10DE BRUGGENDAG BRUG OVER HET VERBINDINGSDOK IN ZEEBRUGGE

16 MAART 2023

SBE

Introduction

Design conditions and concept choice

Fixed bridges and foundations

Swing bridge

ABOUT SBE

- Offices:
  - Sint-Niklaas & Namur (BE)
  - Rotterdam (NL) – Central Station
  - Valencia (ES)
- +200 colleagues

reach out to our experts at play

Joris Meersschaert

Tristan Wolvekamp

INTRODUCTION

DEVELOPMENT OF THE INNER HARBOR (ACHTERHAVEN)

EXTRA CONNECTION BETWEEN ZEEBRUGGE CITY AND THE A11 MOTORWAY

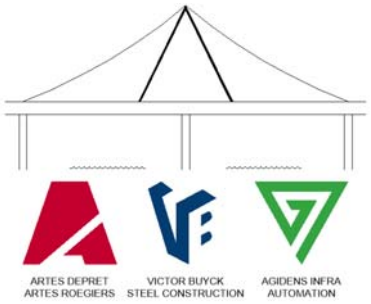
VERBINDINGSDOKBRUG ZEEBRUGGE

Largest movable bridge of Europe (130 m)

Client: MBZ

THV:

- → Contractors: Artes Depret – Victor Buyck – Agidens
- → Design: SBE – Stendess – Demako



TIME SCHEDULE

1. Dialogue and BAFO: January 2019 until December 2019
2. Choice of THV: end of December 2019
3. Start Final Design: March 2020
4. Receiving building permit: September 2020
5. Start construction: October 2020
6. End construction: April 2022
7. Testing and loading test: May 2022
8. Official opening: 22 May 2022

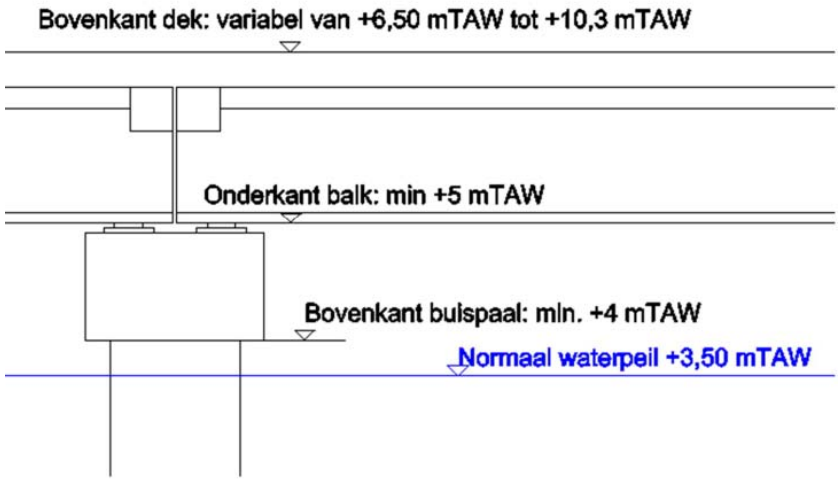
Short completion time!
Only 3 years between start preliminary tender design and opening of the bridge
Execution time on site = 1,5 year

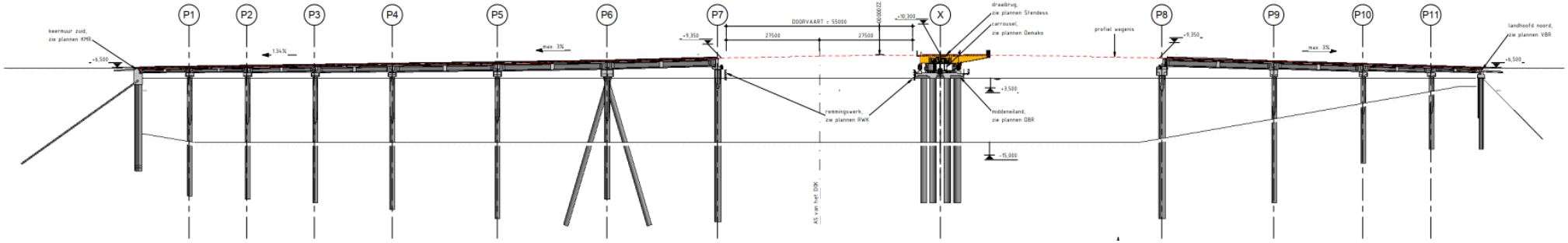
OVERVIEW PROJECT

DESIGN CONDITIONS AND CONCEPT CHOICE: WHY A SWING BRIDGE ?

GEOMETRIC CHALLENGES

- Limited height available due to geometric limitations
- Bottom level canal: -15,0 m TAW (design level -16,0 m TAW)
- Longitudinal slope of the road: maximum 3%
- Unlimited passage height on bridge
- Passage width = 55m and unlimited passage height when bridge is open
- Control and command rooms need to be watertight or above level +5,00m TAW





FUNCTIONAL REQUIREMENTS

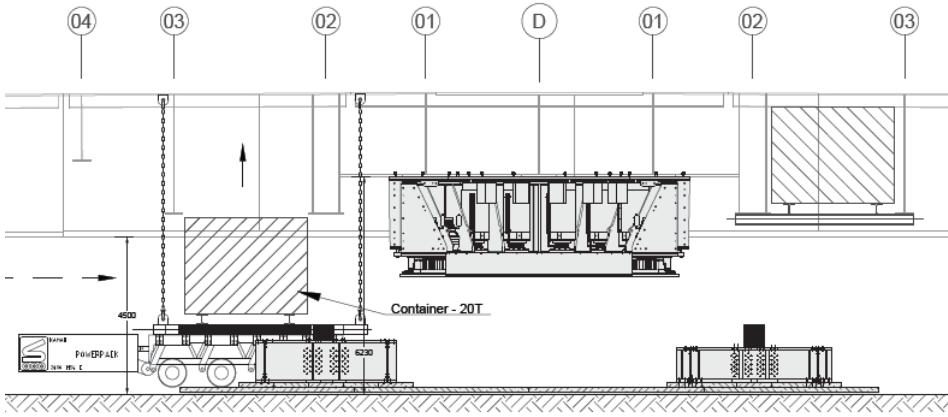
- 2 lanes of 5m + 0,5 m free space, suitable for harbour crane of **500 ton ->**
- Separate bicycle lane 3 m+ 0,5 safety distance at both sides
- Inspection and maintenance must be possible without use of vessels
- Access by a 40 tons crane for all mechanical parts
- During maintenance: always one lane available for traffic. Opening and closing of the bridge must be possible at all times.
- Wind until 9 Bft: opening at normal speed. Wind at 10 Bft: opening at 1/2 speed
- Only expansion joints allowed at the transitions between movable bridge and fixed bridge and between fixed bridge and abutments

WHY A 2-BEAM SWING BRIDGE ?

