



Van Brienenoordbrug T&I operaties



Description of exchange method



Overview of Exchange Method

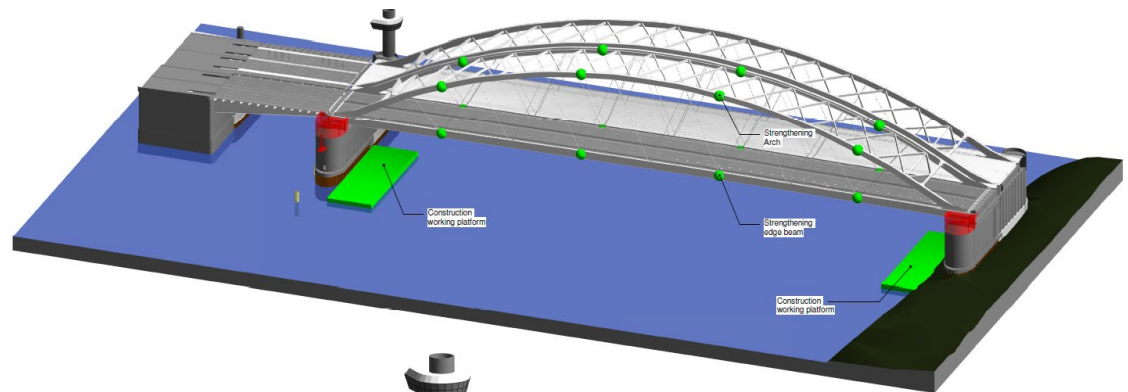
- Two barges with four jacking towers on each barge raise the bridges
- Barges are then moved in a controlled manner using winches, tugs and associated mooring lines to bring each bridge clear of the piers.
- Each bridge is then parked at a mooring point in the Nieuwe Maas
- It is then jacked down in two stages to a lower level to allow transportation to a fabrication yard where WBBb shall be renovated.





Stage 1 - Enabling Works – Pier Top Works and Strengthening

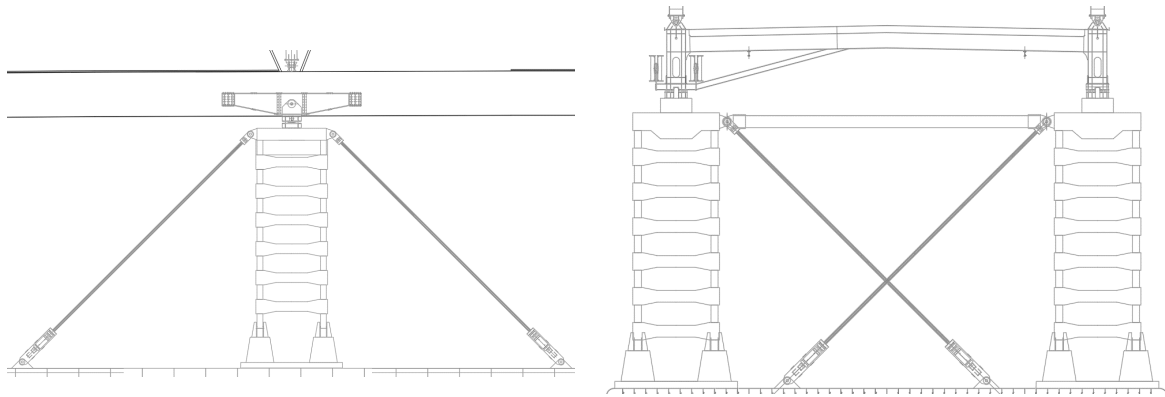
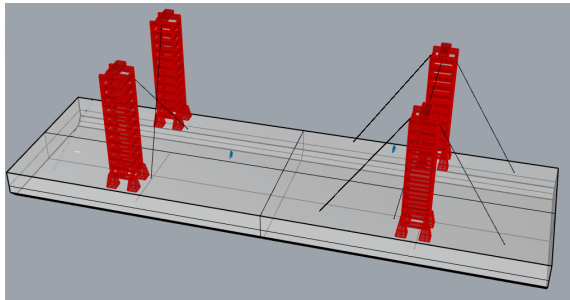
- Barge set up for use as working platform positioned adjacent to Pier 10
- Install temporary piles, sheet piles and fender system at Pier 9 to provide longitudinal restraint to the barges.
- Shorten radar to allow for float in/out and removal of concrete on west prow
- Install steelwork for strengthening of main girder at barge support locations
- Prepare connections to receive props and support points.
- Cutback inspection walkway between bridges at deck level and replace with temporary platform. Provide temporary edge protection on OBBb.
- Install horizontal guide system on piers to ensure controlled vertical jacking operation.





Stage 2 – Enabling Works – Barge Control and Jacking Tower Systems

- Construct jacking tower systems on barges away from site location.
- Install Strand Jack system to restrain the jacking tower systems longitudinally (at 2 locations) and transversely (at all locations).
- Construct temporary dolphins required for mooring arrangement.
- Perform required dredging at Pier 9 to ensure minimum 500mm underkeel clearance during swap Off/On.
- Manoeuvre spacer barge adjacent to Pier 10

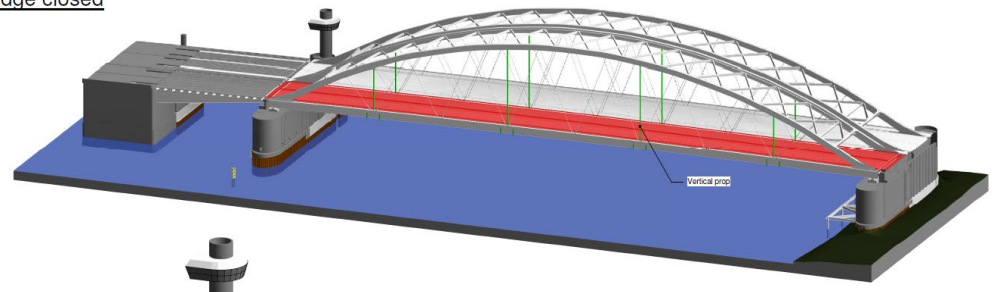




Stage 3 – Preparation for Float Off

- Remove asphalt, barriers and deck movement joints.
- Cut back end of deck at north end to provide 500mm clearance to existing structure for float off.
- Disconnect utilities and drainage.
- Finish reinforcement of edge girders above deck (if required).
- Install props in arch.

