e-maritime

NOVEMBER 2019

PORT OF GÄVLE AND ITS EXTENSION

LIST OF CONTENTS

Front Cover: Aerial View of the Port of Gävle

Photo Credit: Port of Gävle

Back Cover: Formwork Travellers used for construction of the quay

Photo Credit: e-maritime

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Dear Readers

This special issue is dedicated to the Port of Gävle in Sweden and its extension. Port of Gävle is a natural east coast hub for import and export, strategically located about two hours north of Stockholm and right next to the industrial Central Sweden region.

The increasing demand for container transport is the reason for the development of a new terminal that will effectively double the port's size.

In the first article we bring an overview of the Port and the Project.

The next article was prepared by Johan Ericsson from the Port of Gävle and describes the Project in further detail, construction works and plans for the future.

Design of the Port extension is described in the third article which was written by Johan Alderborg of WSP Sverige AB. The company was assigned by the Port of Gävle to design the reconstruction and extension of the existing quay and to execute a geotechnical study. The design requirements were to enable the quay to handle bulk goods and containers. The article is accompanied by relevant drawings.

The last article of this issue brings information on equipment which is used in the project. The article was prepared by Inma Gómez of Rúbrica Maritime.

On the following pages, you can also find more information on e-mosty and e-maritime magazines, our Editorial Plan and Partnership offer.

I would very much like to thank all people and companies who have helped me prepare this issue; David Stork - thank you for reviewing this issue and for your valuable comments and your assistance, Guillermo Muñoz-Cobo Cique (Arup) - thank you for final check of the articles.

Next Issue will be released on 30th March 2020 and will focus on Shipyards, Ports and Maritime Industry in Turkey. We would like to invite you to contribute with your technical article; the deadline for submission of your draft is 15th February.

We welcome your ideas, comments, articles and participation in the preparation of e-maritime magazine, you can contact us here.

Magdaléna Sobotková

November 2019

Acknowledgement

I would like to thank the people and companies below for their cooperation, assistance and time; thank you for preparing and reviewing the articles, for your valuable advice and comments and for providing the photos and videos. Thank you for showing me the port and the construction site.

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September Issue is shared with the magazine e-mosty ("e-bridges"): "Bridges, Vessels and Maritime Equipment" which is published on 20 September on www.e-mosty.cz.

It can be read **free of charge** (open access) with possibility to subscribe.
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The magazine brings **original articles about design, construction, operation and maintenance of vessels and maritime equipment, docks and ports from around the world**.

Its electronic form enables publishing of high-quality photos, videos, drawings, links, etc.
We aim to include all important and technical information and show the grace and beauty of the vessels and structures as well.

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It is published quarterly: 20 March, 20 June, 20 September and 20 December.
The magazines stay **available on-line** on our website. It is also possible to download them as **pdf**.

The magazine **brings original articles about bridges and bridge engineers** from around the world.
Its electronic form enables publishing of high-quality photos, videos, drawings, links, etc.
We aim to include **all important and technical information** and show the grace and beauty of the structures.

We are happy to provide media support for important bridge conferences, educational activities, charitable projects, books, etc.

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The readers are mainly bridge engineers, designers, constructors and managers of construction companies, university lecturers and students, or people who just love bridges.

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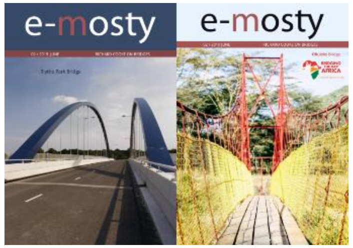

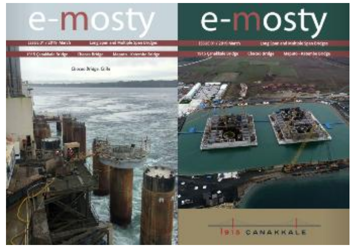

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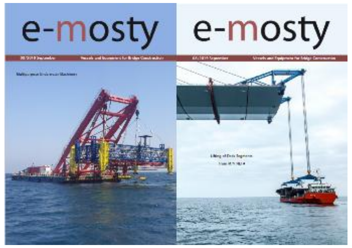

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PORT OF GÄVLE AND ITS EXTENSION

INTRODUCTION

Magdaléna Sobotková

INTRODUCTION

Port of Gävle is a natural east coast hub for import and export, strategically located about two hours north of Stockholm and right next to the industrial Central Sweden region.

The connection is provided by road and rail, with comparably little traffic and queues, which make it easily accessible for goods owners in Stockholm and Mid Sweden.

Large ships LOA 245m, beam 42m, draft 12.2m, 3,000 – 3,400 TEU, can dock efficiently in the port for quick loading and unloading at the container terminal, bulk terminal, combi terminal and energy terminal.

↓ *Figure 1: Aerial View of the Port*

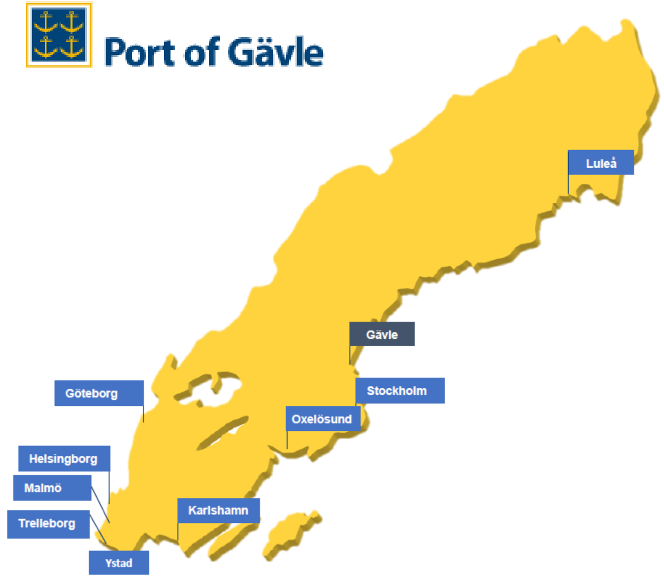


Figure 2: Ten largest ports in Sweden with Port of Gävle indicated

November 2019

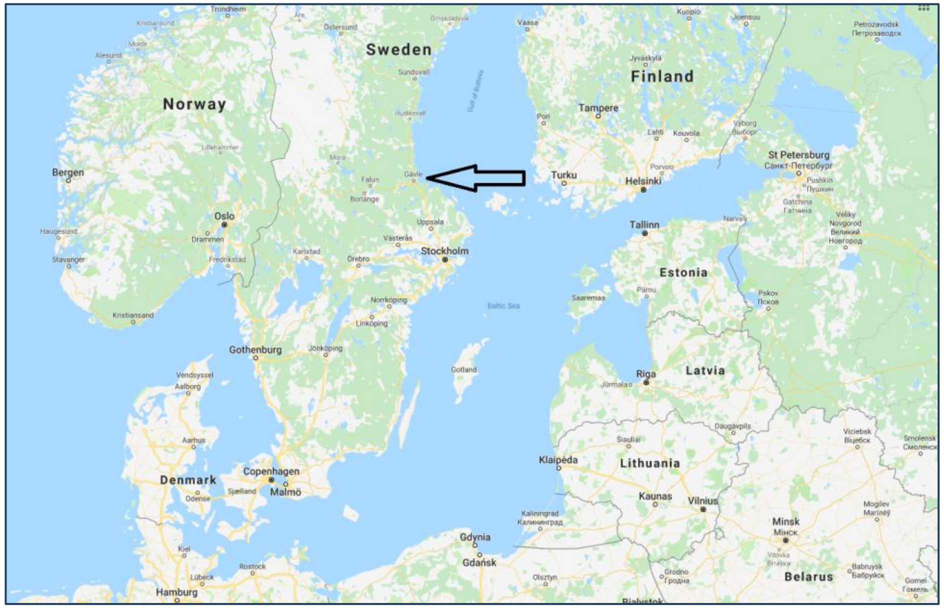


Figure 3: Location of the Port of Gävle

Figure 4: Location of the Port and its Connection to major strategic places

OPERATION OF THE PORT

The Port is operated by YILPORT Holding. YILPORT Holding started activities in 2004 by acquiring Sedef Port, a former shipyard from STFA Holding.

In 2005, the Group acquired Alemdar Holding, Inc. and subsequently merged the two operations to create YILPORT Container Terminal and Port Operators, Inc.

Gävle Container Terminal in Sweden was acquired by YILPORT in 2014, together with Port of Oslo in Norway.

YILPORT secured the rights to Baltic Sea Gateway in Sweden as well which renders YILPORT as the sole operator in Port of Gävle.