- Unlimited passage height and width on bridge deck
- Manoeuvrable under storm conditions
- Passage width = 55m and unlimited passage height for ships
- No need for expensive and time consuming basement below water level
- Making it symmetrical reduces length of fixed bridge
- Limited energy consumption

.v. middendeel - Zijzicht

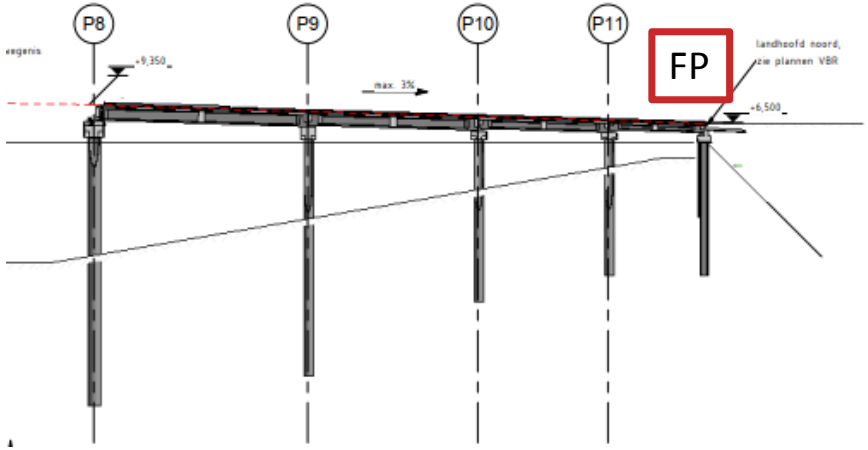
- **Challenge**: dry access to the electromechanical installations for maintenance
  - The Carrousel lifting and turning device avoids hydraulic and electromechanical parts at the bridge tips
  - The extension of the northern pedestrian bridge and stairway connexion to the middle island allows permanent access to the EM installations



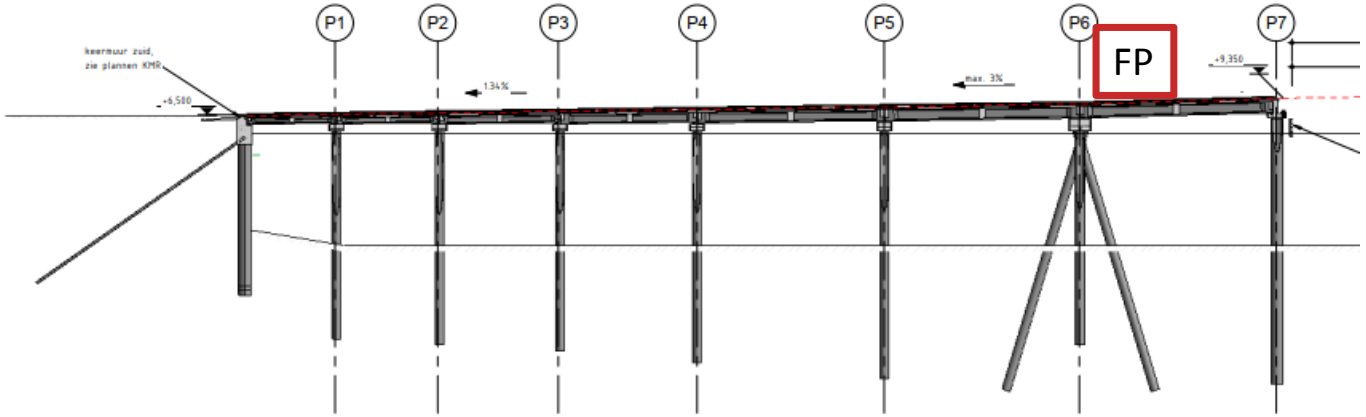
FIXED BRIDGES AND FOUNDATIONS

SUPERSTRUCTURE FIXED BRIDGES

- Two concrete bridges:
  - 170m and 100m length
  - total of 11 spans (14m – 33m) with variable heights to respect the 1,5 m free height between normal water level and bottom side of beams

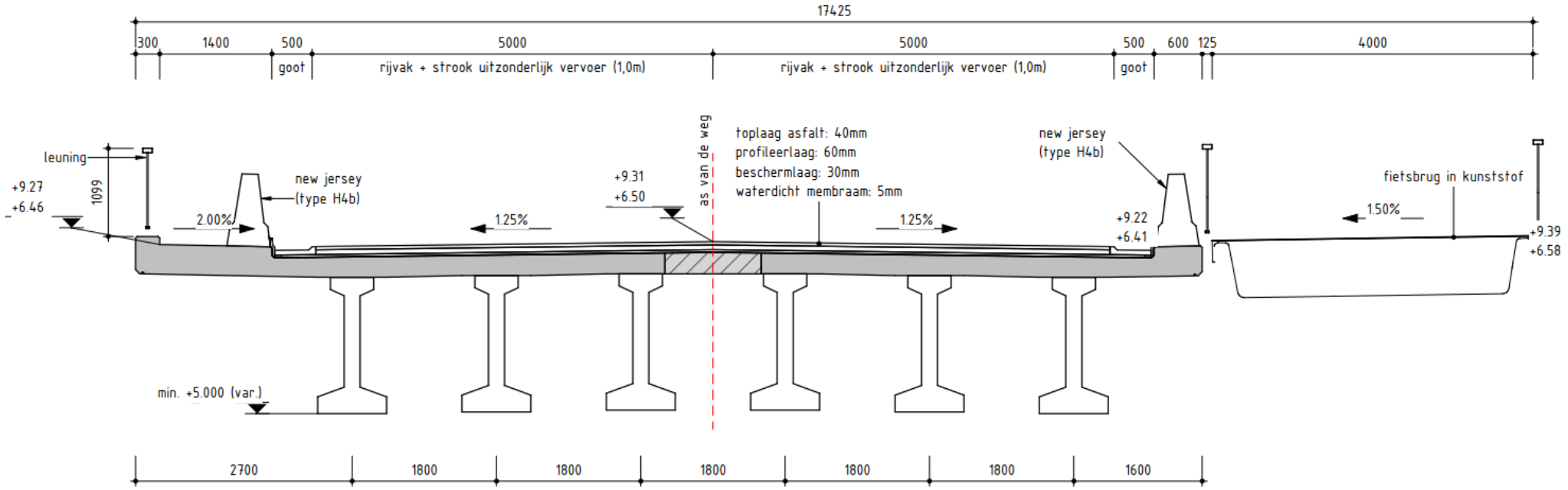


- 1 fixed point (FP) for every



SUPERSTRUCTURE FIXED BRIDGES

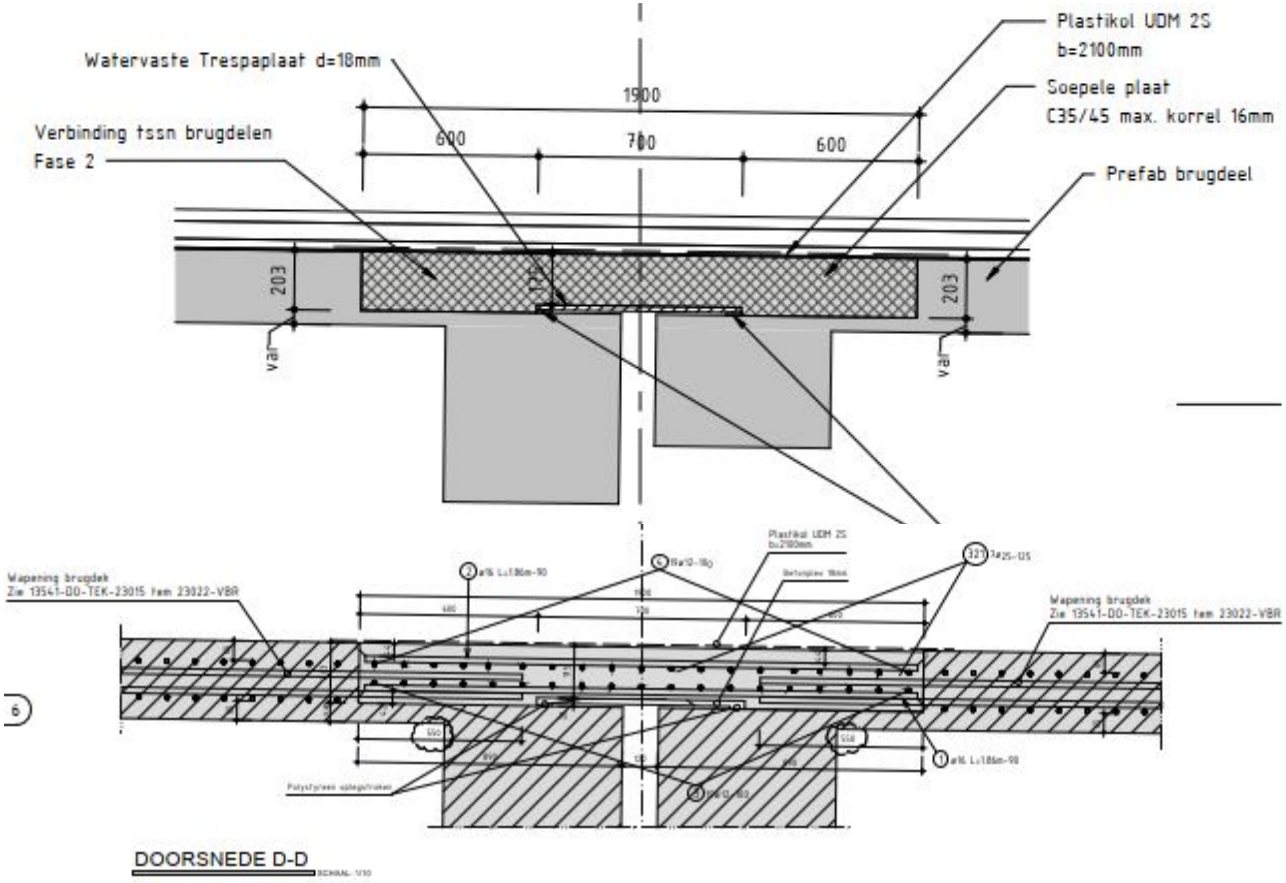
- 11 spans (14m – 33m)
- every span consists of 6 prefab pretensioned beams (height: 1m – 1,9m)
- NewJersey anchored due to limited working space