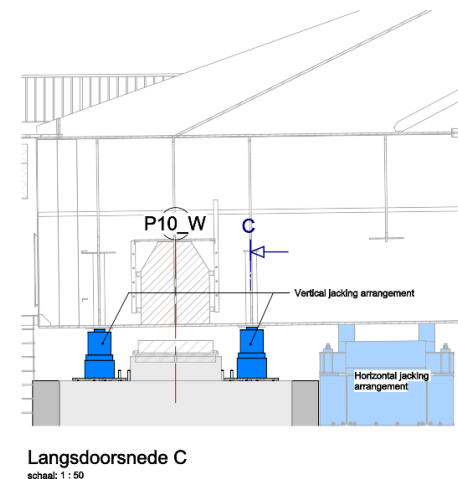
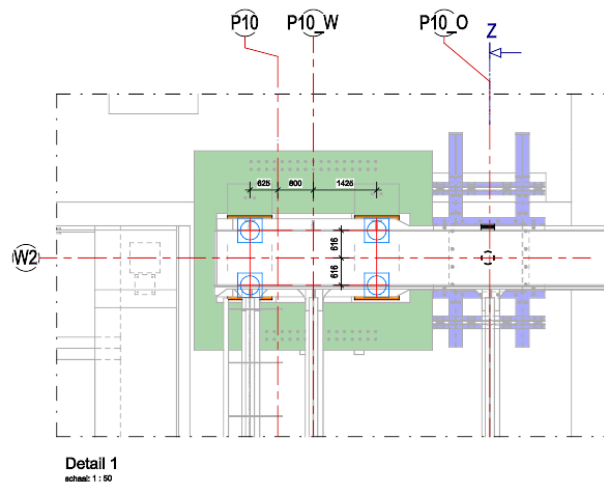
Stage 3 - bridge closed





Stage 4 – Jack WBBb to Release from Bearings

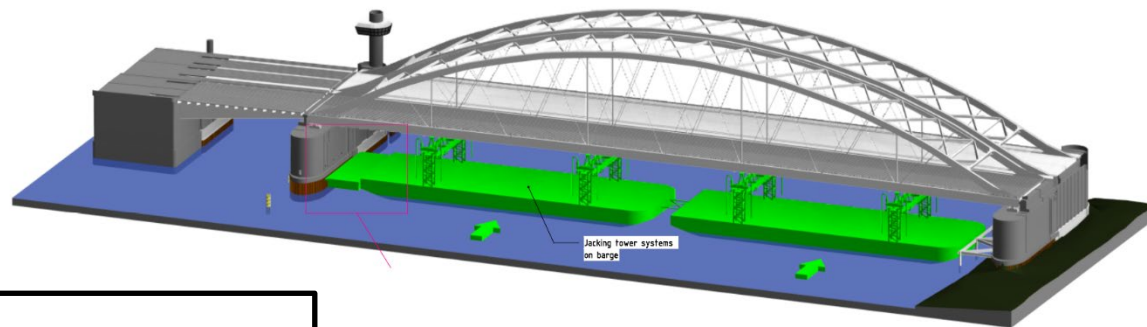
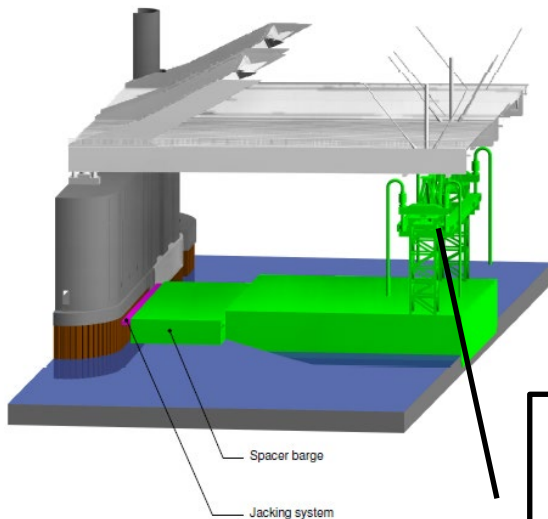
- Release existing bearing fixings.
- Jack up the WBBb using 4 No. short stroke jacks at all 4 pairs of existing jacking points to ensure that deck is not seized to existing bearings.





Stage 5 – Position Barges beneath WBBb

- Manoeuvre barges into position under WBBb at low tide.
- Spacer barge positioned between barge system and Pier 10.
- Jacking system between spacer barge and Pier 10 to provide close control of longitudinal position of barges.

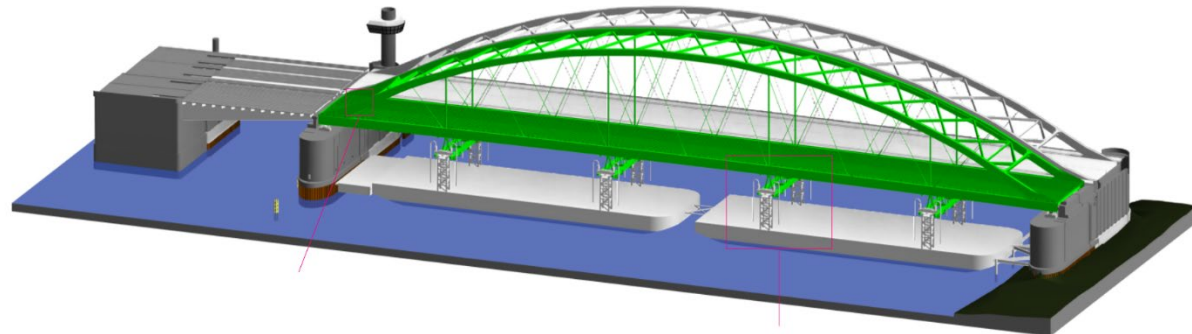


Jacking system from Reference Design shown in these images.



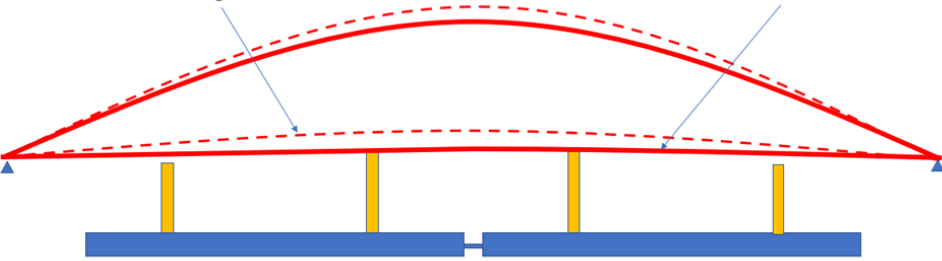
Stage 6 – Engage Jacking Tower System and Lift Off

- Raise Jacking Tower system with appropriate levels for inner and outer towers for final situation. (barges to be horizontal at the start)
- On rising tide engage jacking tower system with deck edge girders.
- De-ballast barges to pick up weight of WBBb. (during deballasting the barges will pitch but should revert to horizontal at end of pick-up)



Profile at point of lift off from bearings

Start of pick-up profile

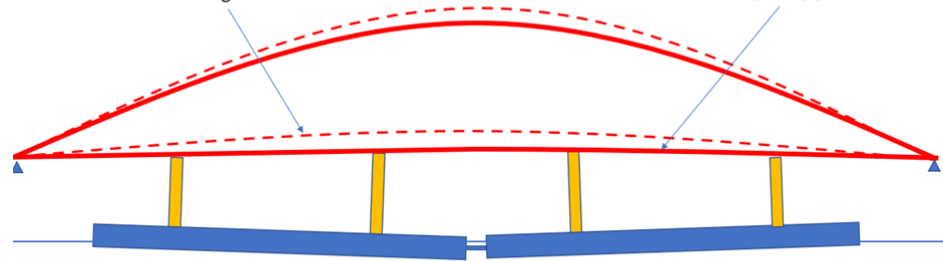


Beginning of Pick-Up:

- Barges horizontal with equal ballasting over barge area
- Top of tower support point profile parallel with point of lift-off soffit profile

