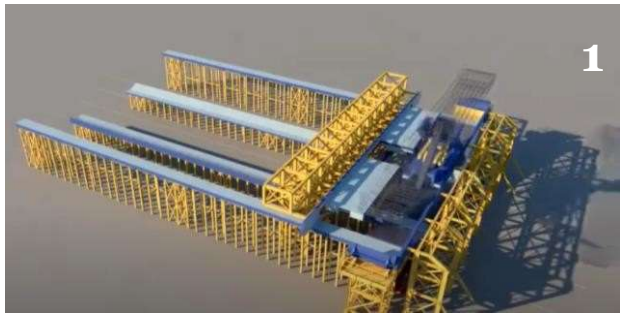
- Temperature of Grouting Mix

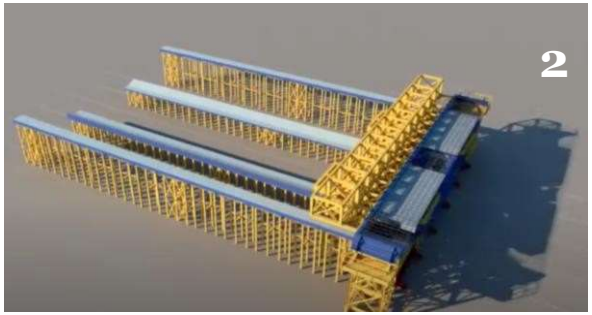
- Cube Casting of Grouting Mix

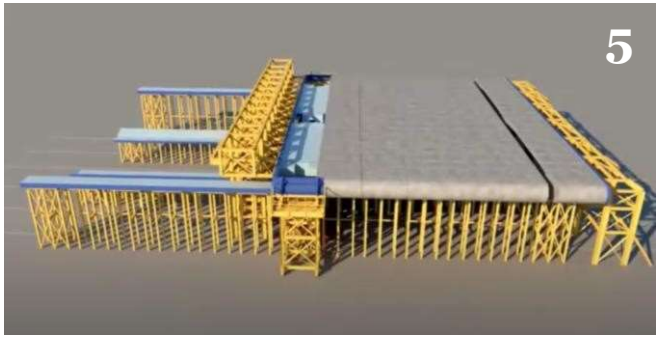


- Grouting of span

Segment casting – Longline method



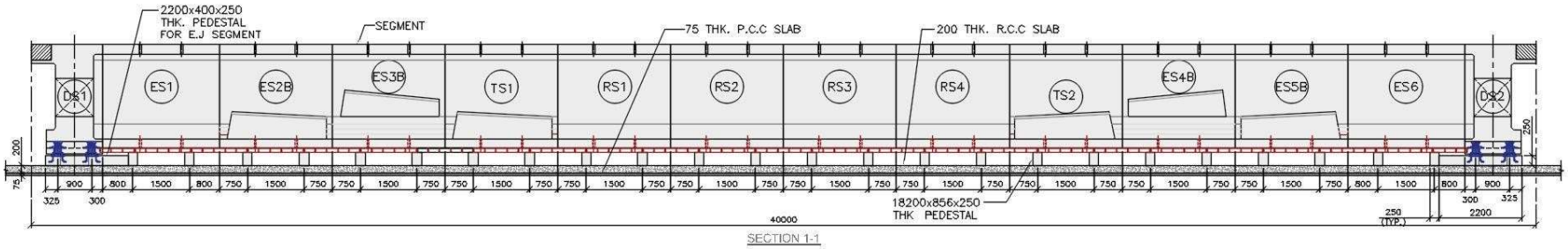


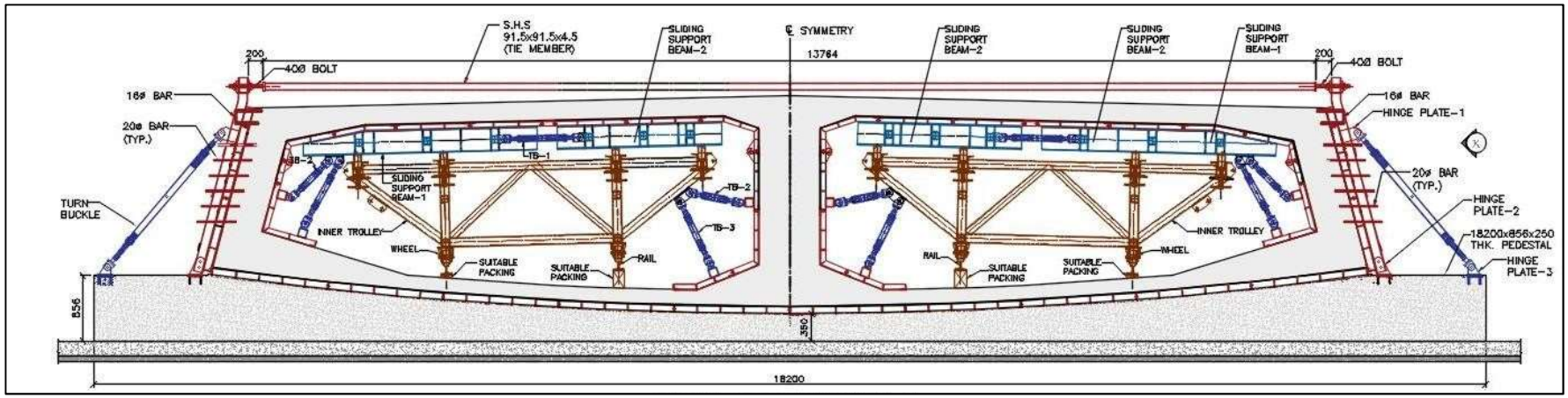


Good Features –

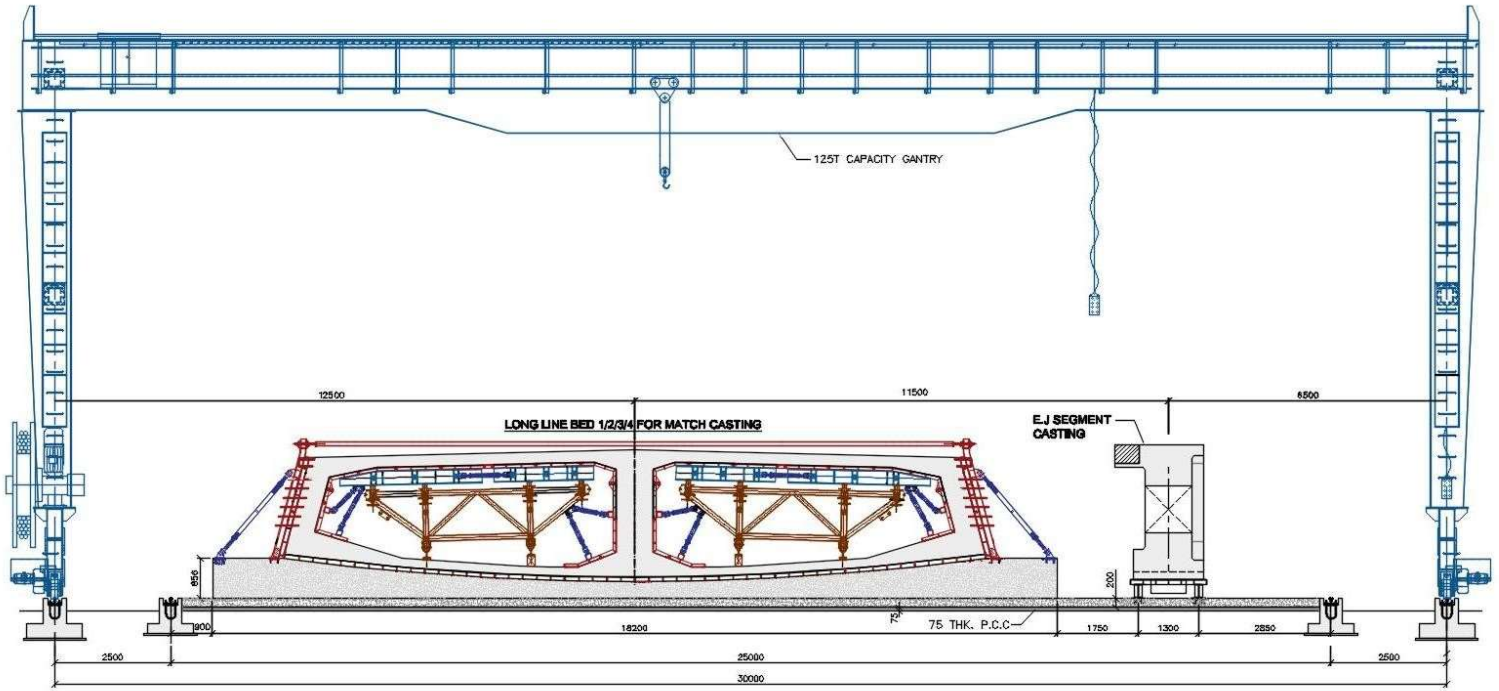
1. **Good Control on profiles**
2. **Safe arrangement for segment disengagement**
3. **Low shear key breakage**
4. **Good possibilities for Form vibrators**