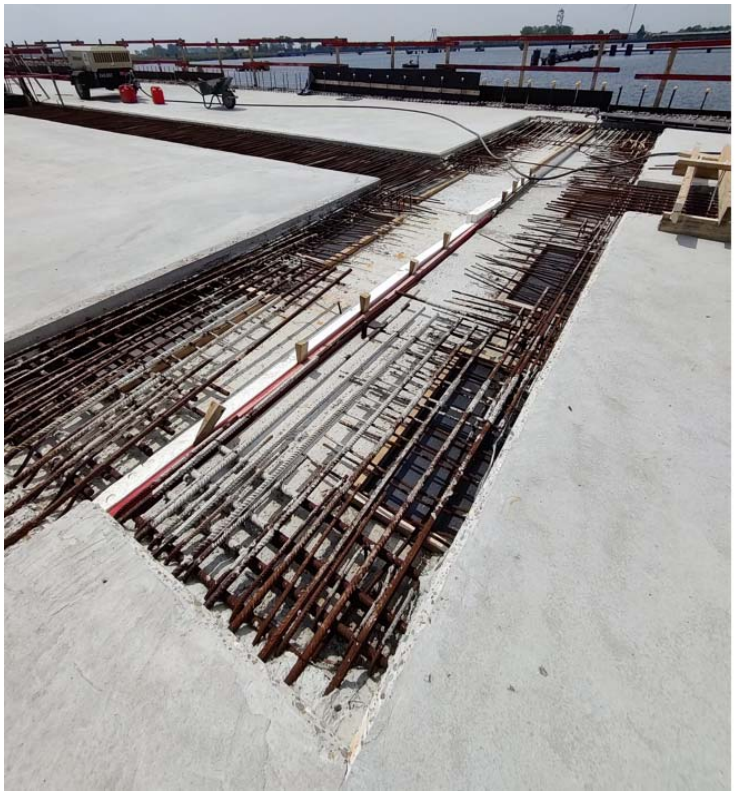


SUPERSTRUCTURE FIXED BRIDGES - EXECUTION

- Innovative construction method to reduce working time off land: prefab elements of 33 x 6,5 m
- Maximum lifting capacity: 400 tons

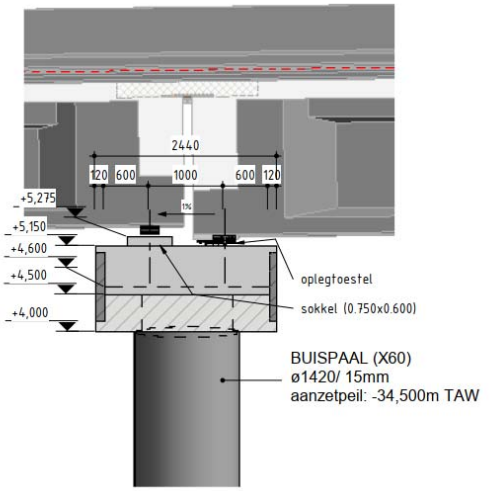
SOEPELE PLAATVERBINDING (FLEXIBLE SLAB CONNECTION)