Profile at point of lift off from bearings

Start of pick-up profile

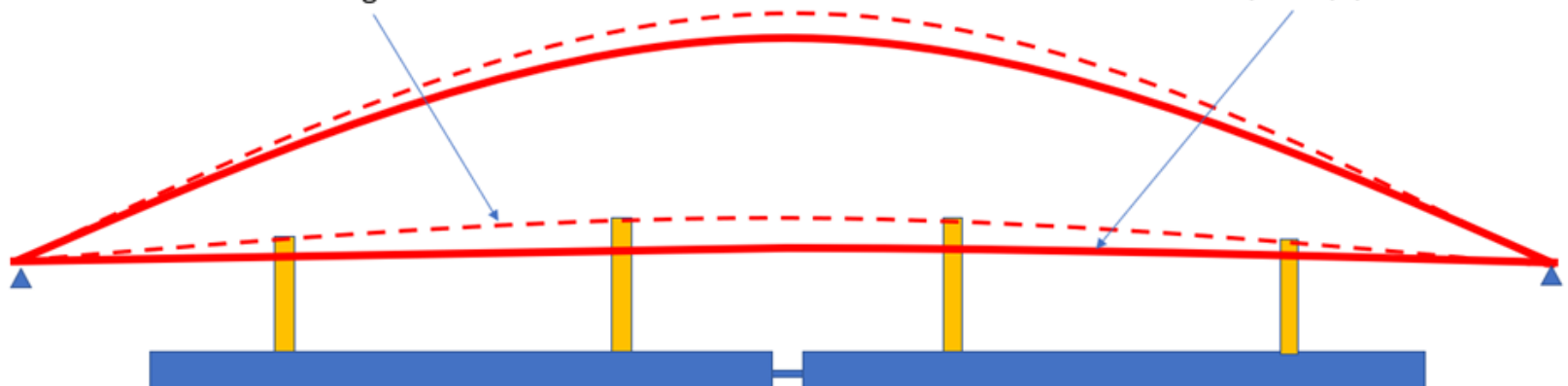


Pitching of Barges during Pick-Up:

- Barges will pitch as initial de-ballasting occurs and barge is eccentrically loaded by inner props
- Magnitude of imbalance in load between inner and outer props has not been calculated.
- The peak imbalance will occur at point at which outer props engage.
- In the event that bending stresses are too high with even ballasting applied, the pitch of the barge can be created without loading the structure by using uneven ballasting initially.

Profile at point of lift off from bearings

Start of pick-up profile



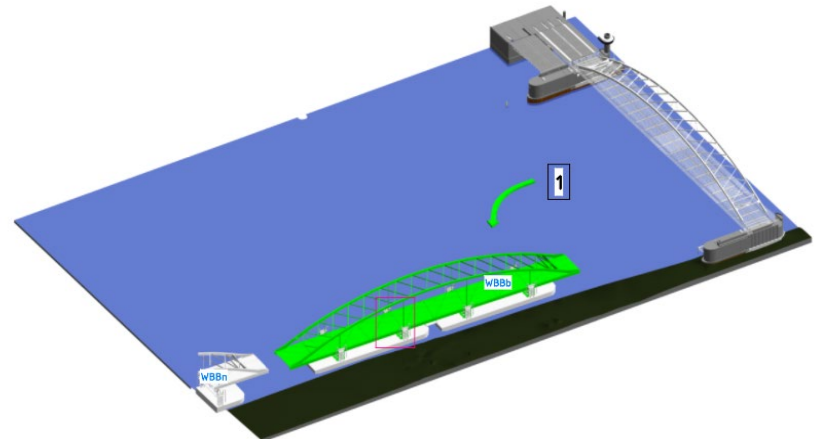
End of Pick-Up:

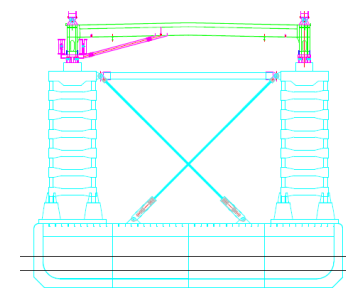
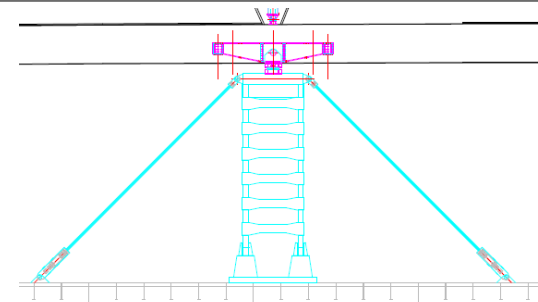
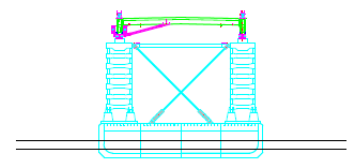
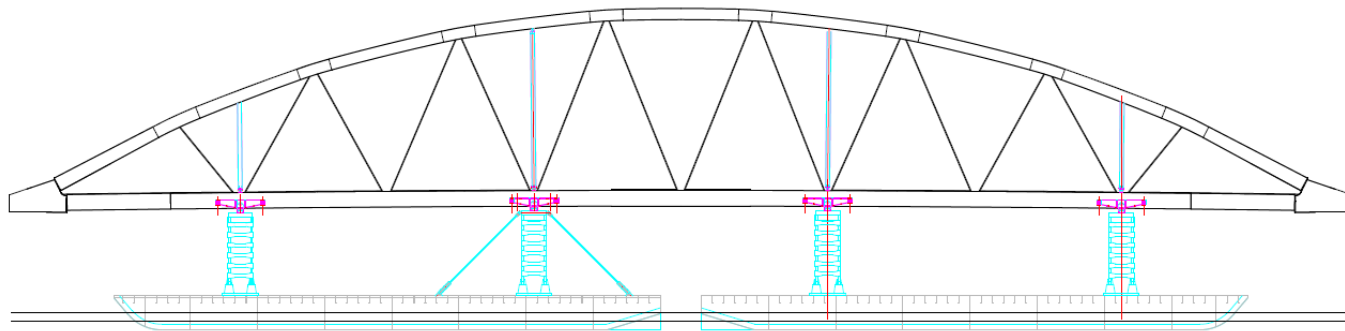
- Barges horizontal with equal loads applied and equal ballasting over barge area
- Top of tower support point profile defined by deflection of soffit by equal loads