YILPORT Holding aims to create world-class, multipurpose facilities on an international scale. This vision is powered by the company's growth strategy to become a top 10 global port operator by 2025.

The numbers indicate that the company is well on its way to achieving this target, as YILPORT Holding was acclaimed as the 12th biggest international terminal operator in the world on Drewry's 2017 ranking.

YILPORT's Intermodal terminal, Stockholm Nord in Roserberg, is one of the country's largest.

It offers excellent opportunities to supply the Stockholm region with import volumes through Port of Gävle. Continuous container trains operate between Gävle and Stockholm.

YILPORT® HOLDING INC.

Stockholm Nord Intermodal Terminal is located in the north of Stockholm, inside the newly developed logistics park.

The terminal can handle all types of cargo moved by rail; such as cars, timber, trailers, building elements, and containers.

It is positioned to capture the needs of the growing consumer segments and the supporting supply chain networks. YILPORT Stockholm facility also offers added value as a container depot with direct rail shuttle service for the export-rich Gävle hinterland.

The terminals working together are a key part of YILPORT's growth strategy in Sweden.

The combination of Port of Gävle and YILPORT is very efficient.

Port of Gävle provides the infrastructure and YILPORT manages operations, a stable and long-term cooperation that is much appreciated by the customers of the port.

Port of Gävle and YILPORT strive together to increase the portion of shipped goods.

The industry in mid-Sweden handles large import and export volumes. Within a 250 km radius from the port, 17 million tons of steel and processed wood is produced annually.

A large portion is shipped in containers from Port of Gävle. This portion is expected to grow rapidly as the requirement for environmentally friendly transports increases throughout the society.

Port of Gävle is a dynamic logistic hub with constant activity. Ships, trains and lorries, dock, discharge, load and depart, every hour of every day, all year round.

Port of Gävle and YILPORT operate six terminals, of which the container port is the largest on the east coast.

It is open 24/7 and disposes of available land close to the quay.

All global container shipping companies already use Port of Gävle, and now the container port will be expanded to be able to receive more and larger ships.

** 1 TEU corresponds to a 20-foot container*

← Figure 5: Six Terminals of the Port

CONNECTIONS TO OTHER PLACES

Container Express shuttle train to YILPORT Stockholm Nord as the world's first electric highway for trucks was tested on the E16 east of Gävle with the aim to provide green transportation all the way from hinterland industries to Port of Gävle.

It would relieve the pressure on the railroad, and at the same time reduce the carbon dioxide emissions from the truck traffic.

The existing rail connection to Port of Gävle will be electrified in 2021. The investment is financed by the Swedish Transport Administration according to the current national infrastructure plan.

All terminal operations, such as towing, loading and unloading of containers are run with electricity or fossil-free diesel (HVO).

There is also plenty of space available for setting up quayside premises.

The logistics park is located with 20 HA available land and strategically positioned close to the terminals of the port with connection to main lines in all directions, double-tracks to Stockholm and two main motorways.

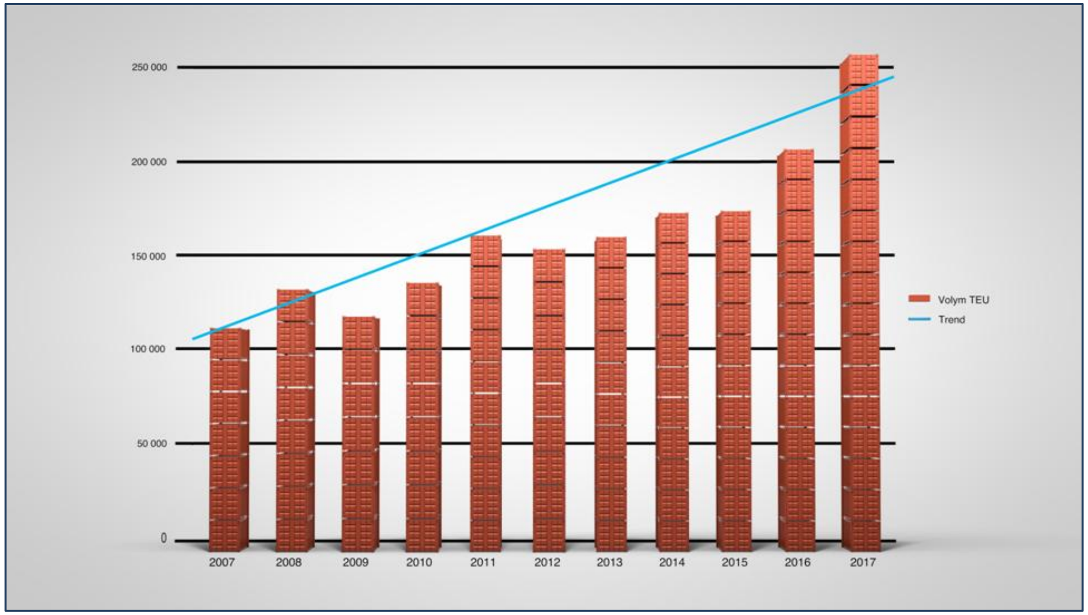


Figure 6: Development of TEU volume and trend since 2007

Figure 7: Development of goods transport since 2000

THE PORT EXTENSION

The Swedish Company Infranode has invested SEK 400m (US$42.2m) in the development of a new container terminal in the Port of Gävle and become a minority shareholder in YILPORT Sweden Terminal Investment AB (YST).

Through this investment, the company has become a partner and co-owner of YILPORT's Swedish operations in Gävle and the Stockholm Nord intermodal terminal.

The proceeds will be used for the expansion of a new container terminal in Gävle to meet the significant growth in demand for container transports.

The Port of Gävle is Sweden's third largest container port and the largest on the east coast and due to significant growth over an extended period of time, throughput is approaching 300,000 TEU.

The increasing demand for container transport is the reason for the development of a new terminal which will effectively double the port's size.

Upon completion of the facility in 2020, the Port of Gävle will have the capacity to handle larger vessels and an annual volume of up to 600,000 TEU.

The new container terminal will be able to receive ships up to 366 meters in length, with a capacity of 14,000 containers.

YST and its subsidiaries hold a concession agreement to operate and develop the port until 2046 with the option for a 10-year extension.

Figure 8: Rendering of the new terminal

About Infranode

Infranode is a long-term infrastructure investor with focus on the Nordics across the energy, transport, telecom and social infrastructure sectors.

Infranode's team includes 10 infrastructure investment professionals with offices in Stockholm, Helsinki, and Oslo with approximately EUR 450m of capital under management.

The investor base comprises pension and insurance institutions such as the Swedish State pension fund AP4, Folksam, Swedish municipal pension fund KPA Pension, LähiTapiola, the European Investment Bank, and the IMAS Foundation.

Infranode is an affiliate to AREIM, an established Nordic real estate fund manager and adviser.

About YILPORT Holding

Yilport Sweden Terminal Investment AB is a subsidiary of YILPORT Holding that is one of the fastest growing international container terminal operators in the world.

Headquartered in Istanbul, Turkey, YILPORT Holding is active in nine countries operating close to 30 sea and dry terminals.

YILPORT Holding is currently the 12th among the top global container terminal operators, ranked by Drewry.

The parent company YILDIRIM Holding also owns 24% shares of CMA CGM Group, the third largest container shipping company in the world.

KEY FACTS OF THE PROJECT OF THE EXTENSION OF THE PORT OF GÄVLE:

Client: Port Of Gävle

Investor: YILPORT Holding, Port Of Gävle

Operator Of The Terminal: YILPORT Gävle AB

Project Manager: Bylero AB

Design: WSP Sverige AB

Contractor (Construction): Rover Maritime

Formwork Travellers: Rúbrica

PORT OF GÄVLE AND ITS EXTENSION

PROJECT AND CONSTRUCTION

Johan Ericsson, Senior Project Manager, Port of Gävle

PROJECT DESCRIPTION

The capacity of the largest container terminal on the east coast is about to be doubled. Port of Gävle and YILPORT are co-investing to meet the increasing demands for container transport.

During the project, the container terminal will be extended with 360m new berth and adapted for much larger container ships.

Work to extend and strengthen the existing quay adjacent to the old container terminal has been ongoing since December 2018 and is expected to be completed in spring 2020.

Video 1: Animation of the project. Click on the image to watch the video

Video 2: The New Quay in the Port of Gävle. Click on the image to watch the video

The cost of the new terminal is close to SEK 1 billion, with berths, cranes, paper warehouses and food inspection stations included, with nearly 50 people working on the project.

The maximum capacity in the existing container port was reached in 2016 and with the new terminal and its 360 meter long new container quay the capacity can be doubled.