Typical Longline method in India





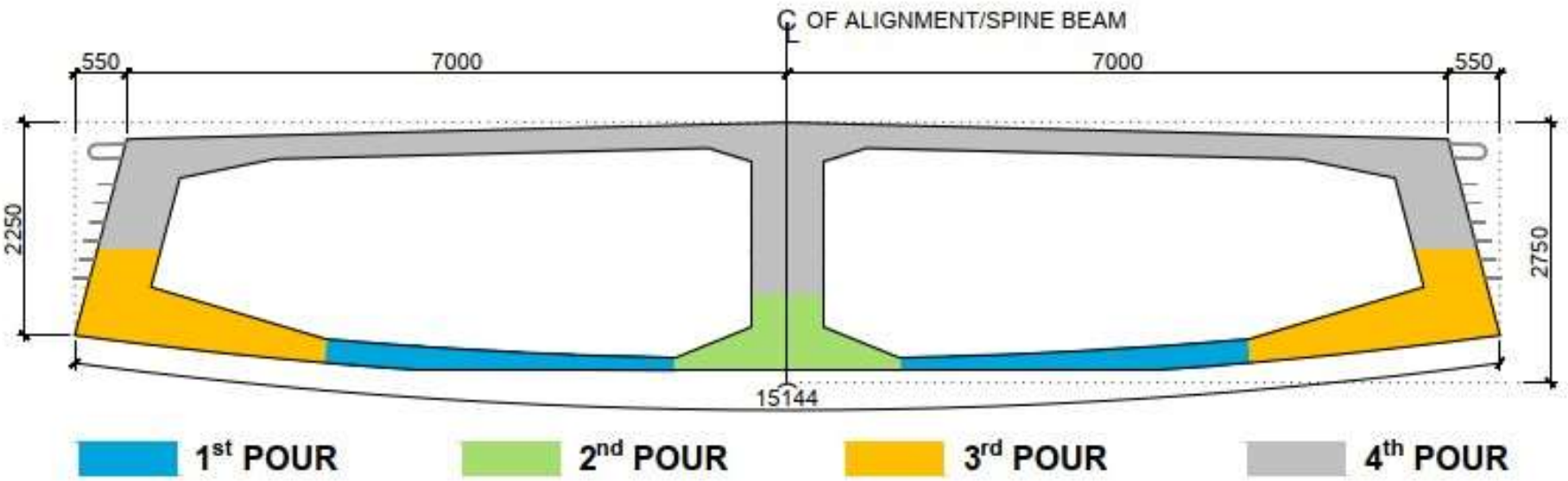
Typical Longline method in India



Deficiencies –

1. **Limited Control on profiles**
2. **Incomplete arrangement for segment disengagement**
3. **Significant shear key breakage**
4. **Limited possibilities for form vibrators**

Typical Segment Pouring Sequence

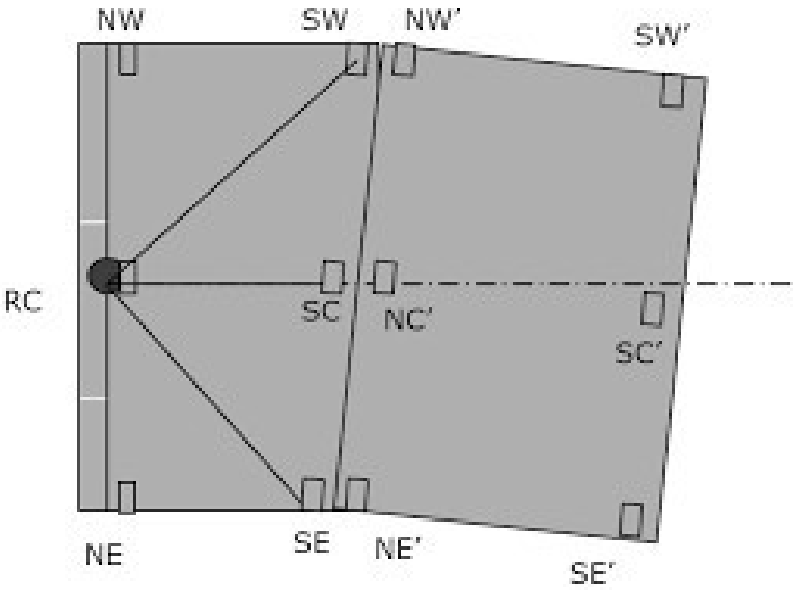


Important aspect to note–

1. **No Cold joints should form**
2. **The Previous pour should be sufficiently stiff before starting the next pour**
3. **Workability adjustment needed for each pour**