Stage 7 – WBBb Float Off

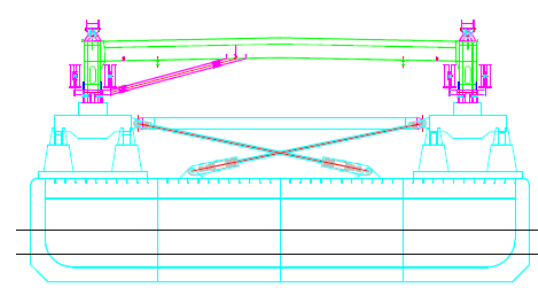
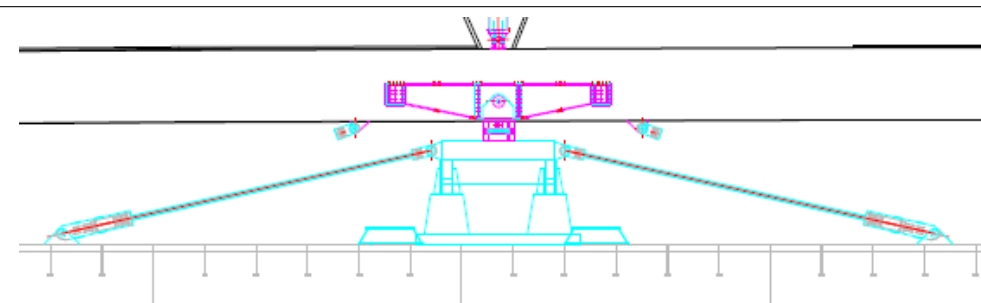
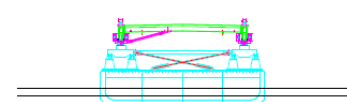
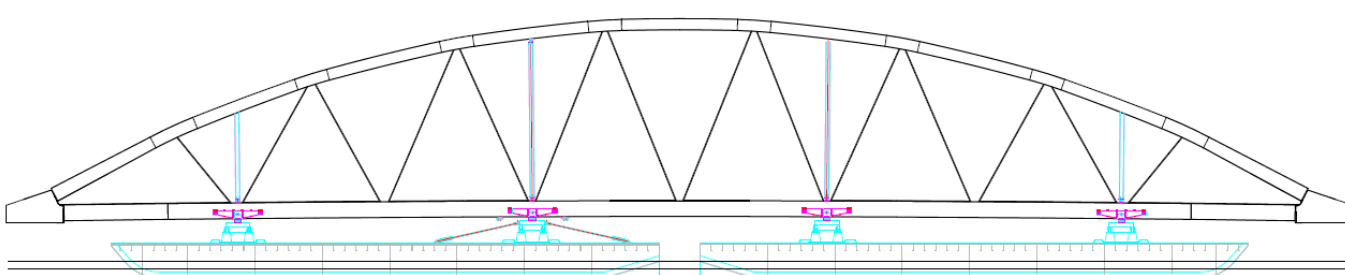
- Release tight restraint in spacer barge jacks.
- Tug/winch barges with WBBb clear of supports.
- Transport the bridge away to the mooring area near the site location so that the path for the WBBn to be floated on is not obstructed.
- Jack down on jacking tower system to minimum height of tower system
- Transfer Strand Jack connections from jacking tower to bridge
- Secondary jacking down process onto yoke and transfer beams using jack and pack system to minimum clearance to deck (approx. 500mm)



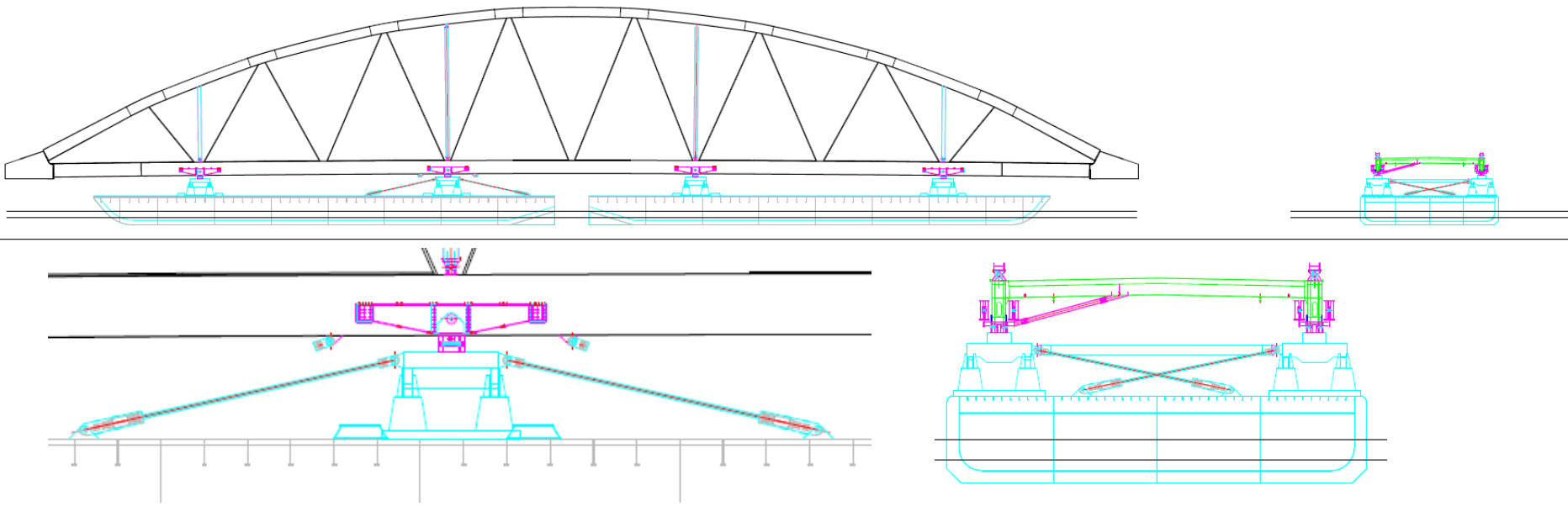


Float
Weather Window

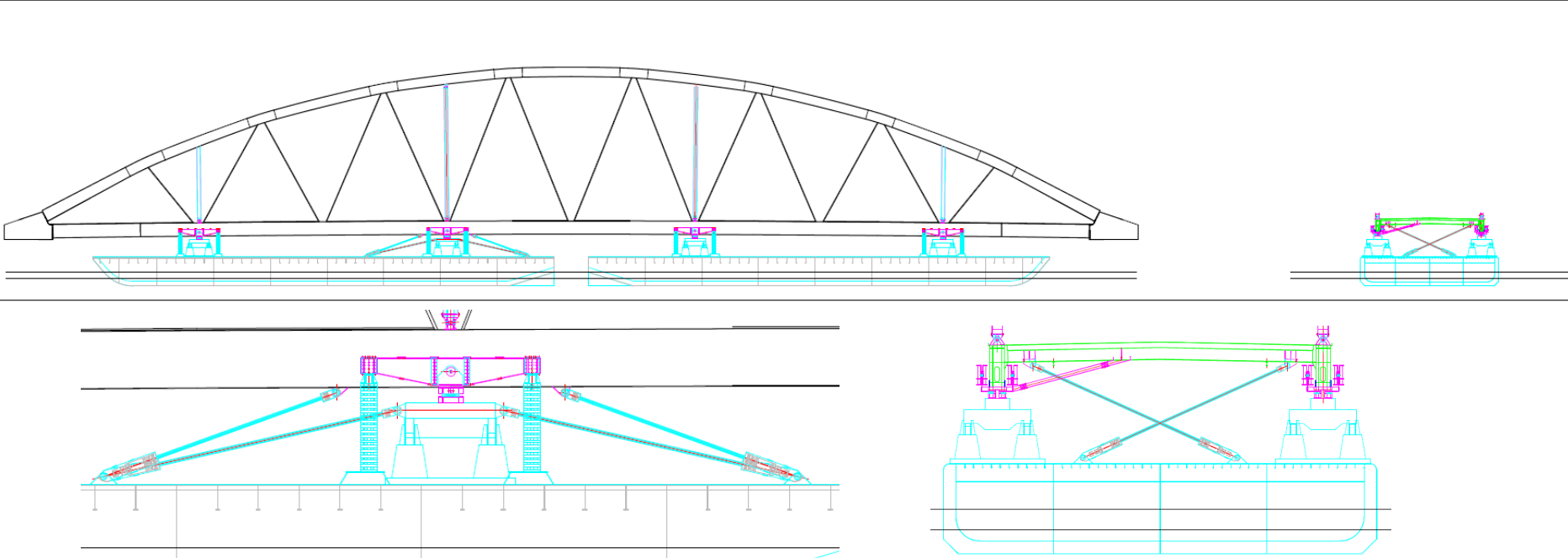
Jack down on jacking tower system to minimum height of tower system