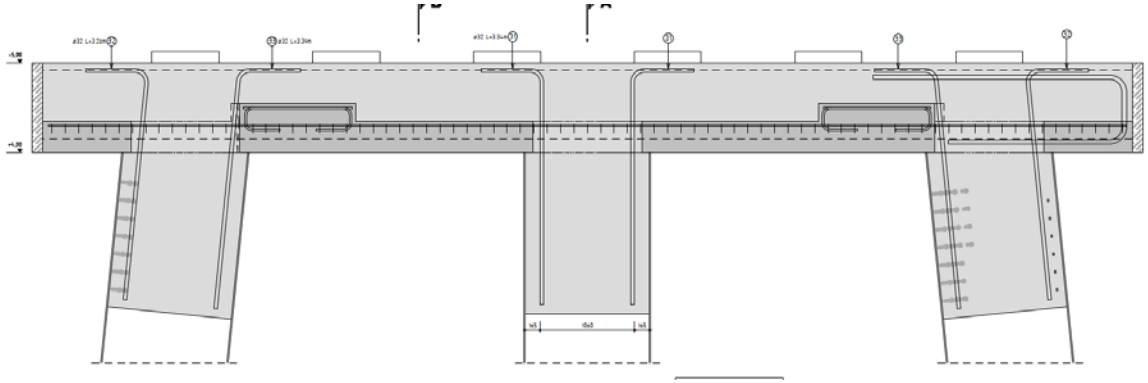




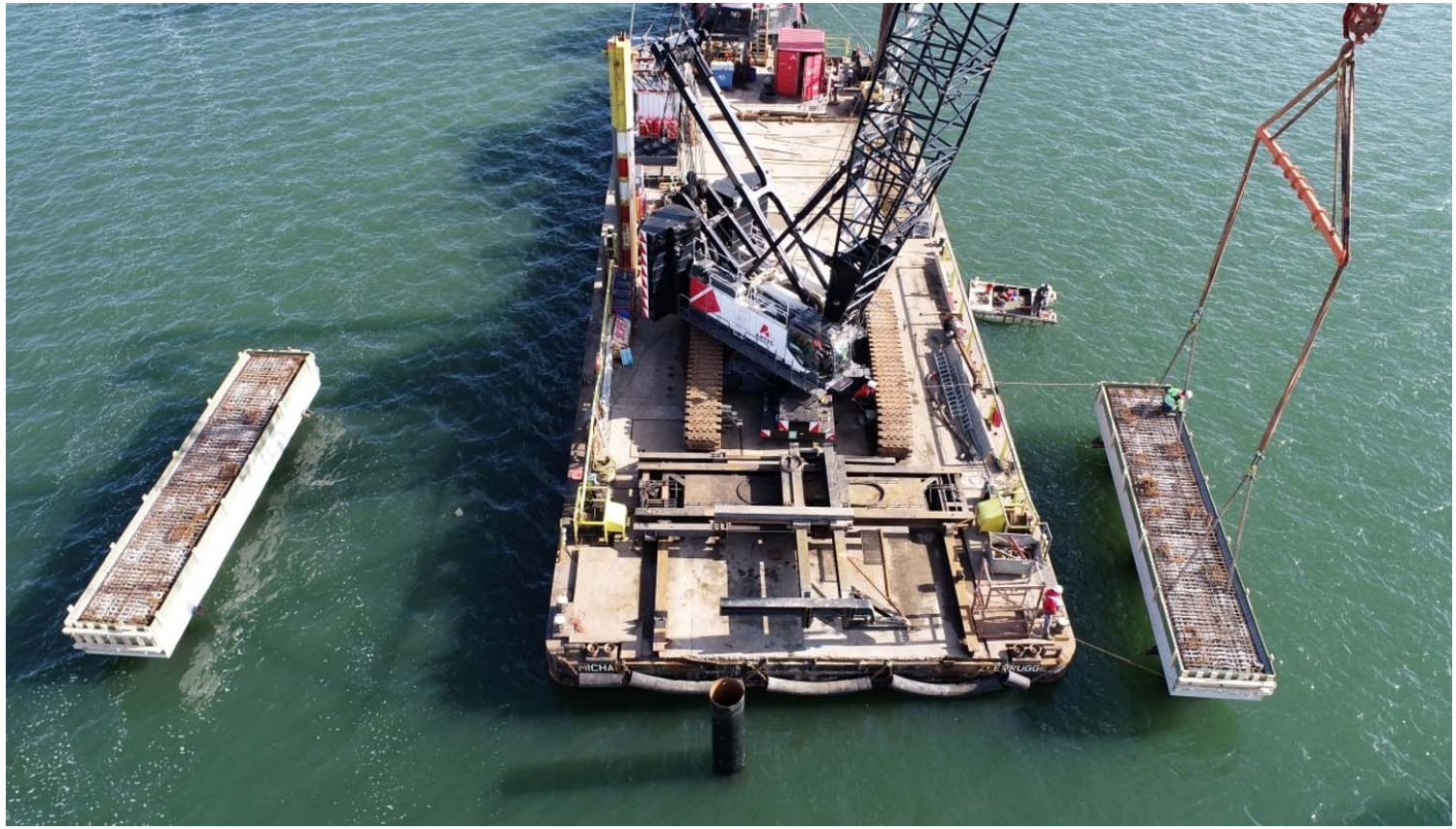
SUBSTRUCTURES FIXED BRIDGES
FOUNDATION PILES

- Steel pipes D1067 – D2030
- Sandstone banks
- Pile caps partly prefabricated on land





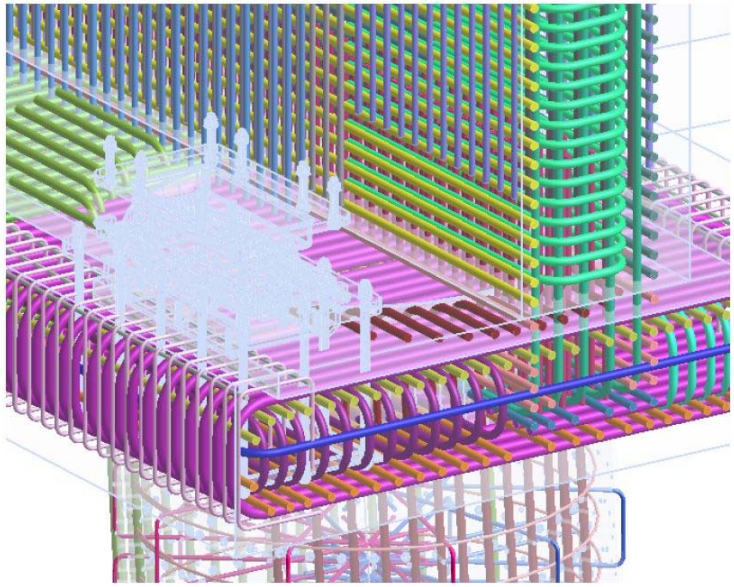
SUBSTRUCTURES FIXED BRIDGES



SUBSTRUCTURES FIXED BRIDGES

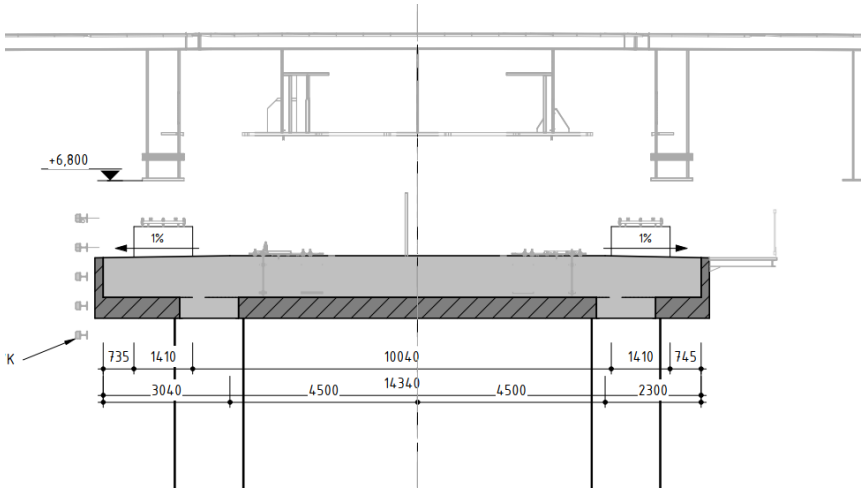
Beam P7 with bearing

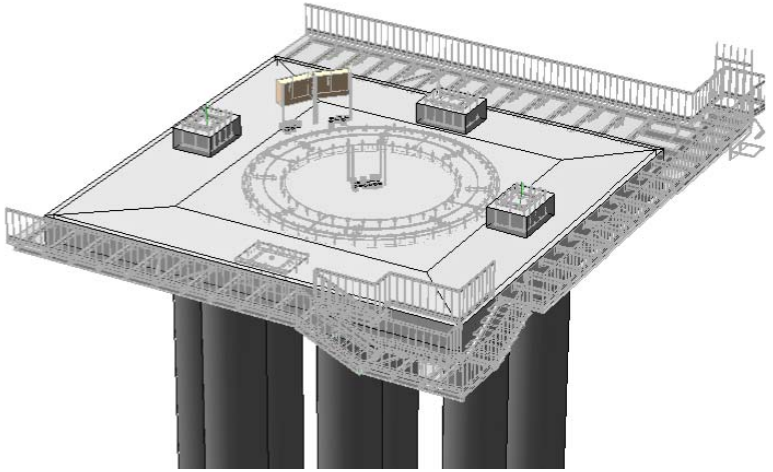
- Heavy and complex reinforcement due to limited available height and large torsion moment
- Fitting anchorage of bearing in the reinforcement