Hence Trial casting of segments with trial mix is essential

Segment casting – Shortline method



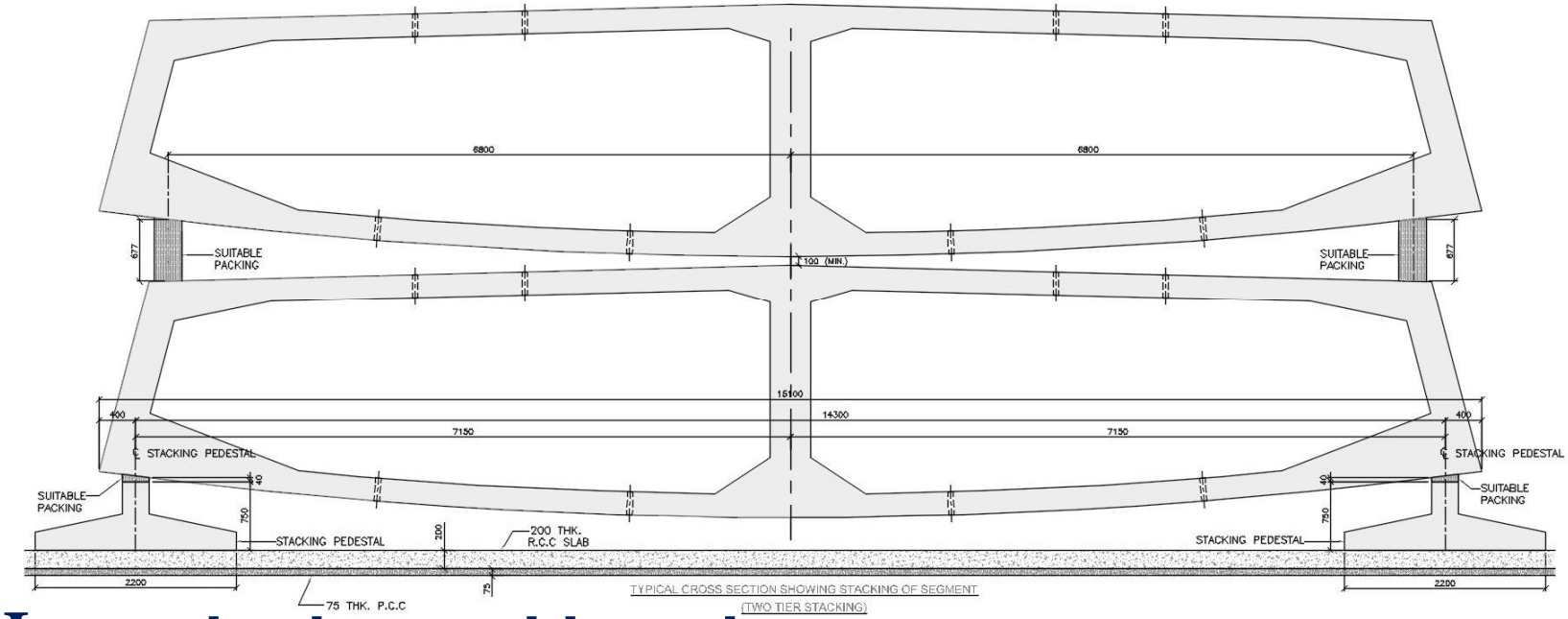
Good Features –

1. Smaller Casting yards

Disadvantages

1. **Requires very strict Geometry control**
2. **Much higher level of mechanisation of moulds**

Segment Stacking



Important aspect to note–

1. **Improper stacking could lead to local cracking in segments**
2. **In case any prestressing is necessary before second level stacking it must be completed.**
3. **Curing of the segments must be carried out here**

Pre dispatch treatment of Segments

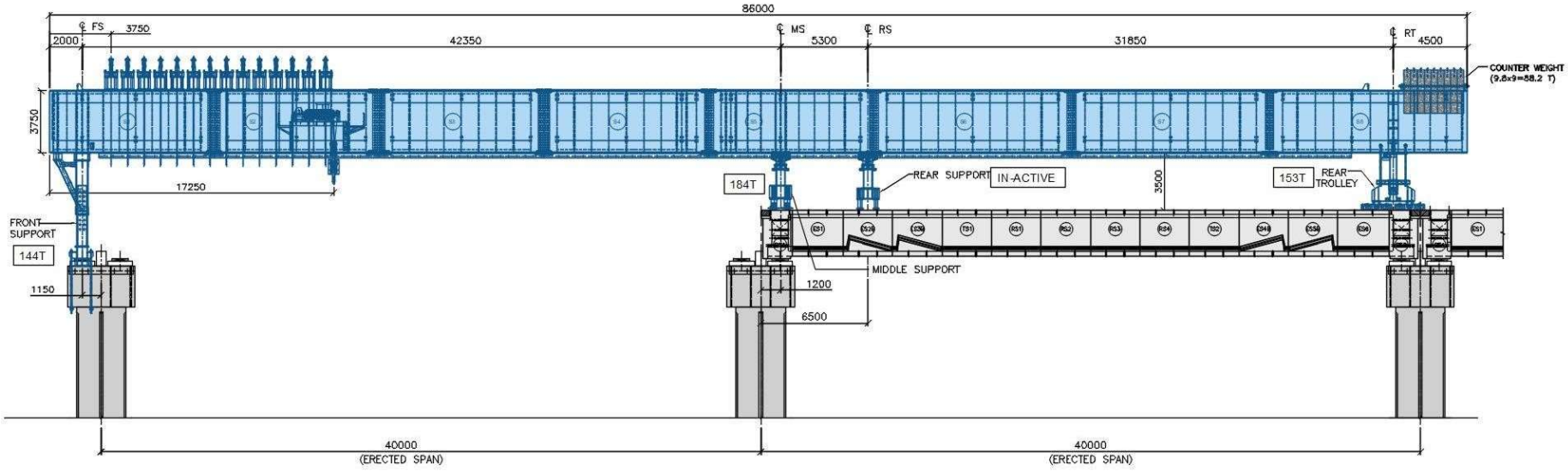
Segment interfaces shall be cleared of all debonding agents by Grit blasting. Wherever this is prohibited by local regulations in open then the provision of doing it in an enclosed area must be made. Grit blasting leads to:

1. Removal of the debonding agent applied during the casting the match cast segments.
2. Removes any laitance at the segment interface which might lead to local weaknesses.
3. Enables good bonding between the parent concrete in the two segments.