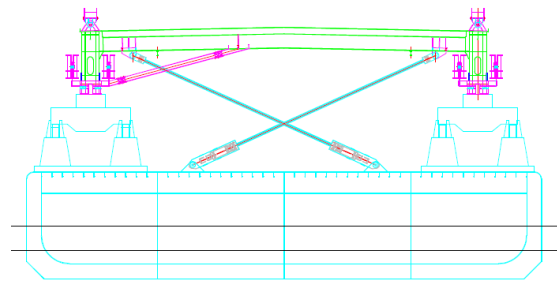
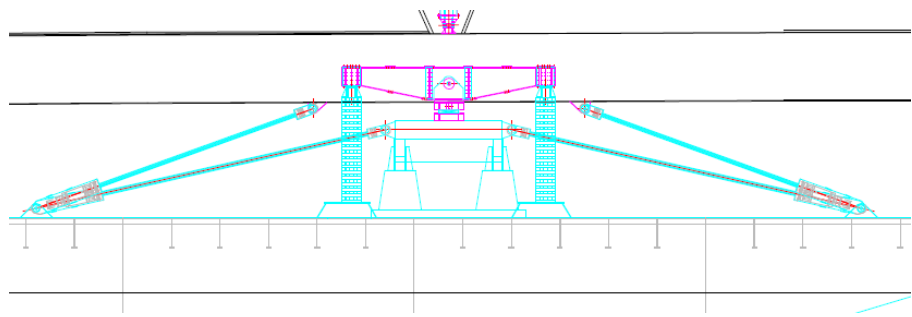
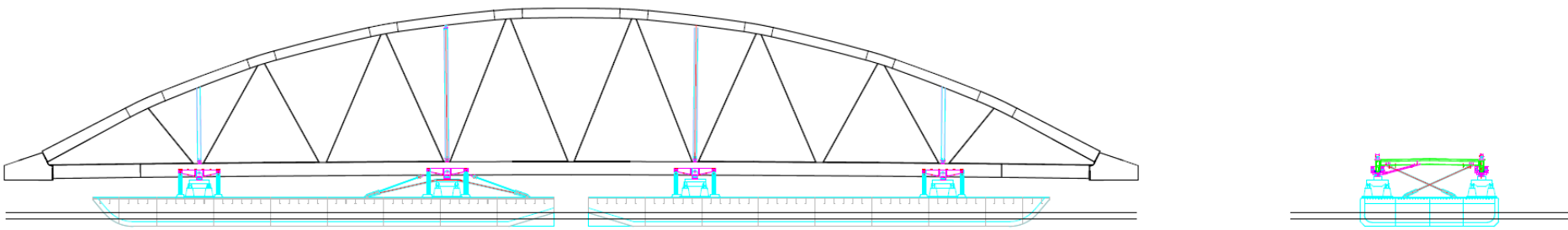


Parked
No Weather
Window

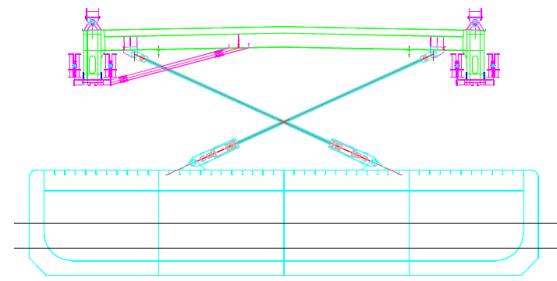
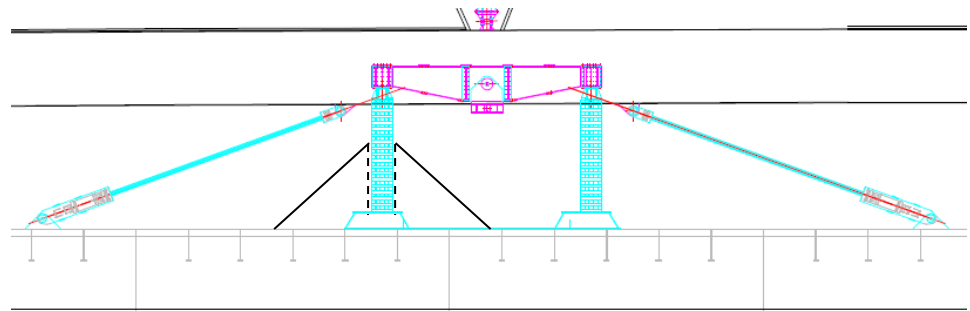
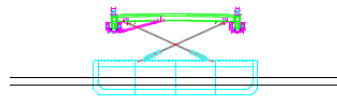
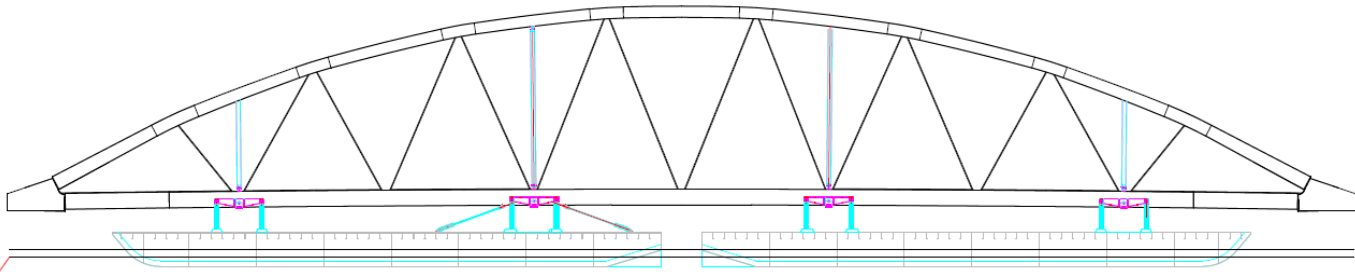