The quay that is being rebuilt and expanded has previously been used for general cargo, now it will have its capacity increased with a new reinforced concrete quay to handle the new container operation.

Port of Gävle

CONSTRUCTION

1,300 piles and about 11,000m^3 of concrete will be used.

On the water side, 650 piles are drilled down to solid rock at approximately 20 meters depth for the crane foundation beam.

The water side and the land side crane beams are designed to handle new STS container cranes with a load capacity of about 80 tonnes / wheel.

Large amounts of reinforcement are being prepared and prefabricated on land and then lifted and mounted in place in the formwork.

The first casting took place in June 2019.

Outside the existing quay, the new crane beam is to be tied to the existing quay. 20m long steel piles of a diameter of 500mm are embedded at least 2m into the bedrock.

The crane legs from the new coming container cranes will roll on the crane beam. There will be three new cranes.

The cranes that the Port Operator YILPORT plans to install extend 124 meters up to its highest position and reach 65 meters from the quay.

The quay is now being extended to 360 meters in length, but it is also possible to extend up to 90 meters more in the northerly direction. It would enable four container cranes to operate simultaneously.

The project will be completed in a period of approximately 16 months, depending on weather conditions.

The actual production started on 12th December 2018, with a break between 21st December and 3rd January. The project is to be finished in spring 2020.

Working hours are typically 07:00 – 19:00, seven days a week.

In the future there is a possibility to dredge down to a depth of 16 metres which would enable the Port to receive large ocean-going vessels with a breathtaking 14,000 containers.

Then the quay would be prepared for it. However, as it is now, there is no dredging depth in Port of Gävle or off the fairway.

There would be more opportunities in the future if there was further expansion and the vessels might be bigger.

The container port will have a capacity of 600,000 TEU (containers with a dimension of 6.10 x 2.59 meters), compared to the previous 240,000 TEU.

With a further extension of the quay to 450 meters, a capacity of 800,000 TEU can be achieved.

CONSTRUCTION IN NUMBERS

- The piles that hold the quay add up to a total length of 26km.
- Over 11,000m^3 of concrete is required for the new container quay which corresponds to 1,500 concrete trucks.
- The New Panamax ships, which the dock is built to accommodate, can be 366 meters long, 49 meters wide, have a depth of 15.2 meters and hold 14,000 containers.
- Current dredging depth of 13.5 meters needs to be deepened to 16 meters in order to receive the world´s largest vessels.

PORT OF GÄVLE AND ITS EXTENSION

DESIGN

Johan Alderborg, Assignment Manager, WSP Sverige AB

PROJECT DESCRIPTION

WSP Sweden received an assignment from the Port of Gävle to design the reconstruction and extension of the existing quay, Figure 1. The assignment also comprised execution of a geotechnical study of the bedrock next to the existing quay.

The geotechnical study was executed by drilling at 12 positions in the water beside the quay, see Figures 2 and 3a, b, c.

The result of the study was that the bedrock is located at approximately -18.0 to -20.0 meters.

The existing depth of the dredging is located at -13.5 meters.

When drilling the new RD Wall, the result of the geotechnical study was confirmed.

The design requirements were to enable the quay to handle bulk goods and its new purpose is to handle containers.

This meant that the capacity of the existing quay had to be increased to handle the new container cranes that are to operate on the new quay.

The existing quay is constructed of piles with overhead concrete beams, T-elements of reinforced concrete.

On the landside it has anchoring with anchoring plates every 20 meters for transferring the loads from the cargo ships, see Figure 4.

Instead of demolishing the existing quay the new quay is built on top and an RD Wall consisting of Ø500/20 piles is drilled in front of the quay line to handle the loads from the container cranes.

To ensure that the new quay will be able to handle bigger cargo vessels in the future the piles in the RD Wall are drilled at least 2 meters down in to the bedrock.

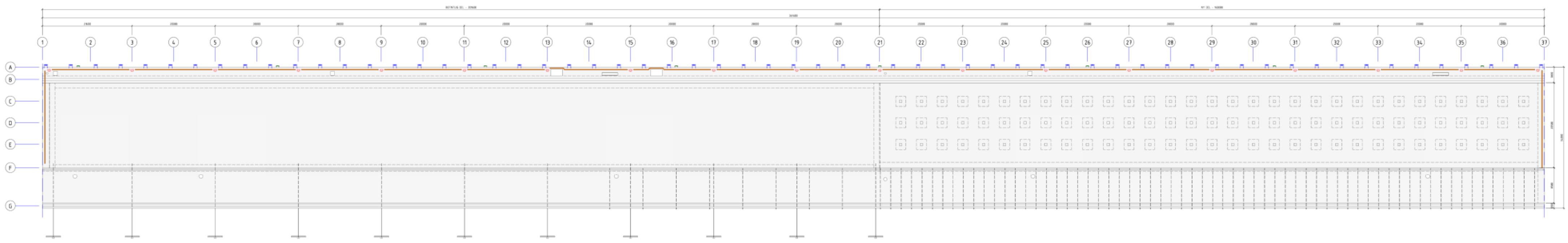
There is also a concrete foundation with RD320/12.5 c/c 3.3 meters alongside the quay on the landside to handle the loads from the container cranes.

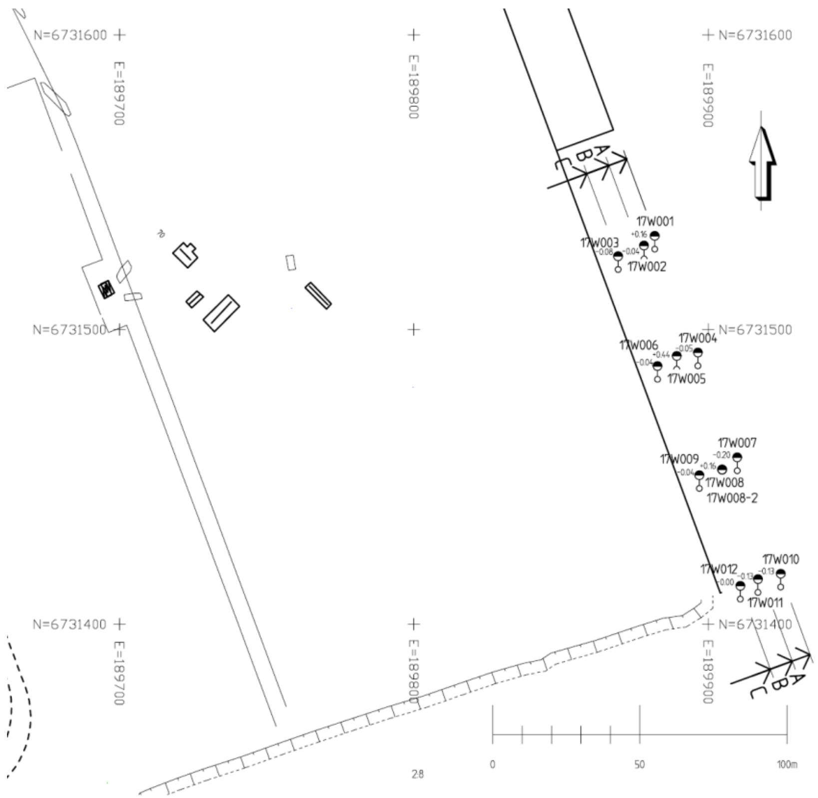
Approximately 10mm of the surface of the existing quay is removed by hydro-demolition so that there will be a connection between the existing quay and the new reinforced concrete.

To handle the loads from the cargo vessels there is a reinforced concrete slab between the quay and the foundation for the container cranes on land.

The existing tension rods are also used to handle the loads from the cargo ships.

The slab is also slanted to handle the drainage of the area on the quay and space between the foundation and quay, see Figure 5.





The RD Wall and crane foundation on land continues along the new extension of the quay for handling the loads from the container cranes.