Segment Erection

Stage 1:

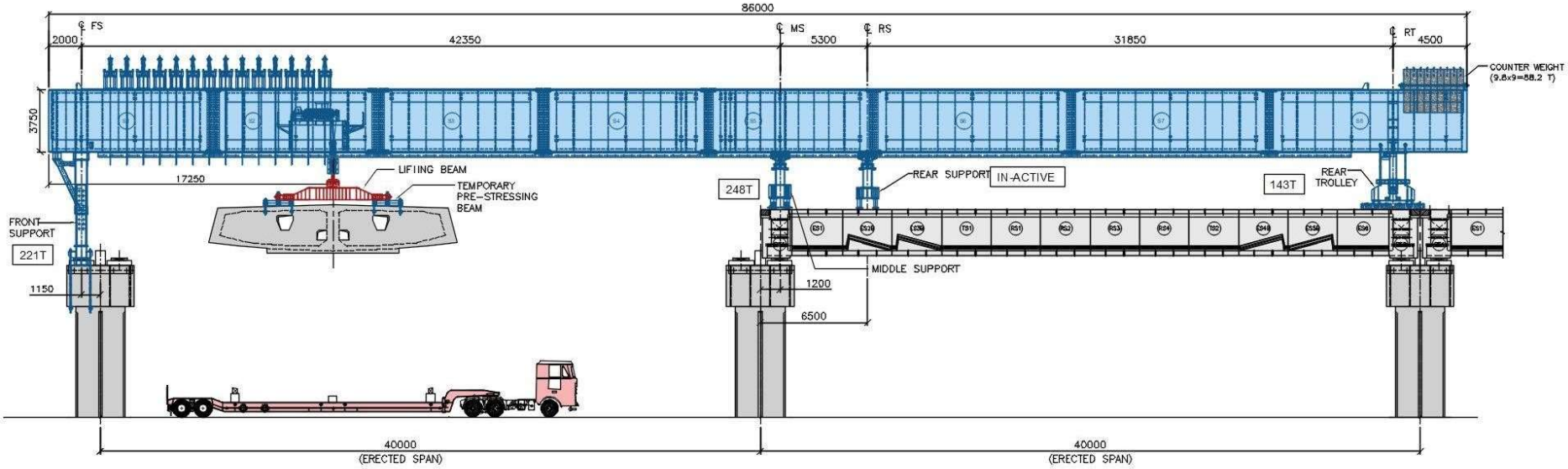
1. Launching Girder is ready for erection of New span and lifting of Segments
2. Move the sliding beams towards the next span to be erected near front support as shown



Segment Erection

Stage 2:

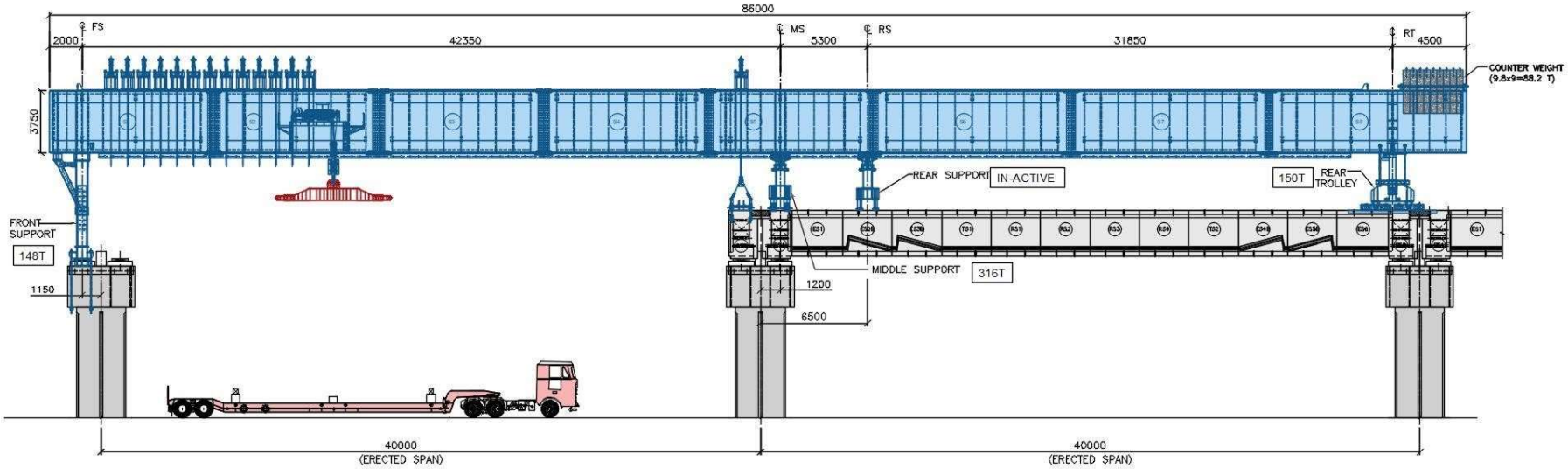
1. Position the trailer below the span and fix lifting/Stressing beam on Segment DS2
2. Lift the diaphragm Segment with the help of Strongback



Segment Erection

Stage 3:

1. Hang the Segment DS2 by vertical suspender on Sliding beam
2. Detach the Strongback from Segment DS2
3. Position the Segment DS2 over Piercap by using sliding beam