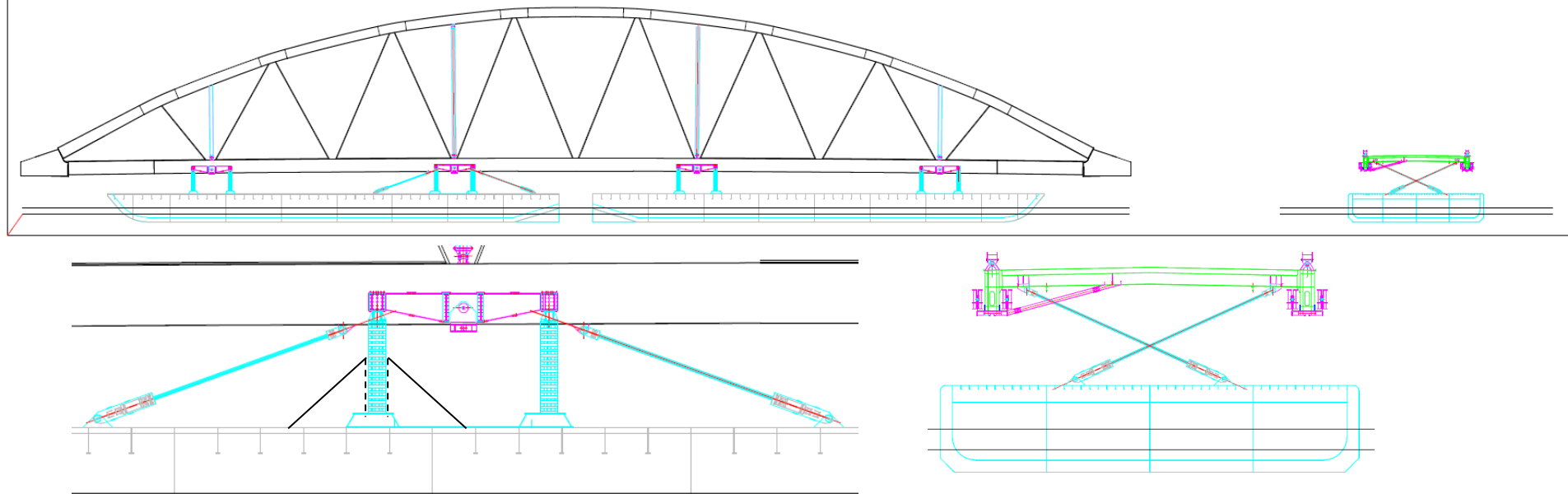
Transfer Strand Jack connections from jacking tower to bridge



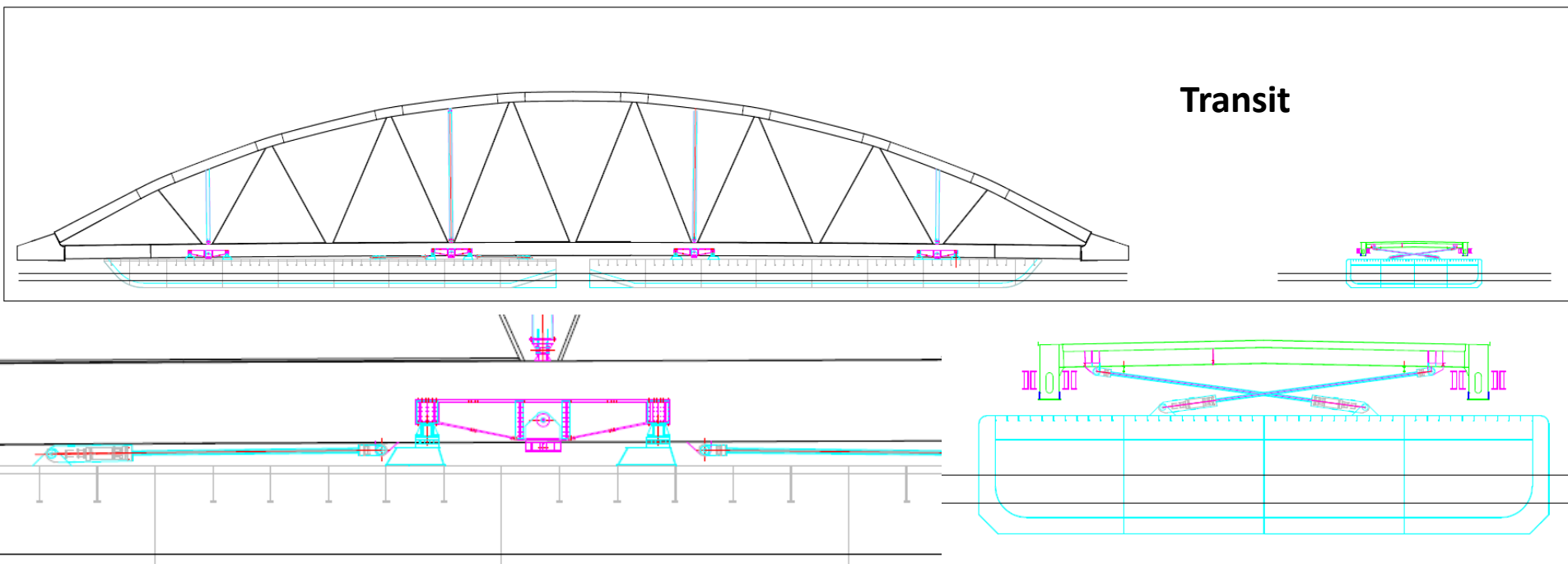


Secondary jacking process onto yoke and transfer beams using jack and pack system





Jacking process down to minimum clearance for transit



Transit

Table 5: Design situations for existing bridges.

Temporary stage (from Section 2.2)	Design Situations
Initial pick-up	Float Off – bridges fully supported on jacking towers at full height, with appropriate restraints provided
Float Off	
Lowering to 'jack and pack' supports	Parked – bridges supported at jacking tower base height, with same restraints as Float Off
Transit Preparation	
Supported on barge deck (Transit)	Transit – bridges supported at jacking tower base height with appropriate restraints

Table 6: Design situations for new / renovated bridges.

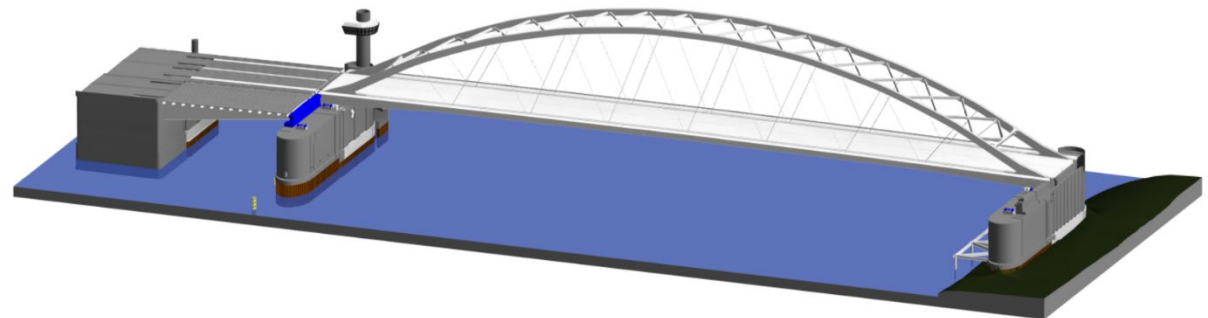
Temporary stage (from Section 2.2)	Design Situations
Supported on barge deck (Transit)	Transit – bridges supported at jacking tower base height with appropriate restraints
Lifting from barge deck to allow installation of jacking towers	Parked – bridges supported at jacking tower base height, with same restraints as Float On
Raising to full height	
Float On	
Lowering on to piers	

Stage No.	Location	OF. Conditions	Wind Conditions	Supports	Bridge Height	Long. Strand Jack Position	Tran. Strand Jack Position	Bearing Shear Connection	Duration	Weather Window
1	Float Off	Site Specific	Float (site)	Jacking Tower	High	Jacking Tower	Jacking Tower	Yes	Days	Yes
2a	Parked	Transit (Head-On & Quartering)	Parked (site)	Tower Base	Mid	Jacking Tower	Jacking Tower	Yes	Weeks	No
2b	Parked	Transit (Head-On & Quartering)	Parked (site) Limited	Tower Base	Mid	None	None	Yes	Hours	Yes
3	Parked	Transit (Head-On & Quartering)	Parked (site)	Tower Base	Mid	Main Girder	Cross-Girder	Yes	Days	No
4	Parked	Transit (Head-On & Quartering)	Parked (site) Limited	Jack & Pack	Mid	Main Girder	Cross-Girder	No	Days	Yes
5	Parked	Transit (Head-On & Quartering)	Parked (site)	Seafastenings	Low	Main Girder	Cross-Girder	No	Weeks	No
6	Transit	Transit	Transit	Seafastenings	Low	Main Girder	Cross-Girder	No	Days	Yes