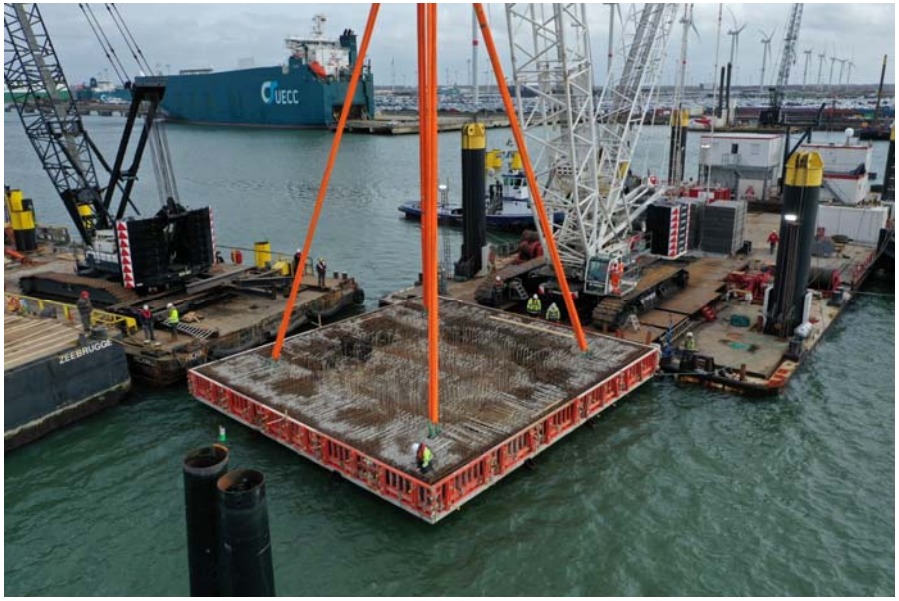
MIDDLE ISLAND

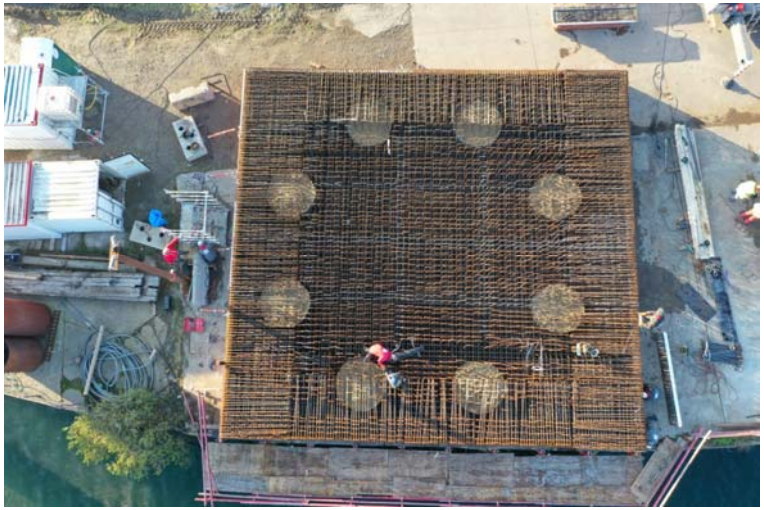
- 14m x 14m x 1,5m
- 8 steel pipes D2030
- Carrousel and bearings need to be anchored
- Partly prefabbed on land: 400tons
- Heavy reinforcement due to limited height and large reaction forces of swing bridge : emergency braking of the swing bridge leads to a turning moment of 19 000 kNm!





MIDDLE ISLAND

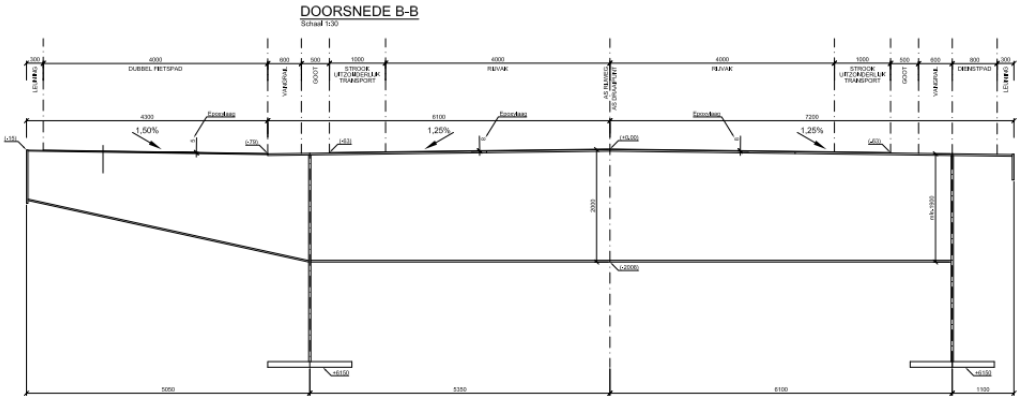


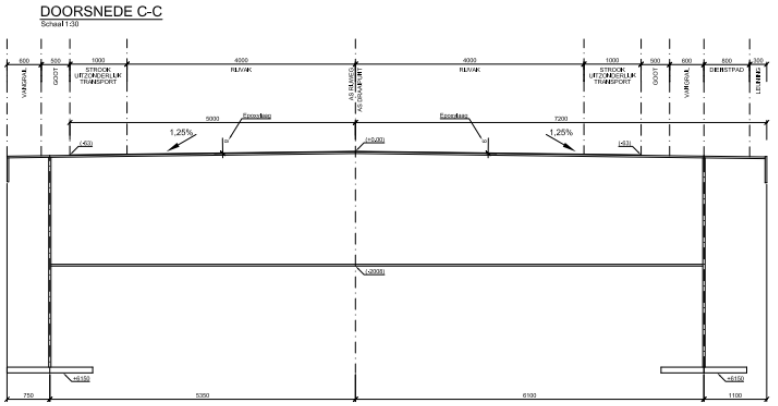


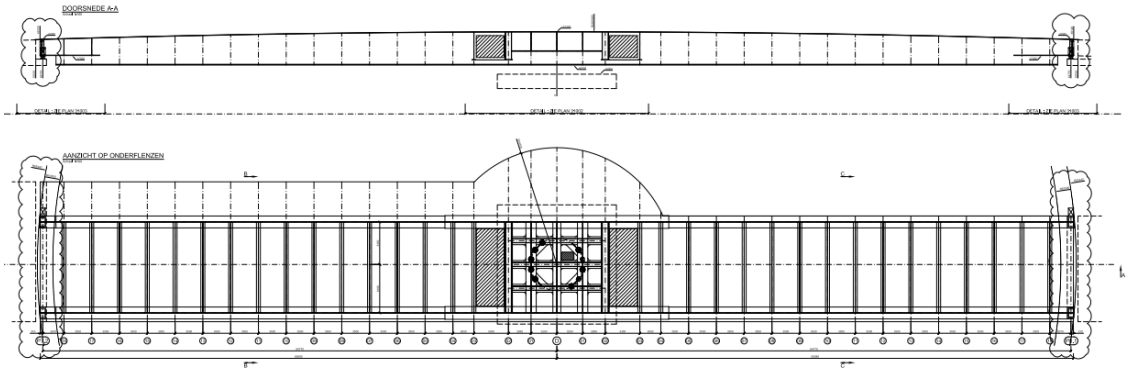
STEEL SWING BRIDGE

SWING BRIDGE

- weight of the bridge is 1800 tons
- length 130m and width 13,3m – 21,9m
- 2 main beams:
  - variable height (max 4,5m)
  - Bottom flange width 1,6m and max thickness of 150mm
- Orthotropic deck (25mm – 60mm)
  - Secondary beams every 3,5m (I beams height 2m)