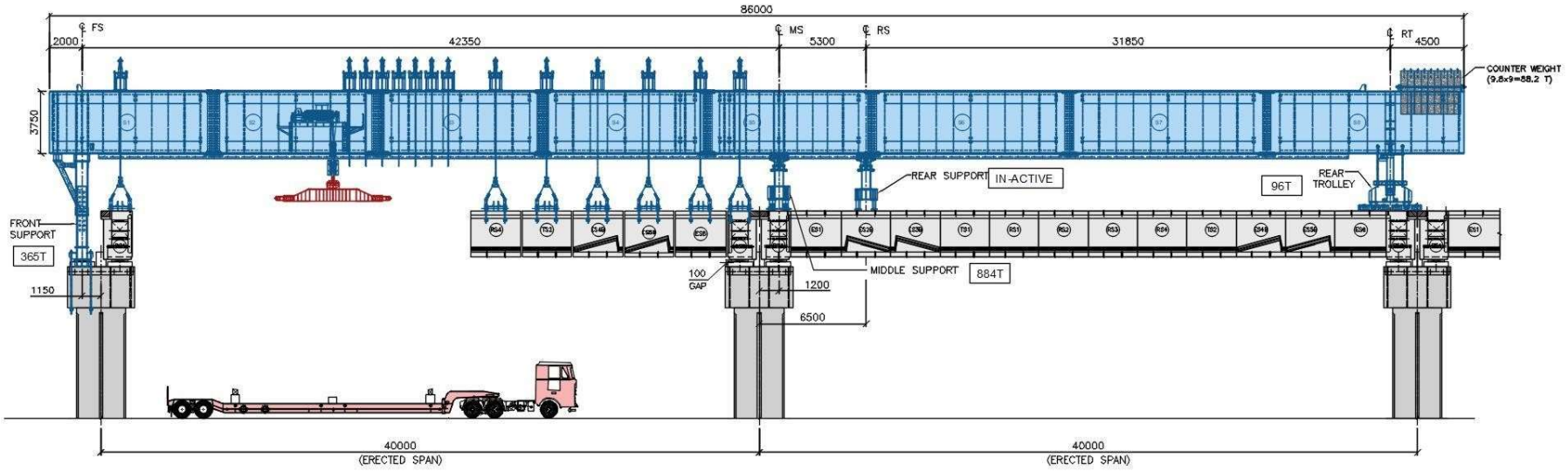


A very Critical stage as there is a transfer from one lifting system to other. All the precautions and checking measures must be strictly followed and recorded

Segment Erection

Stage 4:

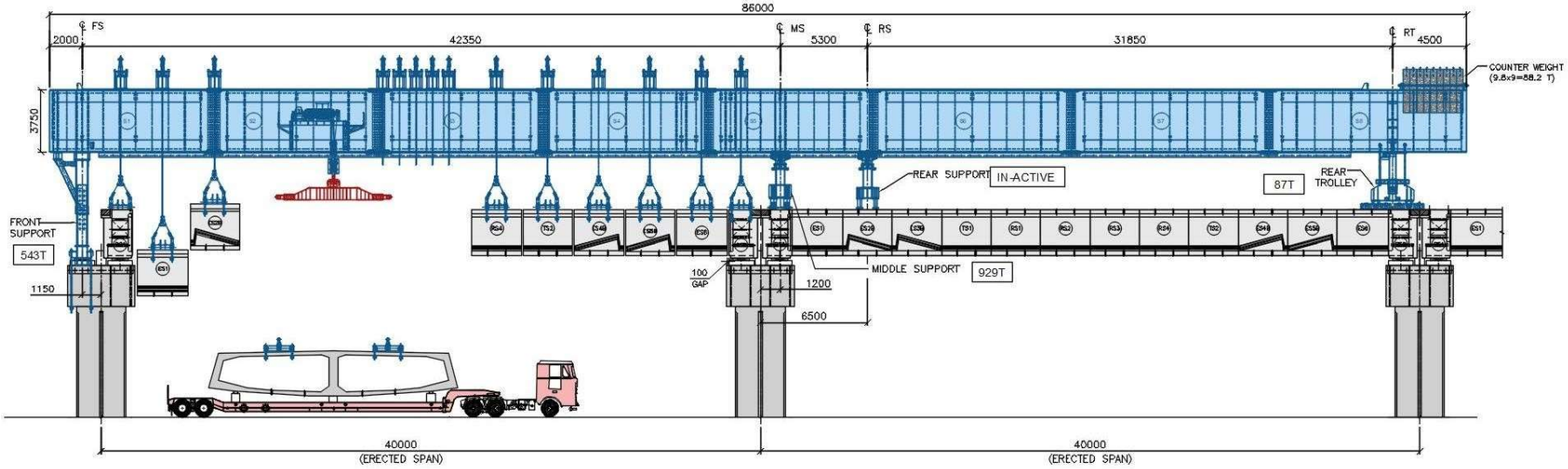
1. Repeat steps 2 & 3 for segments covering approximately half the span
2. Hang the Segment DS1 by vertical suspender on Sliding beam
3. Detach the Strongback from Segment DS1
4. Position the Segment DS1 over Piercap by using sliding beam



Segment Erection

Stage 5:

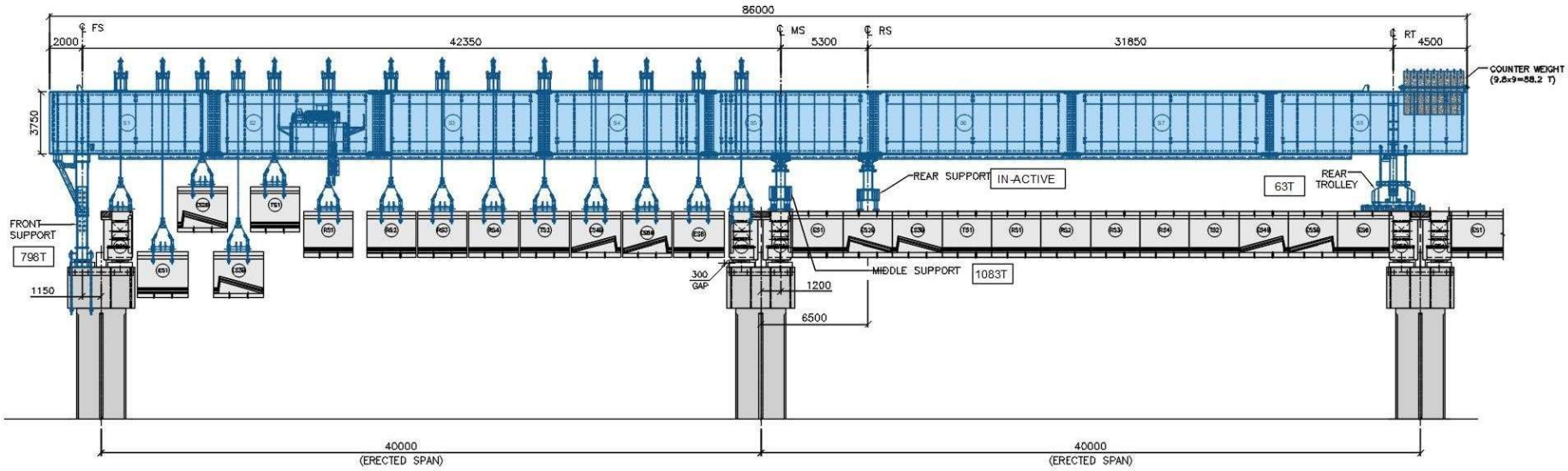
1. Hang the Segment ES1 by vertical suspender on Sliding beam
2. Detach the Strongback from Segment ES1
3. Move the Segment ES1 by slider beam near Segment DS1 as shown
4. Similarly hang the Segment ES2B by vertical suspender on sliding beam
5. Lift the Segment ES2B by suspender bar so that Segment is parked over Segment ES1 as shown