Stage 8 – Preparation for WBBn Float On

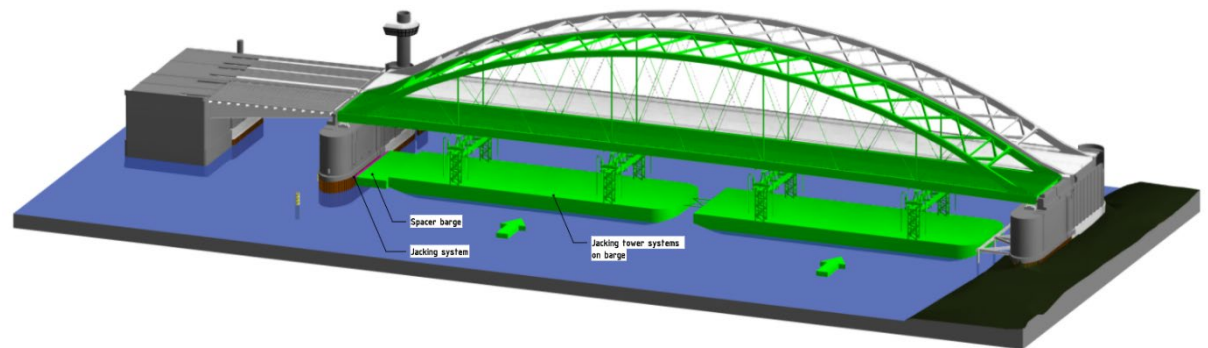
- Complete modifications to bearing plinths and place bearings.
- Install packs on Piers 9 and 10 to receive WBBn
- Replace ‘Evenaar’ beam on Pier 10.
- Jack up WBBn sufficiently to allow jacking tower system to be installed (approx. 5m) using jack and pack process.
- Jack up to full height at mooring position using the jacking tower system.





Stage 9 – Float In WBBn

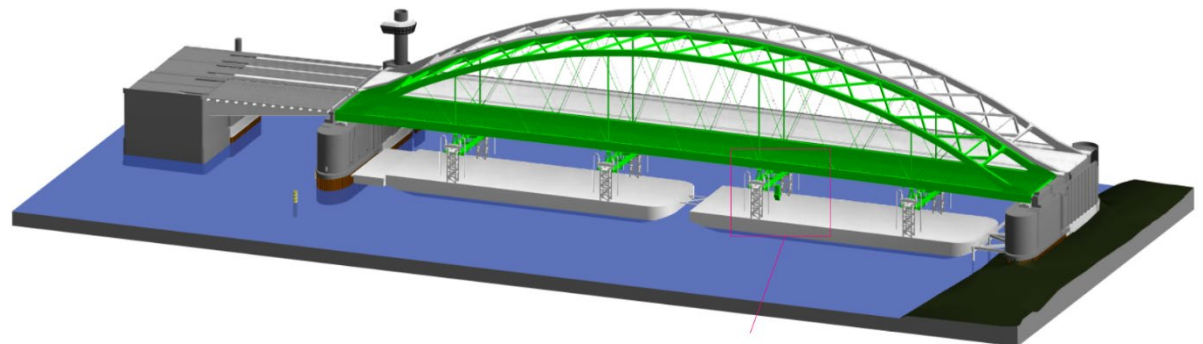
- Using tugs and winches, manoeuvre barges with WBBn into position
- Move spacer barge into position and activate close control jacks.





Stage 10 – Lower and Place WBBn

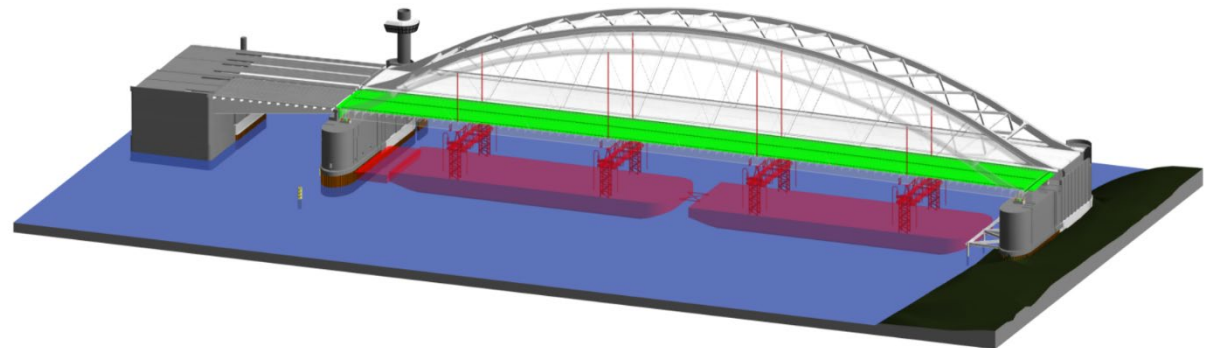
- At high water, ballast barge down and engage with lateral guide systems on bearing shelf.
- Lower towers sufficiently to confirm engagement and support on packs prior to precise setting of bearings.
- Continue ballasting until WBBn is free of jacking tower support system.





Stage 11 – Deck Finishes

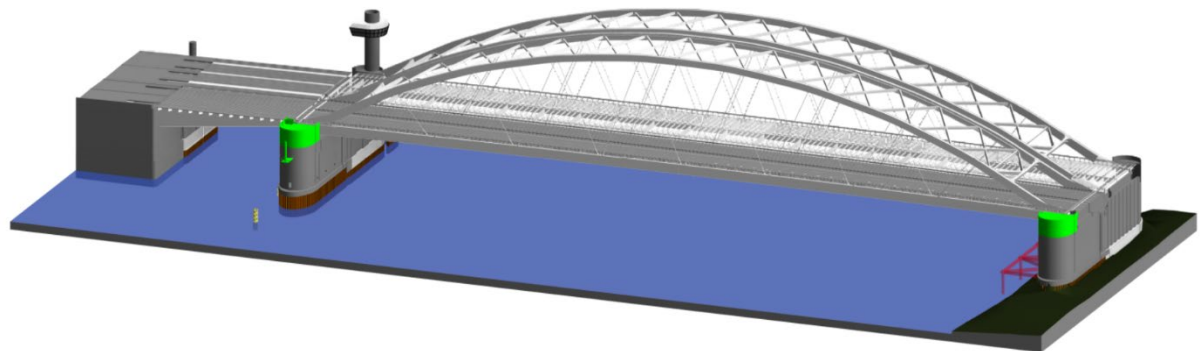
- Remove spacer barges and transport barges.
- Remove temporary props between deck and arch. Paint and make good steelwork at arch connections.
- Align and fix permanent bearings. Transfer load from packs.
- Install movement joints including infill piece at north end of deck.
- Place asphalt, place infill barrier sections
- Connect utilities and drainage