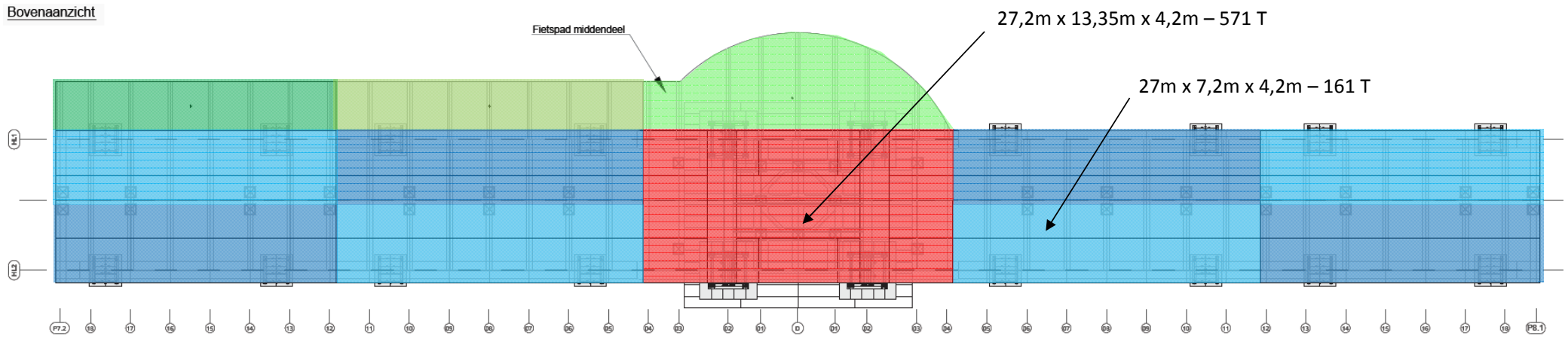






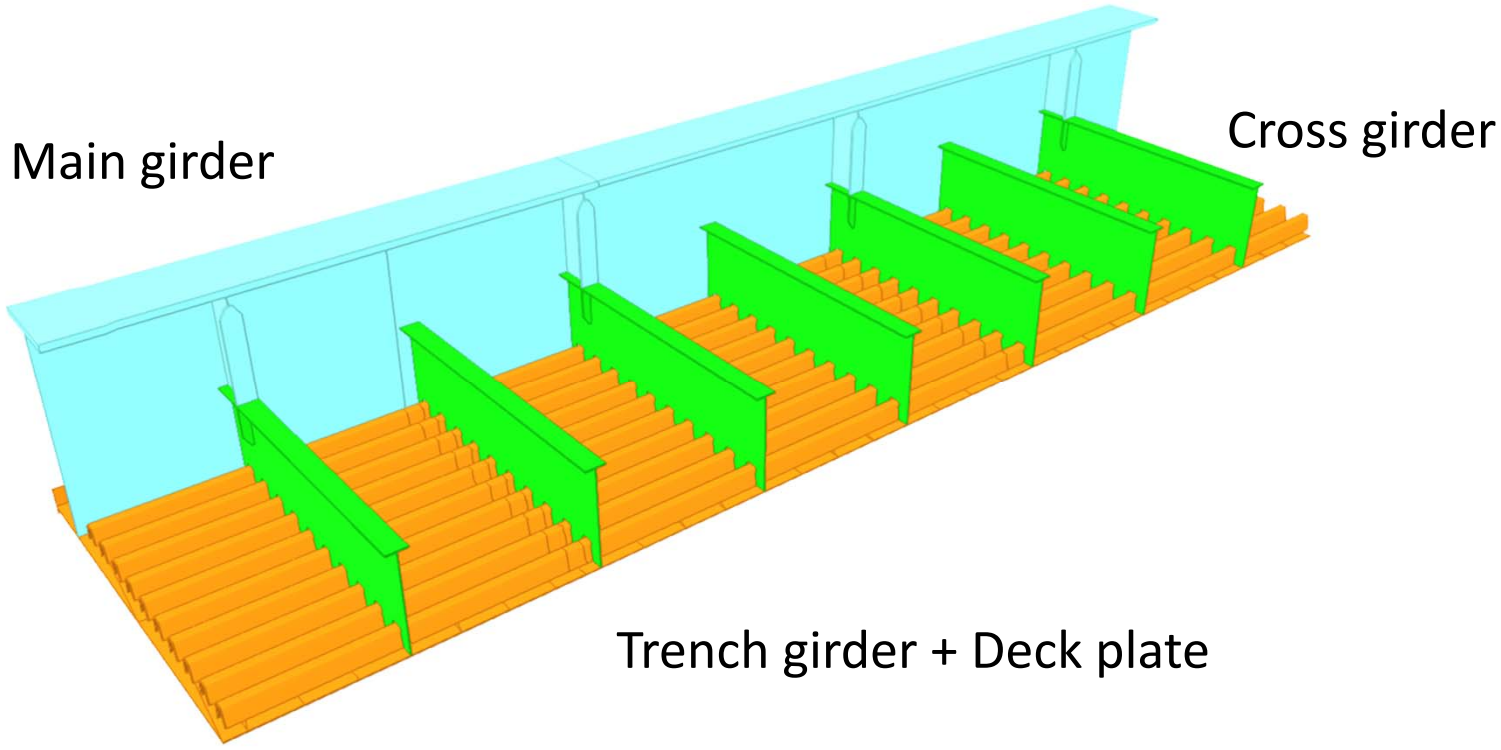
ASSEMBLY METHOD

- Complete steelconstruction assembled in Wondelgem (Ghent) by Victor Buyck
- Carrousel and 2 technical rooms installed and tested in the workshop of Victor Buyck
- Complete corrosion protection and epoxy finished in the workshop



ASSEBLY DETAILS

- Upside down!