Segment Erection

Stage 6:

1. Similarly erect the remaining Segments by repeating step 5
2. Dry matching shall be done Segment by Segment
3. Now create 300mm gap between DS2 and ES6 for applying epoxy glue between Segments



Epoxy Gluing of segments

Hand application of Epoxy Glue

Appearance of Epoxy Glue after temporary prestress

Epoxy Gluing of segments - Issues

1. Two component material – Epoxy resin and Hardener – requires mixing prior to application
2. Has a setting time between 30 minutes to 50 minutes, which starts as soon as the mixing is completed
3. If area coverage is large there needs to be adequate manpower.
4. The Application must be on both faces and completed within approximately 15 to 20 minutes so that the epoxy is still significantly workable
5. Application of temporary prestressing must be completed within the next 5 to 10 minutes.
6. When segment heights are more than 2.0 meters then there must be safe access arrangement to all parts of the cross section.

Epoxy Gluing of segments - Consequences

Good work leads to

1. a uniform load transfer between the segments and achieves the design intent
2. Fills up all the crevices at the cement grout leakages at the segment joints

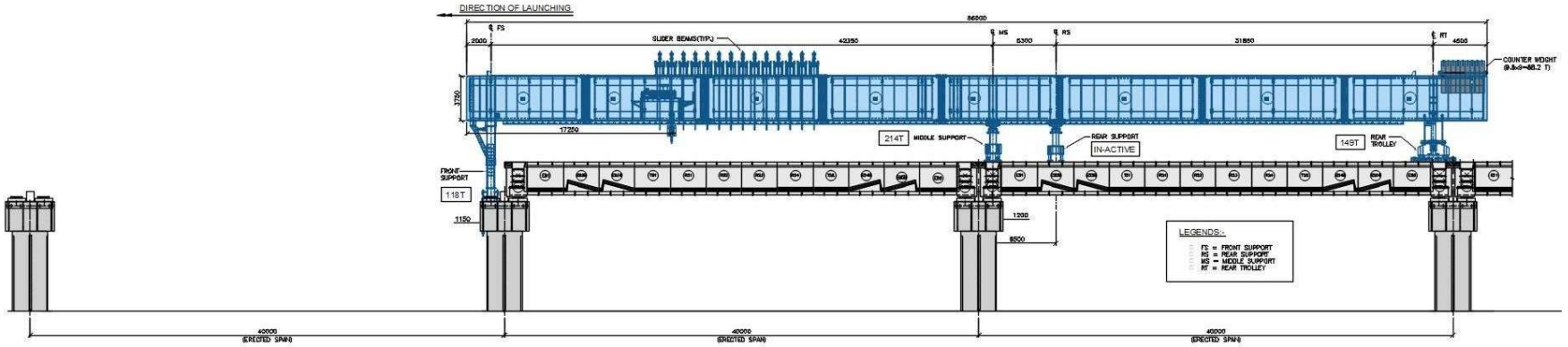
Poor work leads to

1. Loss of match-cast interface
2. Presence of weak pockets of concrete where it does not fill up the crevices due to cement grout loss.
3. Leads to serious problems of stress concentration and hard points created due to partly set patches of epoxy.
4. Acts as a trigger for local crushing of concrete.

Auto-launching of the Assembly girder

Stage 1:

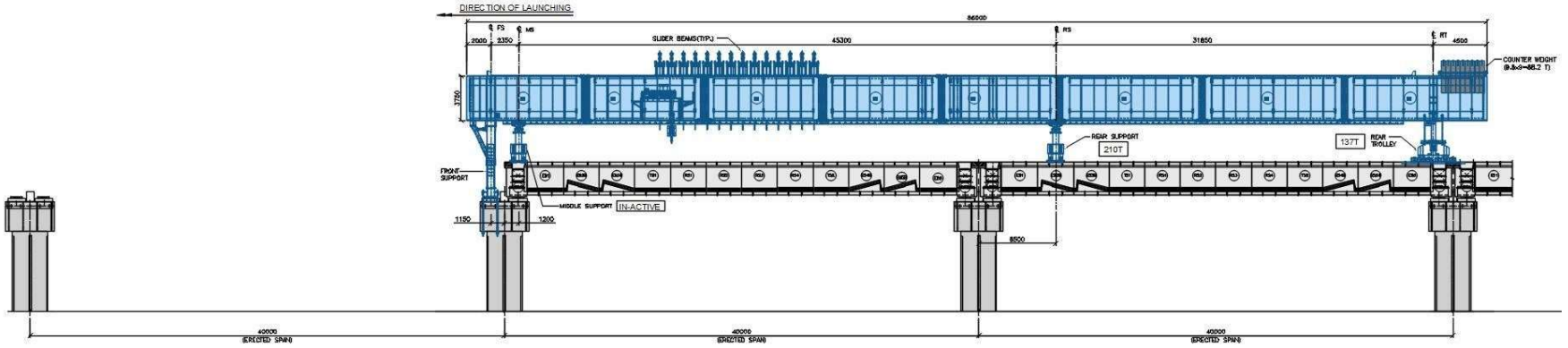
1. Erection of span is completed in all respects and launching girder is ready for Auto launching
2. All the supports are anchored with anchor bars



Auto-launching of the Assembly girder

Stage 2:

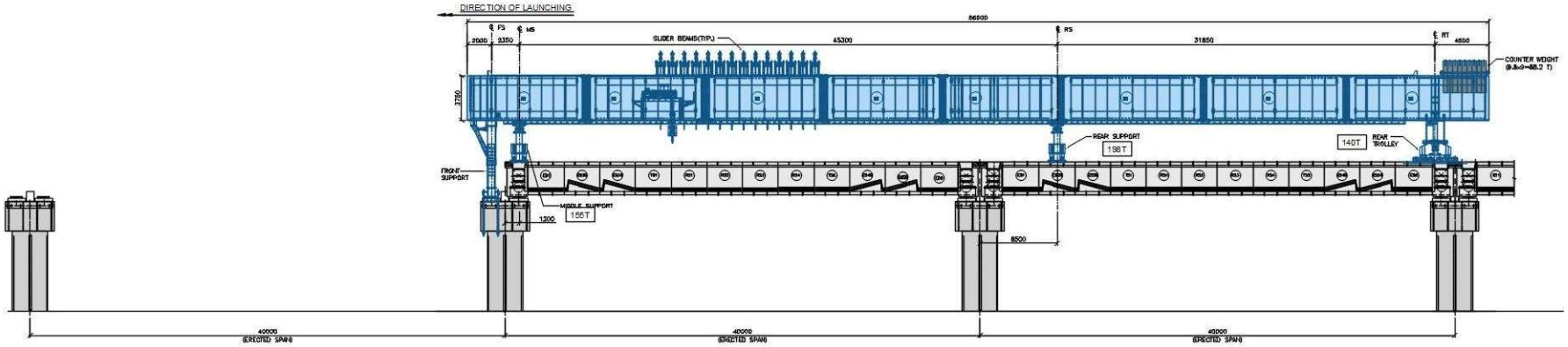
1. Close the jack of middle support so that load is transferred to the rear support; Middle support is free to move
2. Move the middle support to Segment DS1 as shown



Auto-launching of the Assembly girder

Stage 3:

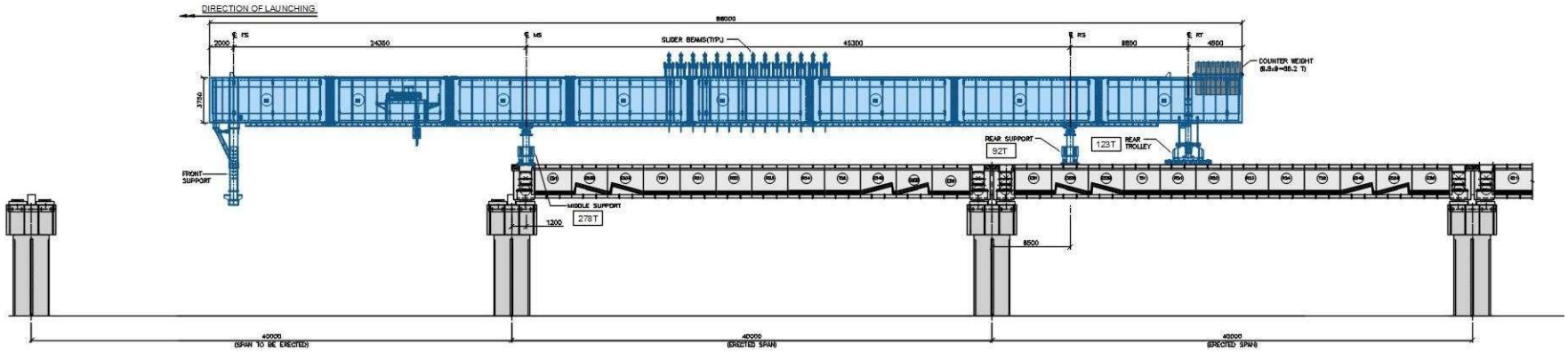
1. Anchor and activate the middle support with anchor bars stressed to induce initial tension of 2 to 5 tonnes per anchor
2. Raise the telescopic leg of Front support so that load is transferred to Middle support
3. Remove the anchors of Rear trolley



Auto-launching of the Assembly girder

Stage 4:

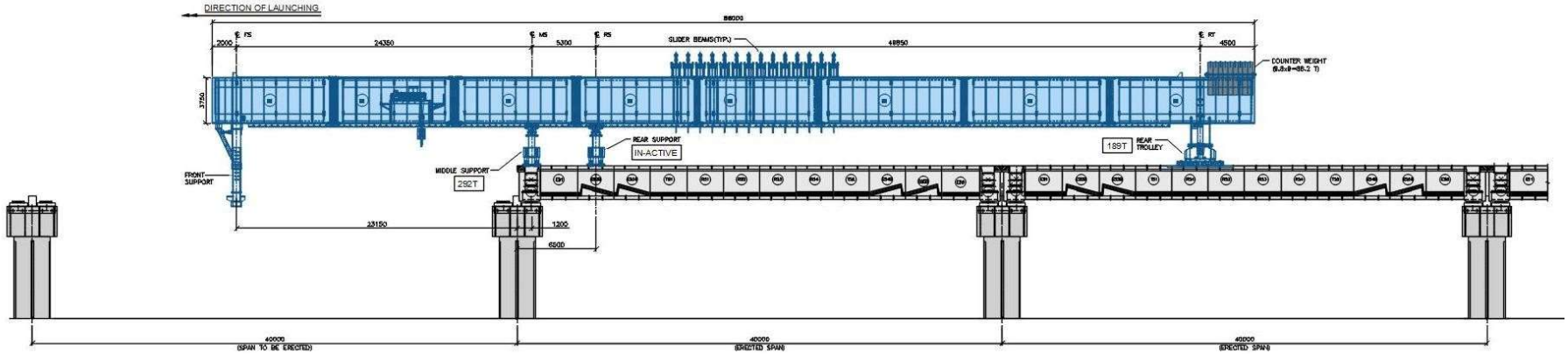
1. Start Auto launching with the help of Push/Pull jacks installed at middle support to launch the launching Girder forward
2. Auto launch the launching girder by 22m as shown



Auto-launching of the Assembly girder

Stage 5:

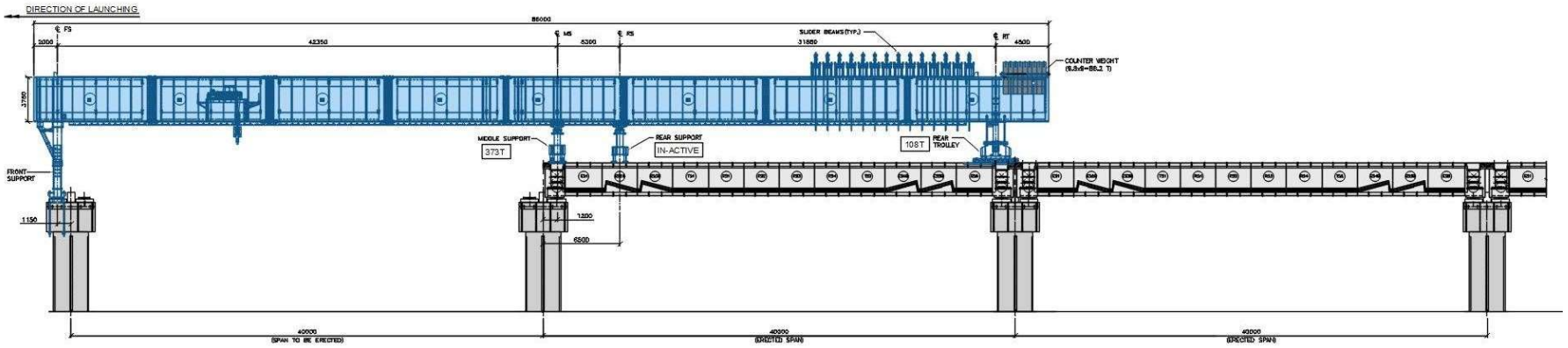
1. Shift the Rear support near Middle support as shown