Stage 12 – Temporary Works Removal and Pier Finishes

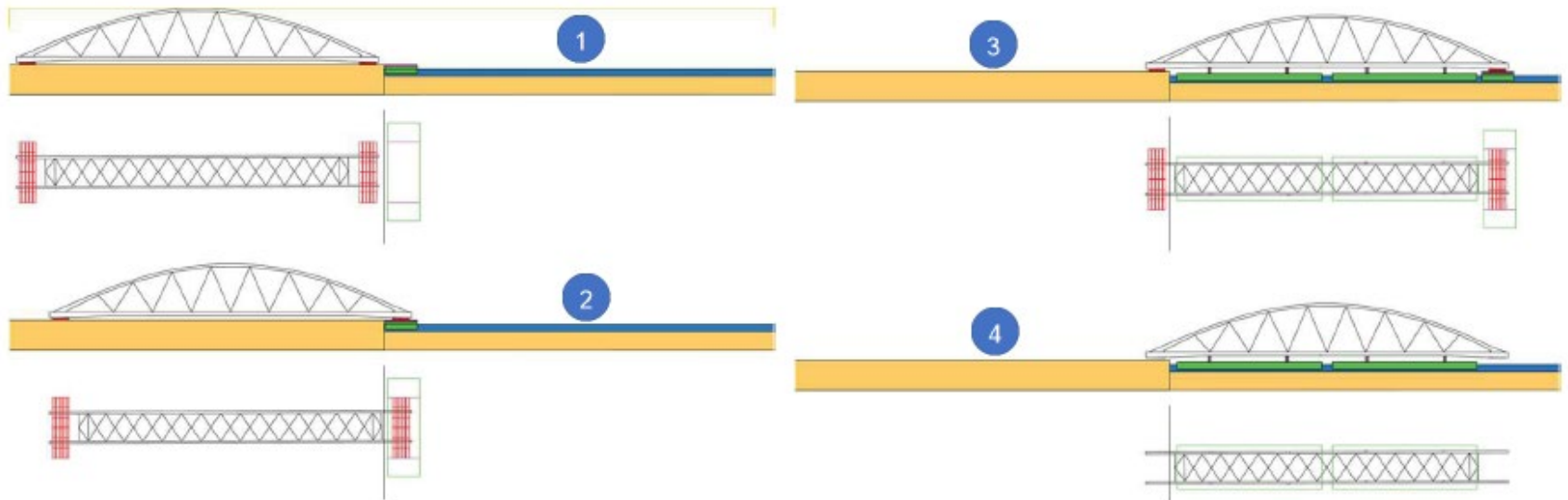
- Finishing works - e.g. paint touchups
- Reinstall piers on concrete piers
- Remove horizontal guide systems
- Remove temporary piles for mooring arrangement
- Remove temporary piles and fender system at Pier 9





Load-in / Load-out

Load-in / Load-out

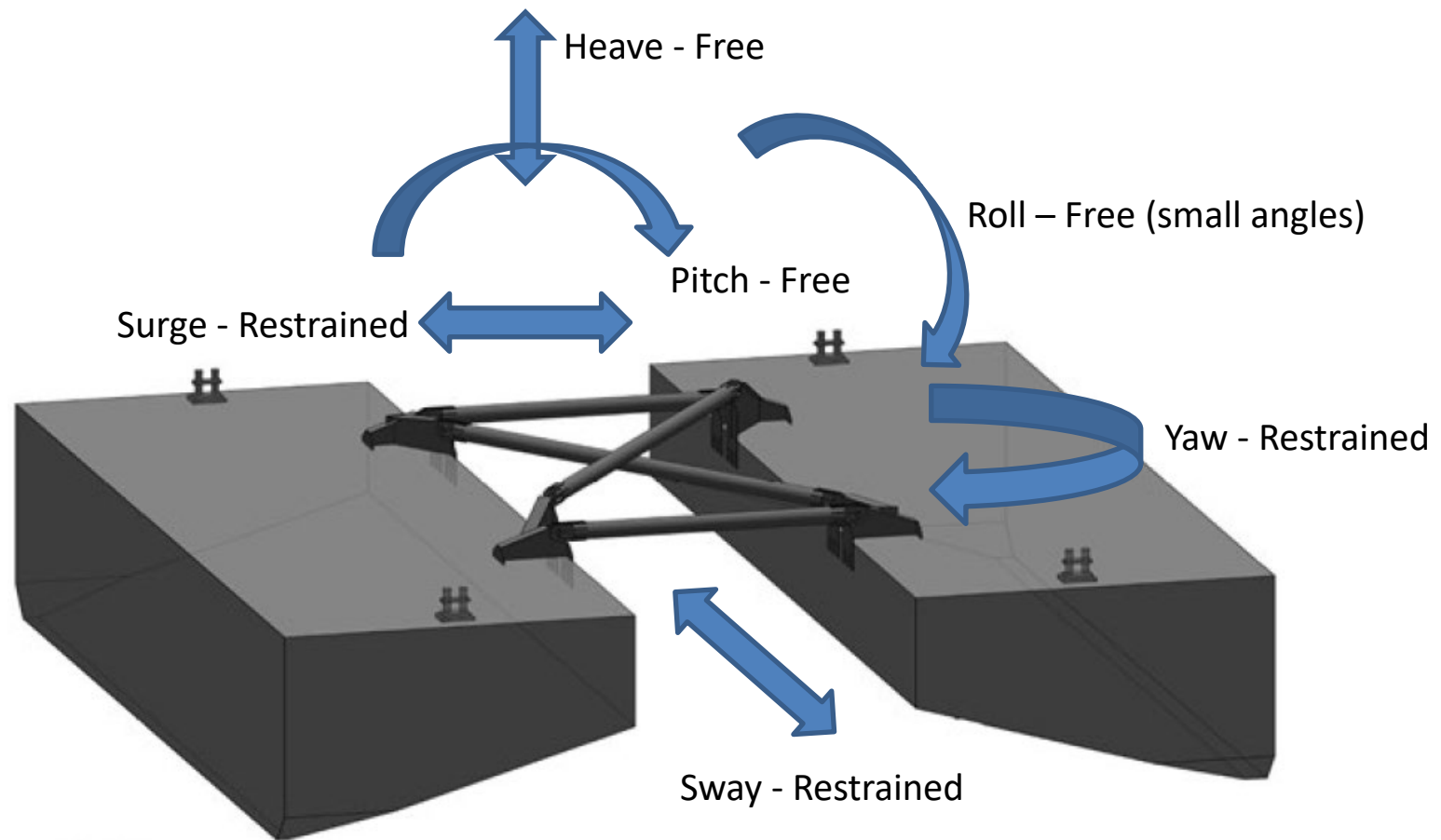


- Step 1: Bridge supported by SPMTs at bearings
- Step 2: Load-out onto barge oriented transverse to bridge axis
- Step 3: Drive bridge out with bridge supported on transverse barge
 - Introduce twin barges, deballast to pick up bridge
- Release SPMT supports, bridge supported for transit



Barge coupling system

Reference design for barge connectors



Design Scenarios

- See Reference Mooring Plan
 - [9V9589-40-GE-00-REFMP-123111.pdf](#)
- OrcaFlex analysis for
 - float-on/float-off
 - Intact
 - Line broken cases
 - Transit around Rotterdam waterways
- Design to EC3
 - Nieuwbouw factors
 - Utilisations ~0.8