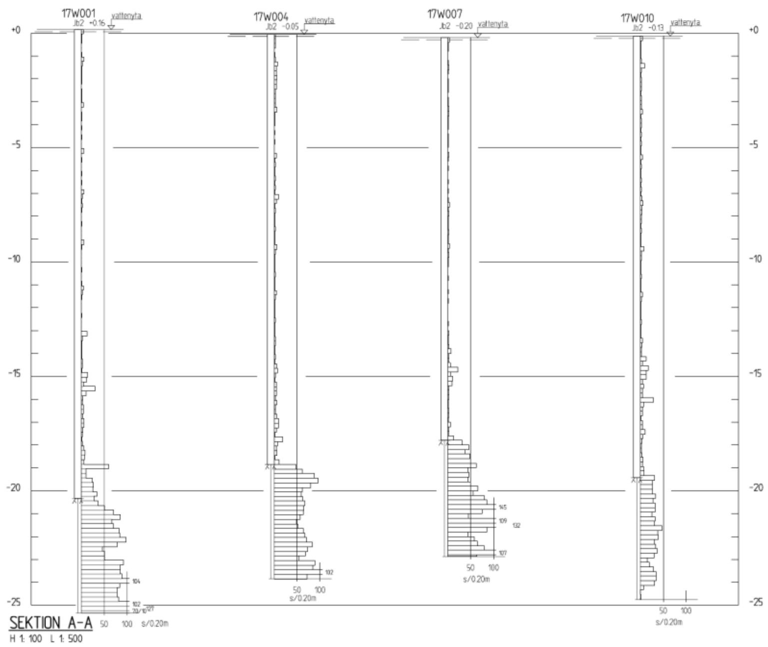
The space between the RD Wall and shore line is filled with moraine and 4 rows of steel piles that are drilled at least 0.5 meters down in to the bedrock, three rows with RD270/12.5 and one row with RD220/12.5, to create a piled slab with reinforced concrete.

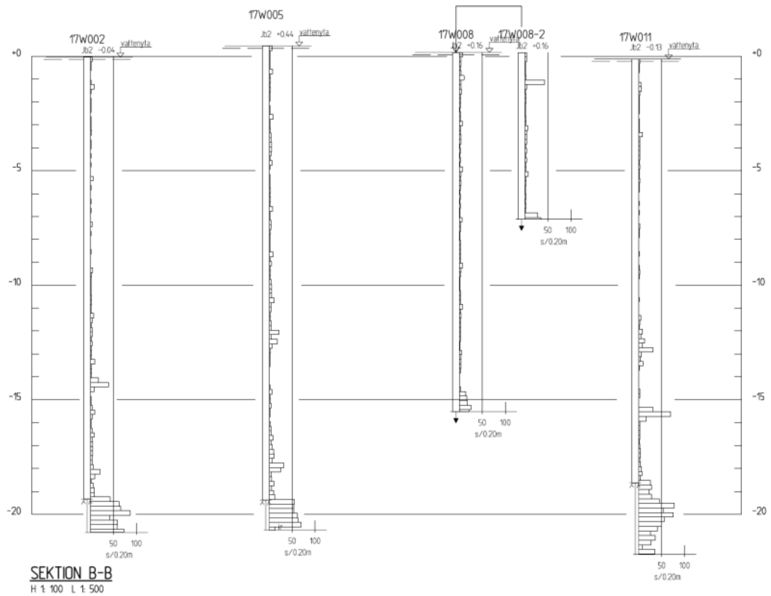
The space between the quay and the foundation is designed similar to the one along the existing quay with the addition of tension rods every 2.5 meters along the extension to handle the loads from the cargo ships, see Figure 6.