Auto-launching of the Assembly girder

Stage 6:

1. Move the sliders as shown to the rear end as shown
2. Complete Auto launching until the Front support reaches its final position as shown
3. Open the telescopic leg of front support to activate it

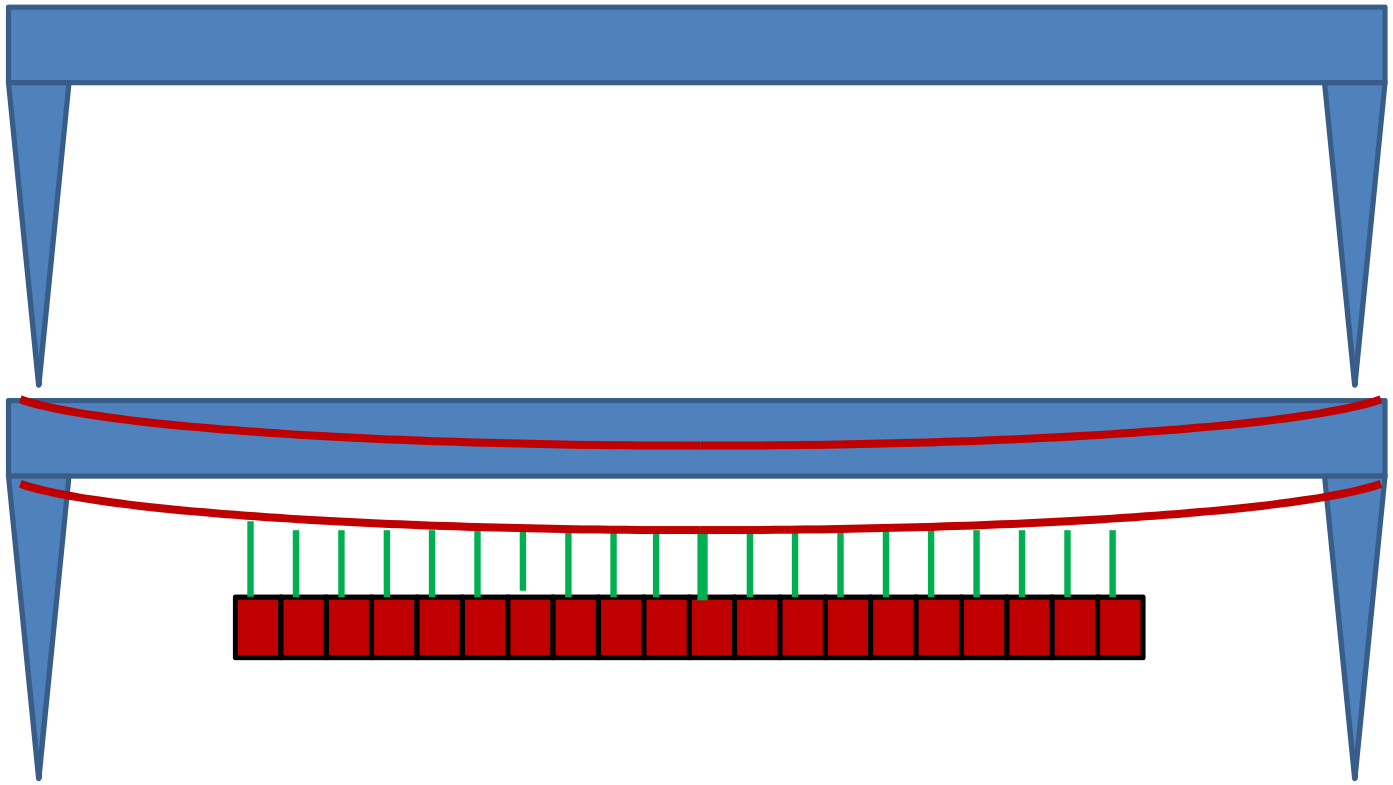


Co-relation with design

This aspect is significantly covered by the three major activities viz.

1. Match-casting
2. Epoxy Gluing
3. Sequence of prestressing

Sequence of prestressing



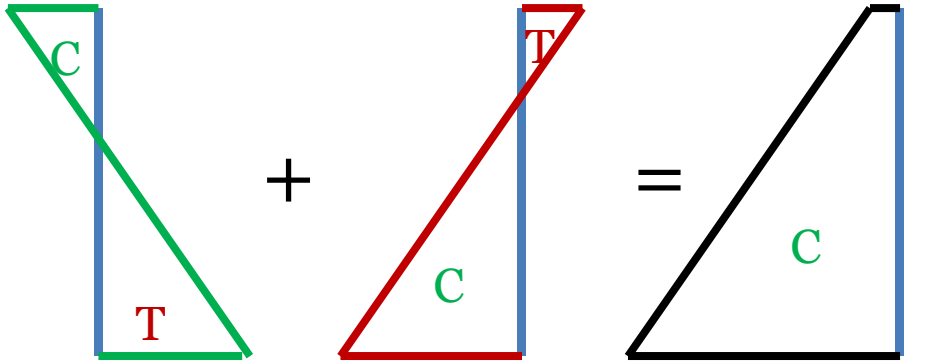
Fundamental Assumptions

1. Stiffness of the Assembly Girder is much lower than that of the Precast segmental superstructure
2. Deflection of the launching girder under segment loads is inevitable

Sequence of prestressing

Factors to be remembered

1. For identical loads the deflection of the permanent structure will be approximately 40 % of that of the Assembly girder
2. Therefore, the mobilization of the self-weight onto the permanent structure will not be 100% due to prestress alone.
3. If 100% prestress is done without mobilization of the full weight on to the permanent structure then the top joints will open out
4. No tension is permitted for segmental construction at any stage



DEAD LOAD STRESSES

PRESTRESS EFFECTS

TRANSFER STAGE EFFECTS

Sequence of prestressing

Actions to be taken

1. In the first stage stress only as many cables as are necessary to sustain dead loads without any tension
2. Mobilize the entire dead loads on to the permanent structure now by either lifting the whole structure bu span jacks or by sequentially releasing the suspenders from the midspan towards the support
3. Carry out the remaining stressing while on the span jacks/permanent bearings