ASSEMBLY DETAILS- MIDDLE PART

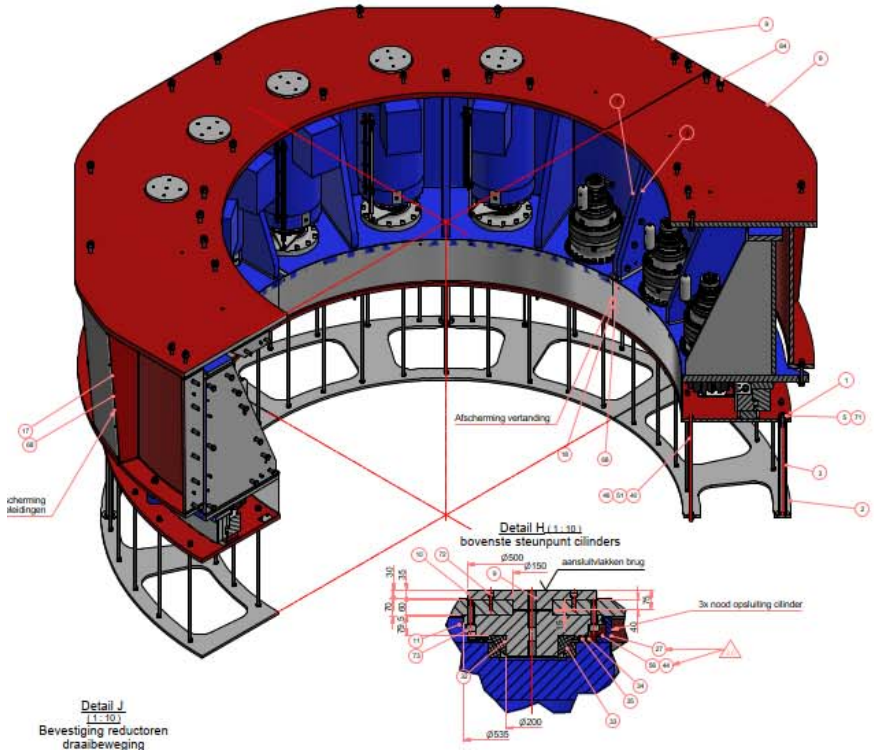
ASSEMBLY DETAILS – MIDDLE PART

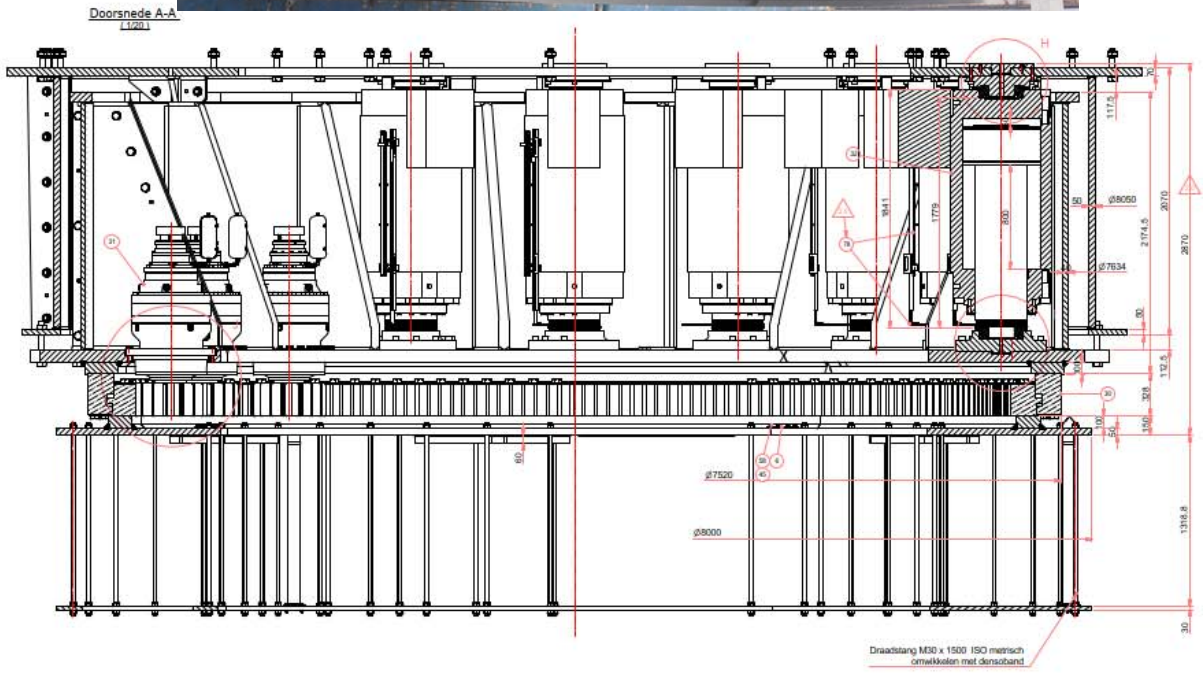
ASSEMBLY DETAILS

MECHANICAL DETAILS

The Carrousel (patented by Demako)

Lifting and turning device, weighing about 80 tons





MECHANICAL DETAILS

The Carrousel (patented by Demako)

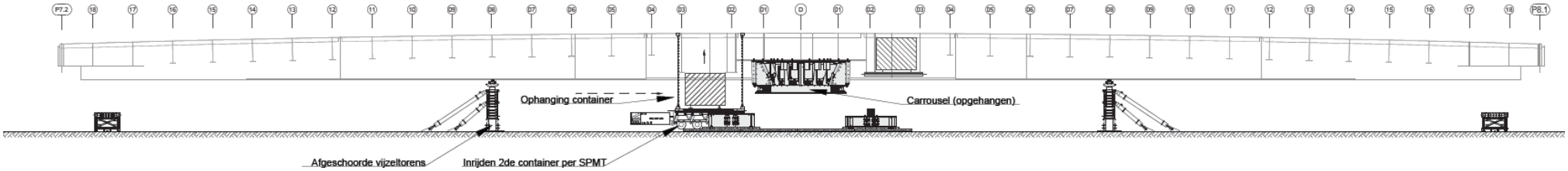
Hydraulic cylinders

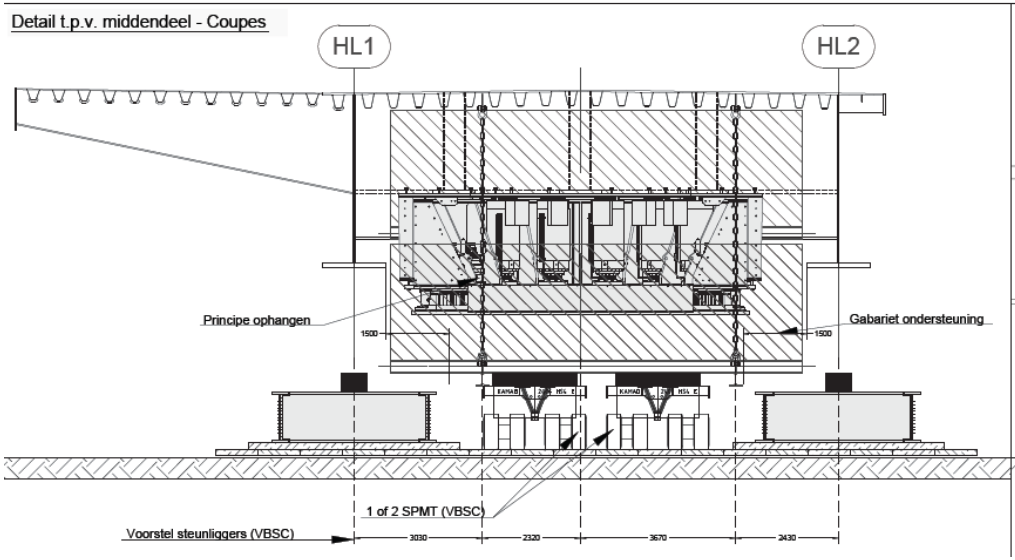
hydraulic power pack in technical rooms

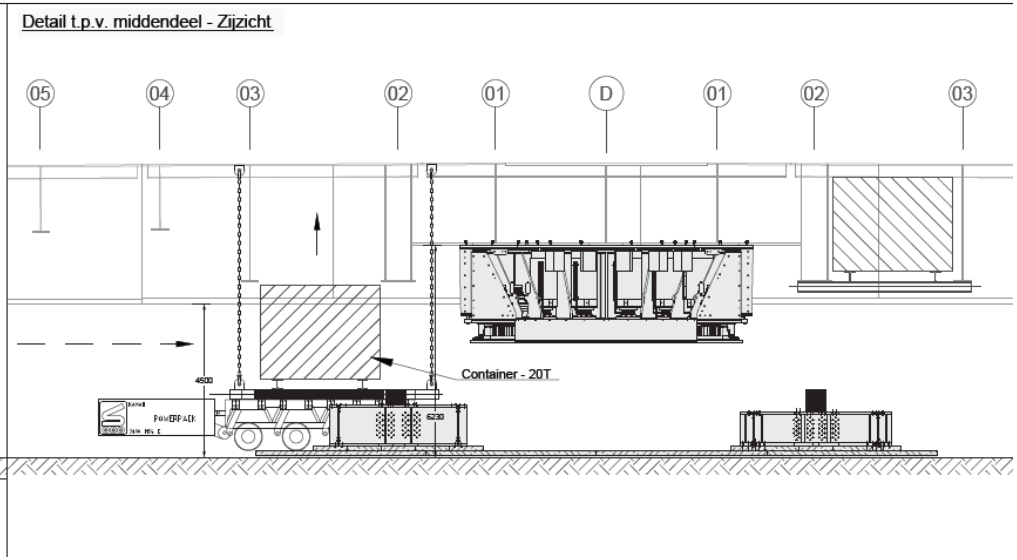
hydraulic motors

CARROUSEL INSTALLATION

- installation of 2 technical rooms, completely equiped, for redundancy and availability