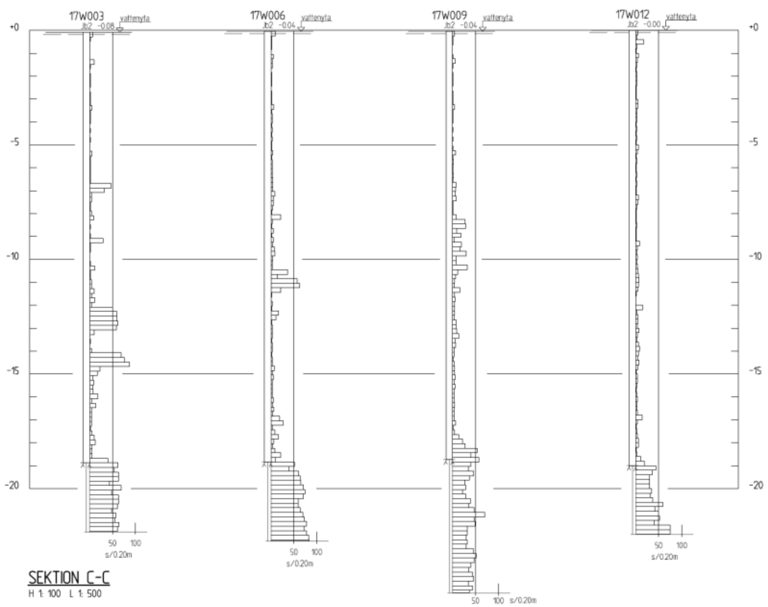
↑ Figure 1: Plan of the Quay

CLICK ON THE IMAGE TO ENLARGE IT

→ Figure 2: Geotechnical situation







Figures 3 a, b, c: Sections of bores executed next to the existing quay

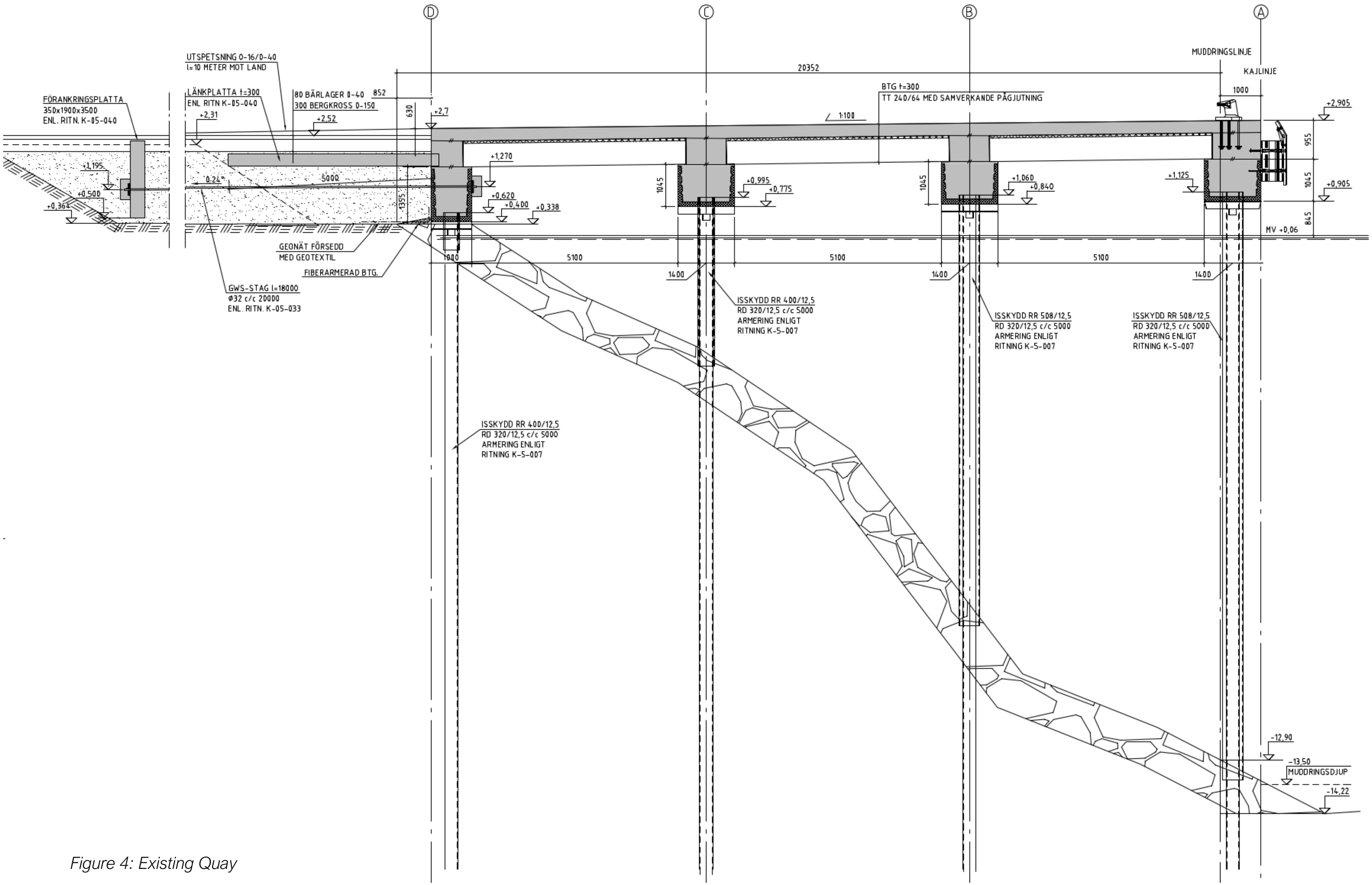


Figure 4: Existing Quay

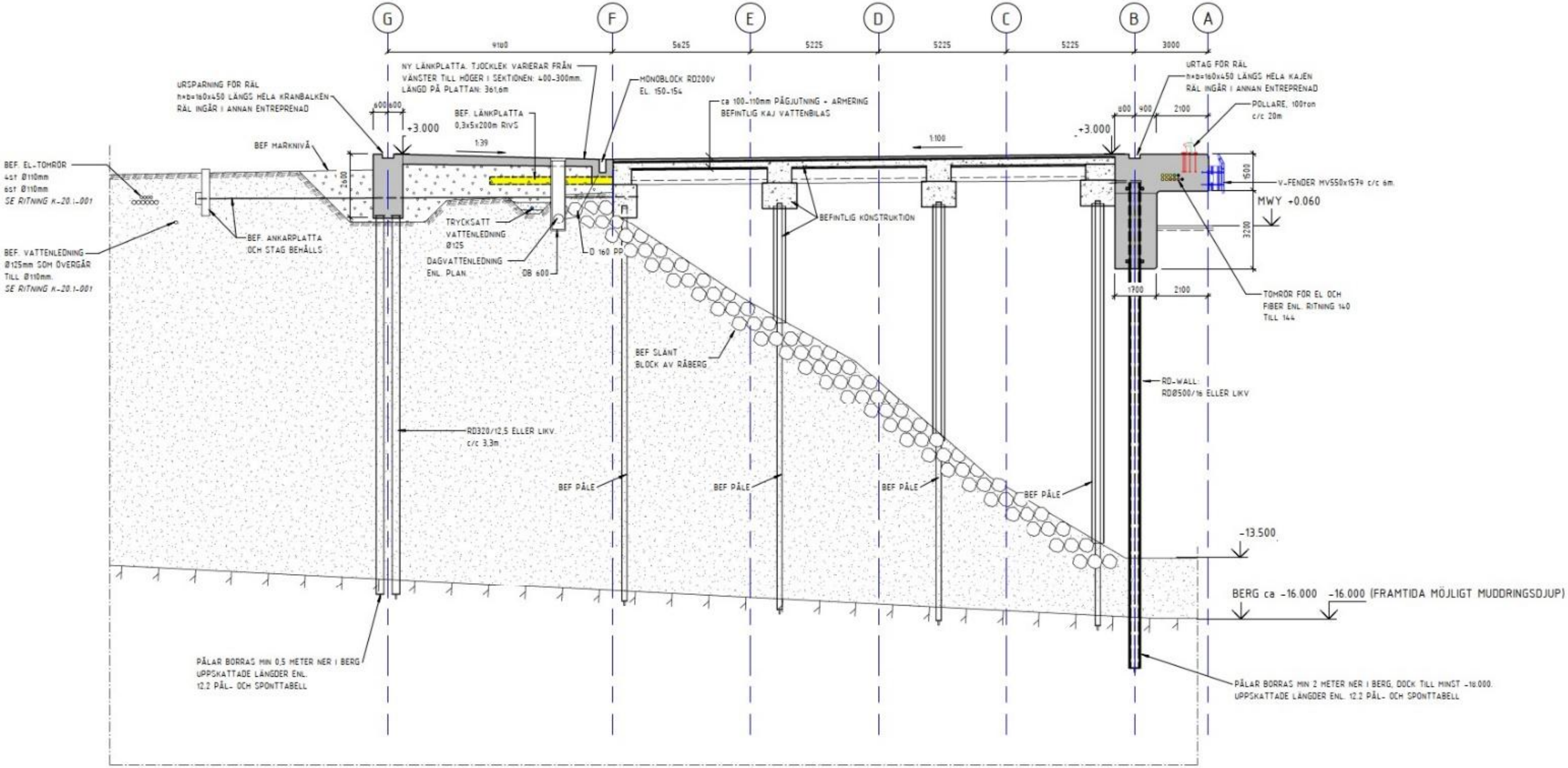


Figure 5: Reinforced concrete slab between the quay and the foundation for the container cranes on land

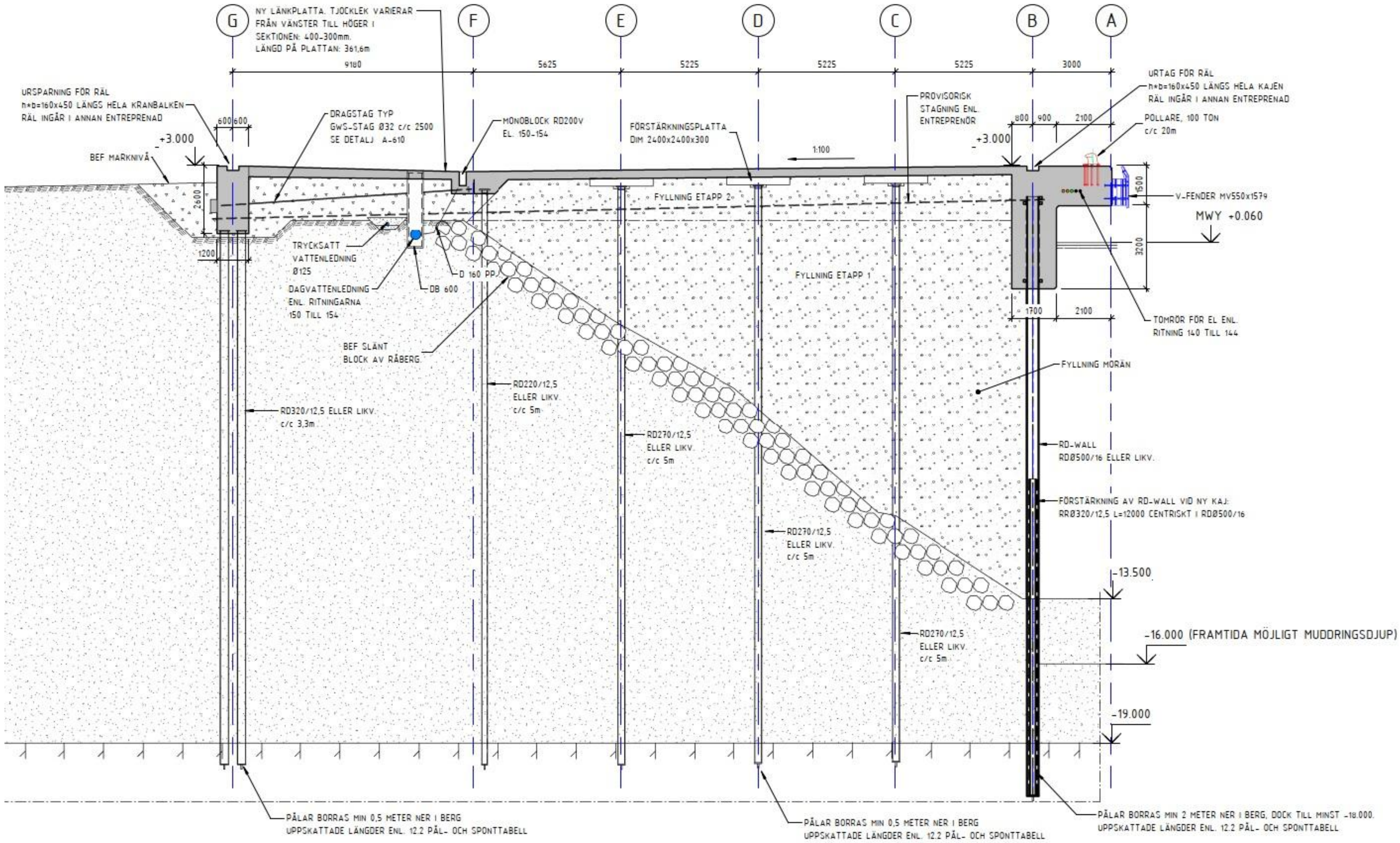


Figure 6: Space between the quay and the foundation

PORT OF GÄVLE AND ITS EXTENSION

CAPPING BEAM FORMWORK

Inma Gómez, Division Director, Rúbrica Maritime

1. INTRODUCTION

This article discusses the equipment which is used for Project of the upgrade of the Port in two phases.

The first phase is the widening and strengthening of 200m of an existing quay.

On completion of this first phase the second phase involves the extension of the quay by 160m.

Having two clearly differentiated construction areas will result in equipment that has to be designed so that its initial configuration is easily modifiable and adaptable for the construction of the second phase of the project.

In this article we will study the design of the formwork for the first phase of the dock, giving at the end of it some comments on the necessary modifications for the execution of the second section.

→ *Figures 1 + 2: Existing Quay Wall*

2. WORK-SITE ANALYSIS

2.1. Configuration of the existing quay

As mentioned above, this phase is about constructing a new quay attached to the existing quay structure to increase its width and strength and thus be able to carry the new cranes for the new port operations.

The first step in the design of the formwork required to construct the quay is to carry out an analysis of the loads existing on site which will determine the design of the formwork.

The existing quay capping beam is supported by a series of 508mmØ piles spaced 5m longitudinally, see Figures 1 and 2 below.

Figure 3: Quay wall of interlocking metal 500mm Ø piles

→ Figure 4: Already concreted steel piles

In the head of these piles, to improve the support of the cantilever beam, there are two HEA200 1.4m 'H' beams welded on both sides of the pile and in the longitudinal direction, coinciding with the width of the beam.

The theoretical axis of the piles is 700mm from the face of the existing quay but they are very misaligned.

This has resulted in a gap of 250mm between the pile and the face of the new quay wall, and a gap of 300 - 350mm in the remaining piles.

2.2. Details of the new quay wall

The quay wall is constructed of interlocking metal 500mmØ piles to be filled with concrete and constructed 800mm in front of the existing quay wall.

The new capping beam will be supported by the piles which will also be on the waterside crane rail centre line to carry the new cranes.

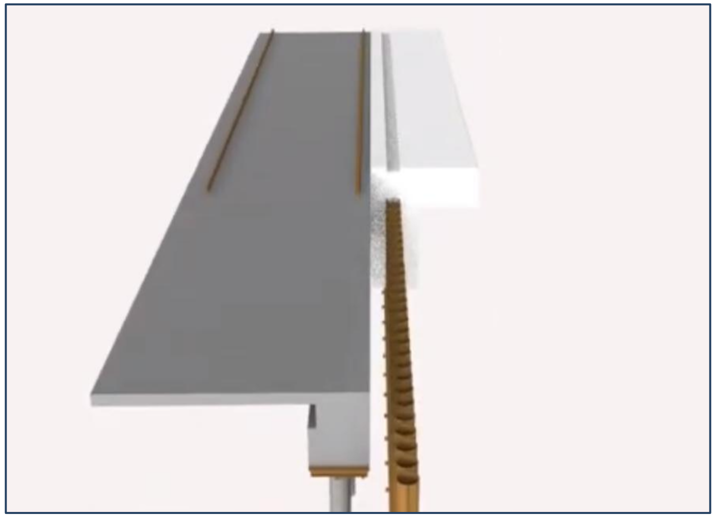
This capping beam has an inverted "L" shape (Γ) which is considered the strongest design for the formwork which will be used to construct the capping beam.

The front overhanging section has a dimension of 2.1m wide x 1.5m high and is considered the most restrictive and conditioning element to design the formwork which will be used to construct the capping beam.

The total height of the new capping beam attached to the old quay is 4.7m with the pile wall embedded 3.55m inside it.

The only connection between the two concrete sections, inside and outside the wall are the rebars welded to the piles.

In Figure 5 you can see the definition of the existing quay as well as the new section to be built.



Video 1: Click on the image to play the video

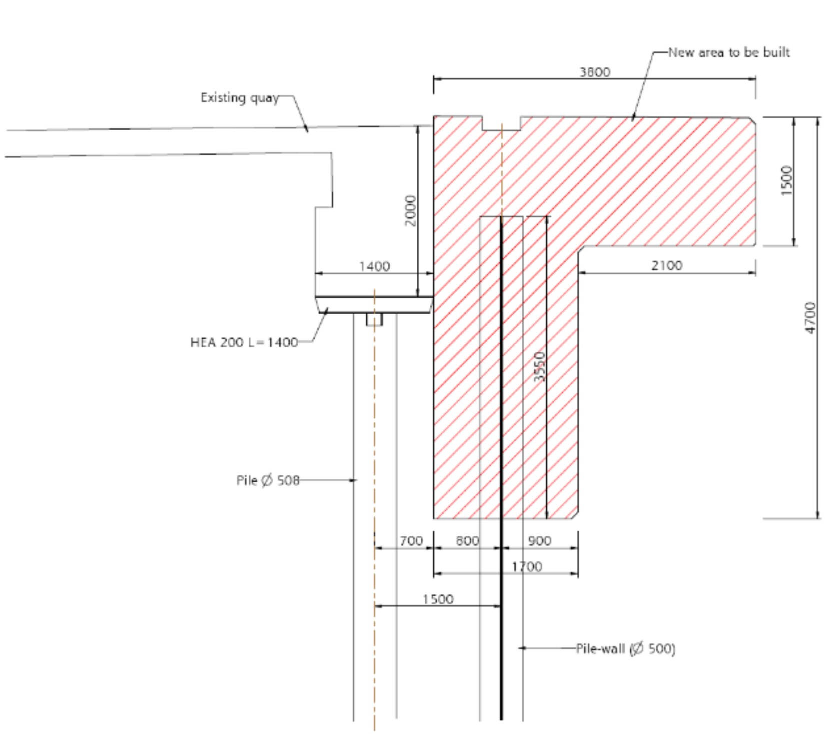
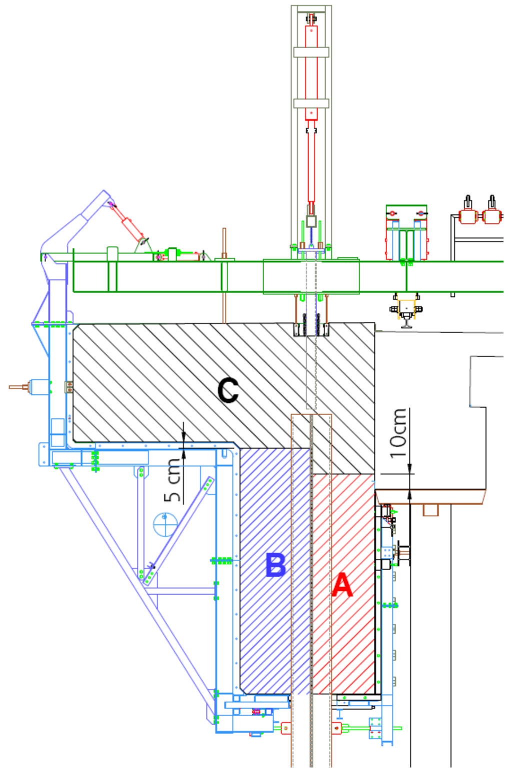


Figure 5: Section through new and existing quay



← Figure 6: Concrete Pour Phasing

3. EQUIPMENT DEFINITION

Due to the large dimensions of the new capping beam it was initially proposed to undertake the concrete pour in several phases.

In the first phase the beam around the pile wall up to a height of 3.2m in line with the lower face of the overhang area will be built and then pouring the entire upper section of the capping beam, 3.8m wide x 1.5m high will be done.

The client initially approved this methodology but when this solution was well developed the client requested that the entire section should be poured using a single formwork structure.

They requested this be undertaken without moving the formwork off the quay and with the concreting being carried out in several phases, as shown in Figure 6.

The reason is to accelerate the execution of the capping beam and guarantee the correct geometry of it.

Another of the client´s requirements to affect the design of the formwork is that operations under water requiring the use of divers should be minimized.

And finally it should be also taken into account that all the reinforcing bars for the capping beam were going to be installed before the formwork was relocated so there should be no elements in the formwork that could interfere with the reinforcing bars at the time of moving it forward.

All this lead to a formwork composed of four clearly defined elements:

- Interior panel: for the construction of the section in the interior part of the pile wall and up to a height of 100mm above the lower face of the existing capping beam.
- Exterior panel: which will configure the outer vertical covering of the pile wall plus the entire upper slab.
- Carriage: for the transport of the exterior panel and as a supporting element for the vertical concreting loads in both exterior and interior panel.
- Front closing panel.

3.1. Interior Panel

The first and main limitation for the design of this panel was the limited space for its installation.

The panel must fit in the gap between the piles of the existing quay and the inner face of the new capping beam. It should not only fit, it is also required to have some clearance to allow the release and repositioning of the formwork.

As the existing piles are so misaligned this has resulted in the existing gap being minimal in many cases and this greatly reduces the allowable design thickness of the panel.

This restriction has greatly influenced the design of the profiles that will make up the inner panel.

This has resulted in the panel being designed to withstand a maximum pressure of $30kN/m^2$ instead of the $60kN/m^2$ which is the pressure this equipment is normally designed for.

Due to the reduced clearance the method of advancing this panel needs to be as simple as possible.

The solution has been to weld an IPN160 profile to the HEAs on the underside of the existing quay piles and the panel to be hung from this profile by means of two Jaguar 500 trolleys.

Once the panel is released it will be sufficiently clear to move it to the next concreting position.

The next design requirement in the panel is its anchoring points to counteract the loads generated during concreting. In order that the panel works properly and does not open or deform, it must be attached along its bottom edge to the pile wall.