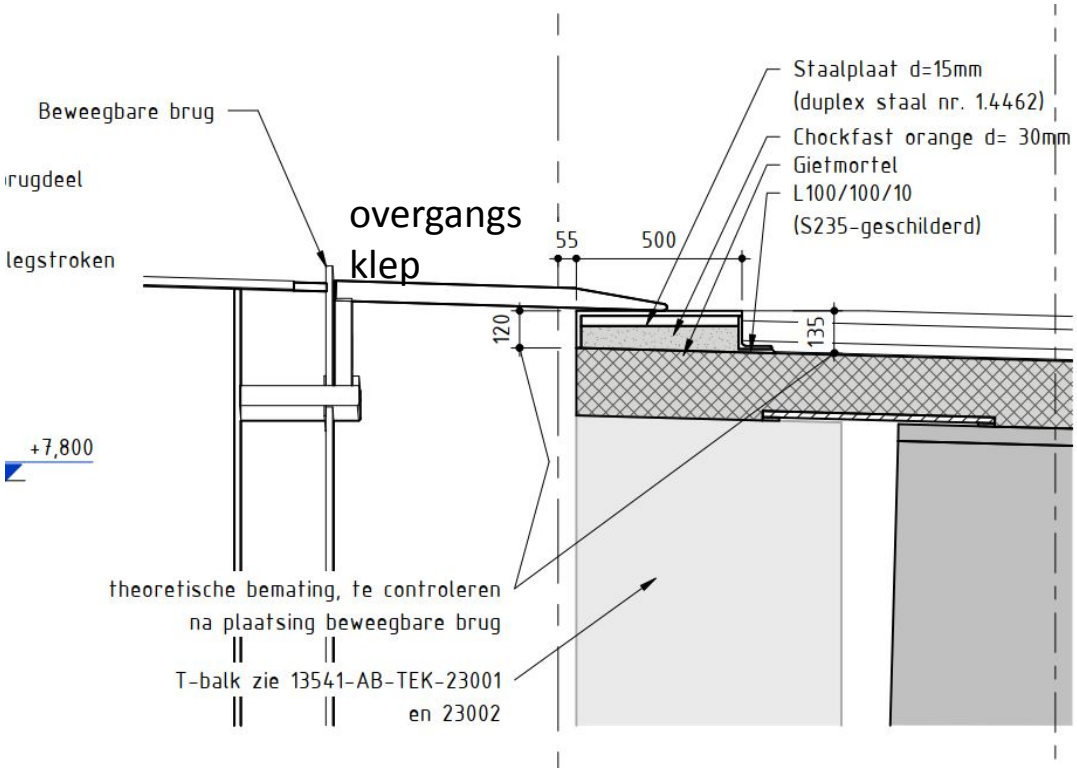


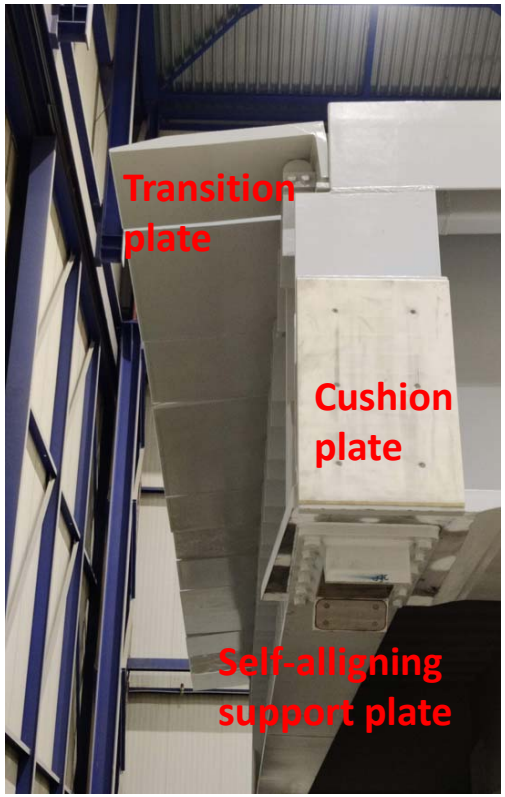




SPECIFIC DETAILS

Overgangsklep (transition plate): Head-ends of the fixed concrete bridge and the swing bridge are non curved => big gap to cover. Span 1,0m, 70mm thick.





SPECIFIC DETAILS

Supporting devices

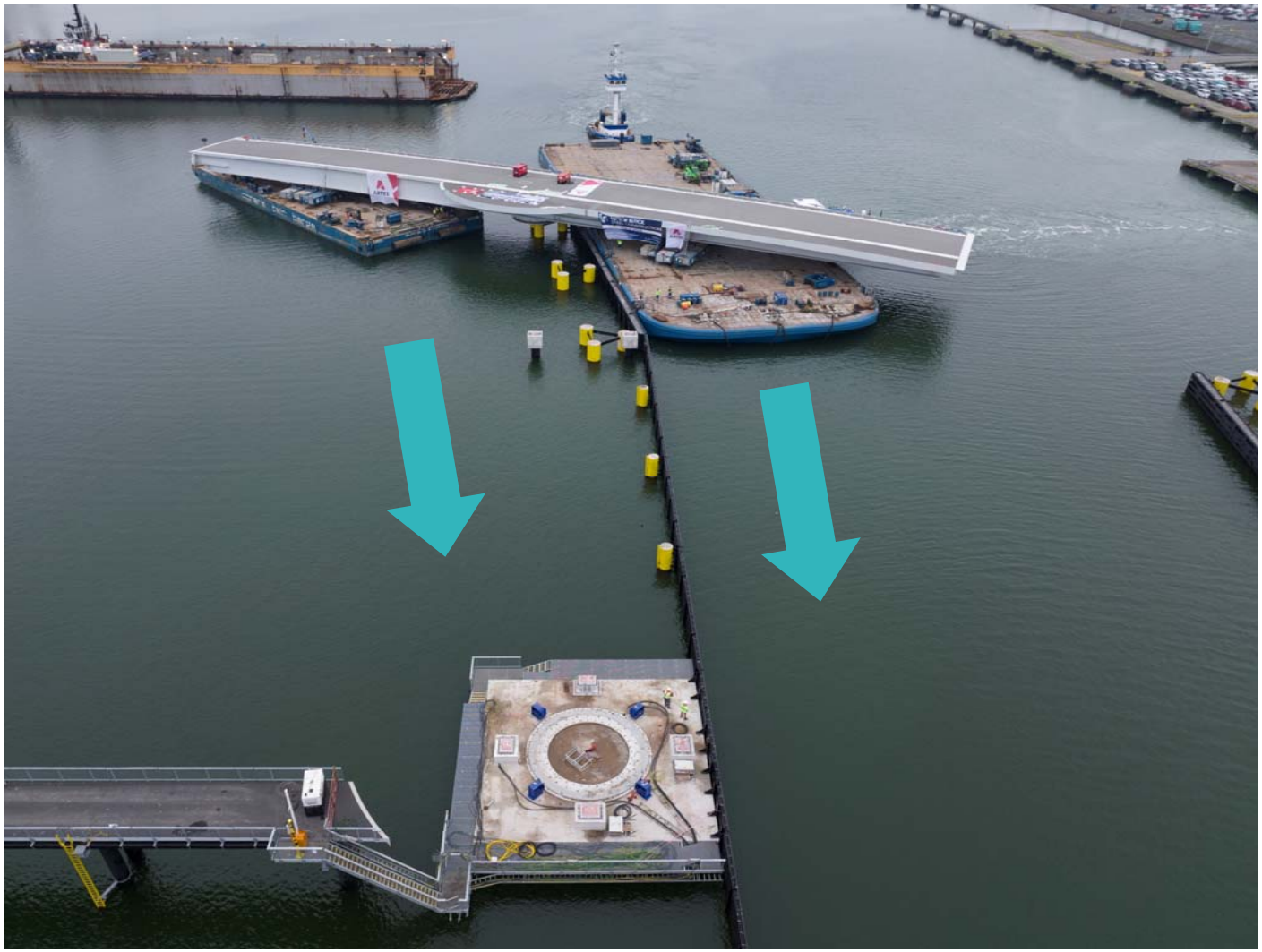
Self centering, composite material and stainless steel

TRANSPORT WONDELGEM - ZEEBRUGGE

→ Via Channel Ghent-Terneuzen and the Wester Scheldt

INSTALLATION ON SITE

- Using 2 pontoons, swing bridge at +/- 45°
- Interference with guiding frame and bycicle bridge



CHALLENGES ON SITE – POSITIONING OF THE SWING BRIDGE ABOVE THE ANCHOR PLATE

- **2 positioning instruments**
- 4 guiding frames (blue)
- Centering pins

BICYCLE BRIDGE

- Composite bridge with spans of 22m (by Fibercore)
- Anchored to fixed bridges
- Access to middle island, even for a 40 tons crane

Q/A?

THANKS FOR YOUR ATTENTION!