To enable this, a series of lugs was welded every 2 piles to which the panel will be tied by GW32 bar. Each of these connections are designed to withstand a force of 110kN.

In addition to the lower connection the panel is to be propped against the existing quay piles at a distance of 810mm from the panel lower edge.

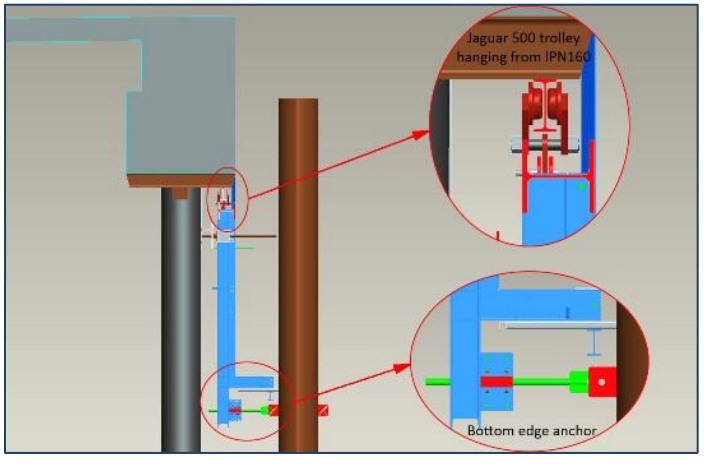
This support will be made using TITAN500 wedge jacks, each holding a load of 257kN.

To counteract the horizontal loads during the concrete pour, the panel will be tied at the top front and aligned with the wedge jacks to the pile wall using a DW26.5 bar.

At the back it will be anchored to the previous section by means of a double flange system using DW15 bars, see Video 2.

Finally, and to support the vertical loads created when pouring the concrete, the bottom panel will be hung from the transverse beams of the transport carriage using vertical hanging bars spaced at 1.15m.

As has already been discussed the reduced available space under the quay and the misalignment of the existing piles made it necessary for the panel to be divided into 6 parts, being cut into 2 halves vertically and in 3 parts longitudinally.



Video 2: Interior Panel

Click on the image to play the video

This will allow for easier installation of the panels at the time of its initial assembly, as well as in specific cases when it must be disassembled and repositioned to overcome obstacles.

The lower closing panel is formed by a fixed section plus a sliding element with the necessary adjustment to make the correct alignment against the wall.

The fixed section is the interior panel itself as it has a lower L-shaped horizontal section which is the formwork for the outermost 0.4m of the lower horizontal face.

The remaining gap is divided longitudinally into a series of palettes, see Figure 7.

Each palette has the geometry of 1 complete pile in the central zone and ½ pile at each end, with a total of 10 double palettes and a single vane at each end.

These palettes fit between two UPN profiles under the horizontal section of the interior panel and have a certain degree of freedom to move independently both longitudinally and transversely so that the panel could be manually adjusted against the pile wall.

3.2. Exterior Panel

3.2.1. Panel configuration

The length of the exterior panel or sea panel will define the length of the other elements of the formwork (inner panel and transport carriage).

This is fixed by the position of the fenders in the cantilever beam.

This panel must be designed to allow the placement and fixing of the fender fastener arrangement so that these are embedded in the concrete after the pouring operation.

The fenders are placed every 6 meters. After several meetings with the client and to meet the project deadline a casting length of 12 meters was chosen.

Therefore as each section is constructed 2 fenders can be fitted after the carriage has relocated to the next section.

With the 12m length the panel will be covering 21 piles being the longitudinal position of it with respect to the pile wall different in each segment. This implies that the end of the panel can be aligned with the axis of a pile or that it can be moved forward or behind it.

This forces the bottom panels that must be adjusted against the pile to have longitudinal regulation in addition to the transverse one to absorb possible misalignment of the piles.

The panel is calculated and sized to withstand a maximum pressure of 60kN/m^2, which will result in a design of the panel as described below.

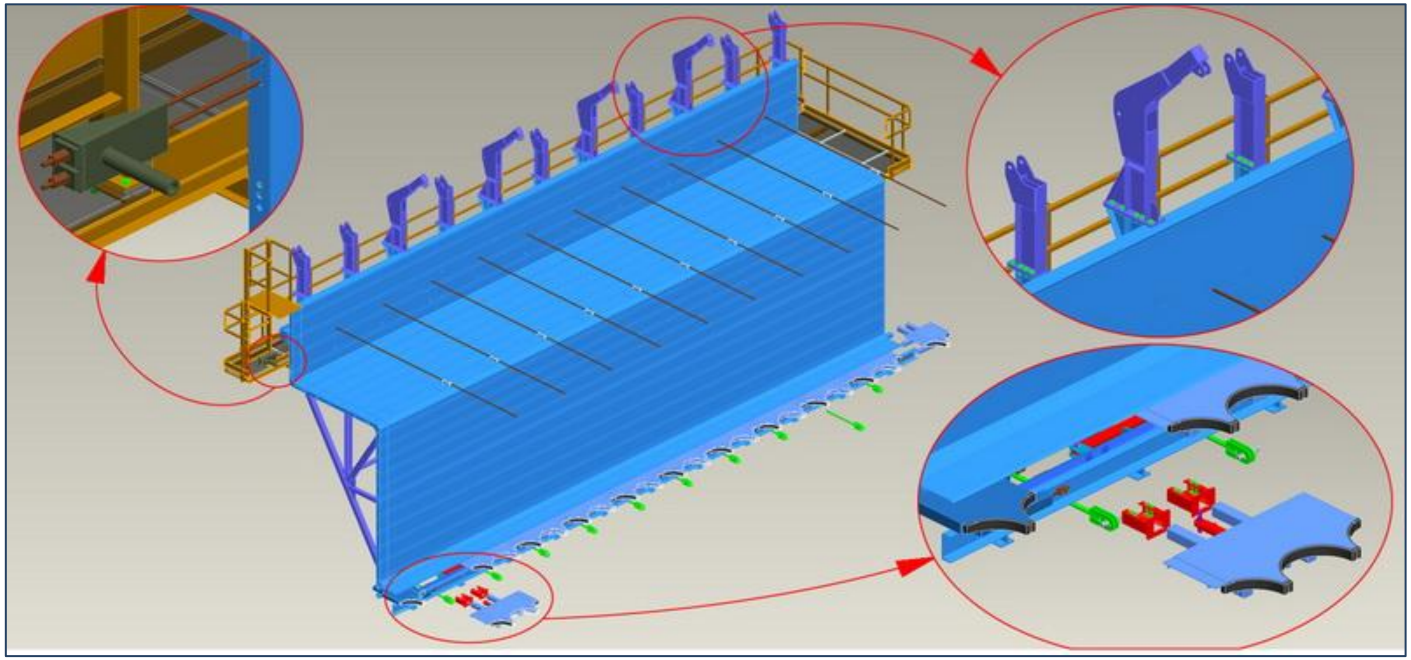


Figure 7: Exterior Panel

Formwork metal sheet has a 5mm thickness. It is stiffened at the bottom with IPE80 horizontal profiles with a maximum axis distance of 310mm where the load is greater and 330mm at the top.

A second level of IPE220 vertical beams is installed at 1.15m centers, coinciding with the distance between two piles.

They have propping brackets from the lower face of the hanging area to the vertical face of the lower part of the beam, see Figure 7 and Video 3.

Video 3: Exterior Panel

Click on the image to play the video

3.2.2. Supporting arms

To fix the panel to the carriage, each of the vertical beams is extended until reaching the transverse beams of the transport carriage.

They are attached to the carriage by 30mmØ pins manufactured in 42CRM04 material so that they are strong enough to support the weight and forces generated by the formwork.

In addition, 4 of these 11 beams will be modified to act as a connecting element with the hydraulic cylinder used for swinging the panel during the stripping operation.

Figure 8: Supporting Arms

3.2.3. Anchoring points

The next item to be discussed is the design to ensure correct panel behaviour during the pouring process and the connections for attachment to the external structures and site elements.

The panel must have the following fastening points:

- Lower fastening to the pile wall:
  The first point to be fixed is the lower end of the sea panel. This is due to its long length. It is necessary to avoid any anchoring inside the formwork in this lower part where the access would be very difficult and needs to be carried out by divers.
  Therefore, this attachment is carried out in the area below the formwork by attaching the panel with GW32 bars to lugs previously welded onto the pile at the level indicated by Rúbrica's design to support the load of 120kN.
  To ensure that this attachment can be done correctly, the GW32 bar will have a positioning tolerance both vertically and longitudinally.

- Fastening to the existing quay:
  In order that this fastening was as effective as possible, it had to be as low as possible, so Rúbrica proposed a position just above the pile wall, separated from it just enough to pass the PVC pipe covering it.
  However, once the client is informed of the loads being transferred to the existing quay they requested that they must be at a distance of 0.7m from the lower face of the hanging area instead of the 0.4m proposed by Rúbrica

since the existing quay's concrete is not able to withstand such force with so little coating.
This change required an increase in the diameter of the bars, going from DW20 to DW26.5.
The fastening at this level will be undertaken as follows: The DW26.5 bars are fitted every 1.15m and embedded 0.54m into the existing quay and protruding approx. 1.1m.
These bars will be embedded in the concrete section and will work both as an attachment for the formwork and as beam reinforcement.
This inner bar will be connected to a temporary external bar on the panel with a coupler SAS WR 3003, which will be removed when the formwork is released.

- Vertical hanging bar:
  To support the vertical loads during the concrete pour, it is necessary to install a vertical hanging bar.
  Rúbrica proposed an initial position where the bar will tie into the lowest part of the formwork, this is, the lower face of the capping beam that covers the pile wall, to the transport carriage.
  At the request of the client to eliminate an additional diving operation, this bar is moved until it is as close as possible to the capping beam but on the underside of the overhang area, so that it can be installed from a barge.
  The DW26.5 bar will go from each of the transverse beams of the transport carriage to nuts welded at the bottom of the panel, having to withstand a load of 200kN.

- Rear anchoring:
  To counteract the longitudinal loadings generated by the concrete pour against the front panel and to prevent the structure from moving forward, there is a rear attachment of the sea panel to the previous section.
  The holes left by the bars of the attachment to the existing quay are used for this anchoring arrangement.

3.2.4. Lower closing panel

Since the capping beam is constructed on a pile wall, the lower closing panel must have a geometry that copies the shape of the pile wall, allowing the correct closing of the panel against it and thus avoiding any possible concrete leakage.

The lower closing panel is formed by a fixed section plus a sliding element with the necessary adjustment to make the correct alignment against the wall.

The fixed section is the vertical panel itself as it has a lower L-shaped horizontal section which is the formwork for the outermost 0.4m of the lower horizontal face.

The remaining gap is divided longitudinally into a series of palettes, see Figure 9.

Each palette has the geometry of 1 complete pile in the central zone and ½ pile at each end, with a total of 10 double palettes and a single vane at each end.

These palettes fit between two UPN profiles under the horizontal section of the sea panel and have individual hydraulic actuators to provide transverse adjustment and hydraulic actuators to provide longitudinal adjustment by means of a pusher beam that moves 2 palettes at the same time.

To ensure a tight seal without concrete leakage, each palette has a 30mm thick rubber / neoprene seal where it comes into contact with the pile.

Figure 9: Bottom Palette

3.2.5. Fender preparation

As mentioned above, the panel will have the holes to accommodate and leave embedded in the concrete the necessary anchors and fastening elements for two fenders.

3.2.6. Working platform

This panel has a working platform to access and place the panel tie rods to the existing quay wall as well as the rear anchoring to the previous section. It also gives access to the front part of the equipment to provide a stable working platform when assembling the front panel and closing elements.

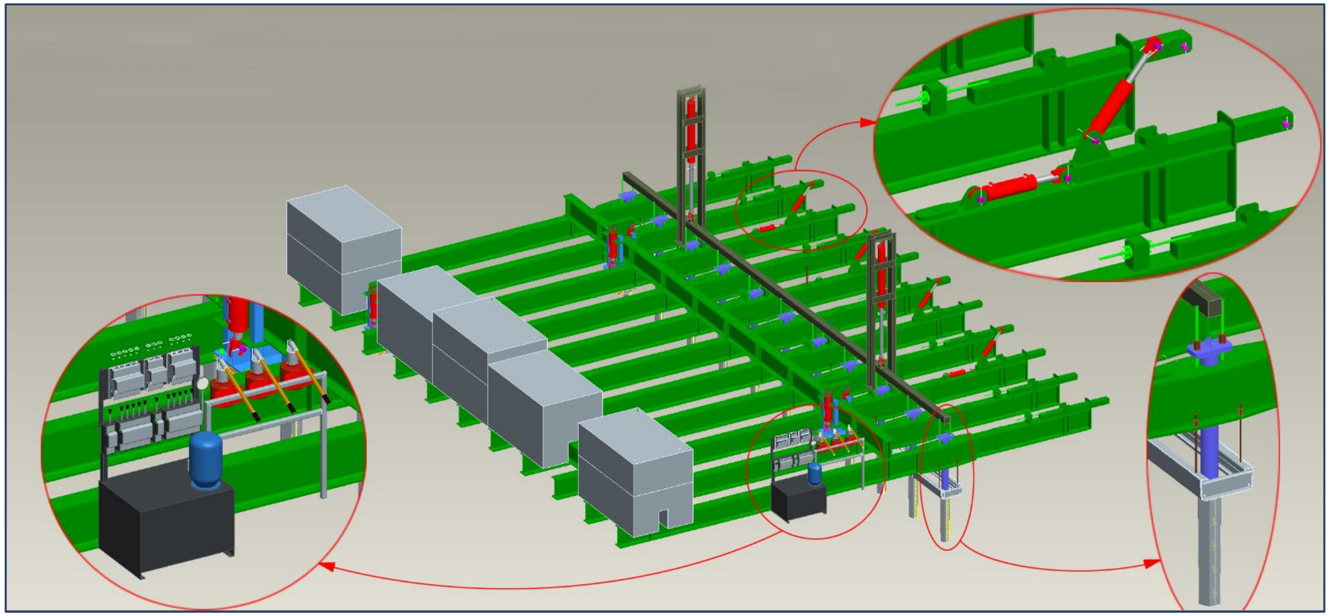
3.3. SUPPORTING AND TRANSPORT CARRIAGE

The carriage consists of 11 cross beams, 1.15m apart, constructed with IPE400 profiles.

These beams are stiffened and tied together by two IPE400 profile longitudinal beams spaced 5mm apart.

The profile closest to the seaside is 400mm from the edge of the existing dock.

The longitudinal beams house 4 motorized wheels that will move the structure. For this equipment, and due to the high loadings which they will be subjected to, DEMAG DRS315 hydraulically driven wheels were chosen.



Video 4: Supporting and Transport Carriage

Click on the image to play the video

These are fitted with self-lubricating spheroidal-graphite cast iron (GGG 70) bearings for low friction and high resistance to wear.

These wheels move on RN45 rails that are required to be leveled correctly as per Rúbrica's design. In addition, each of the wheels will have an independent vertical adjustment using hydraulic cylinders.

This will guarantee that the correct positioning and leveling of the structure can be achieved.

The land-side wheels will support a 47kN load when empty and up to a 104kN load during concrete pouring.

The sea-side wheels will support a 102kN load when empty and a negligible value during concrete pouring. This is due to the fact that at each of the transverse beams there is a vertical leg that will rest on the pile head at the time of concreting to reduce imposed overturning moment.

In this way the load from the concrete at the land side is transferred to these legs relieving the load on the land side wheels.

These vertical legs are within the area to be concreted. For this reason the equipment has been provided with a lifting structure.

This enables all the legs to be lifted simultaneously by means of hydraulic cylinders until they are above the poured concrete so that the formwork can move forward without them interfering in the movement.

During the concrete pouring the legs will be protected by a recoverable conical cover that prevents them from being trapped by the poured concrete.

Hanging from the transverse beams, and centered with the axis of the legs, is the panel that will form the crane seaside rail.

The exterior panel is connected to the transport carriage through a double UPN100 closed profile at the end of each of the cross beams.

These hanging arms have hydraulically operated transverse adjustment on 4 of the beams. These beams will contain the hydraulic actuators to turn the panel in the stripping operation. In the rest of the beams, these arms have a DW15 bar that will be used to fix their position once they are correctly placed by means of the cylinders.

This adjustment ensures the correct alignment of the sea panel thus achieving an accurate positioning of the exposed vertical face of the capping beam.

All hydraulic cylinders required to operate the different elements that make up the equipment are operated from a control panel placed on the first transverse beam of the carriage.

Finally, a series of counterweights will be placed on the inner end of the cross beams to avoid overturning the structure both when empty and during concreting. In total 40tons of counterweight will be required.

Both permanent counterweights and counterweight during concrete pouring are required.

The permanent counterweights are necessary to avoid the overturning of the empty structure. They are made up of different concrete blocks permanently mounted on the crossbeams, with a total weight of 28tons.

The concreting counterweight will only be placed when the concrete is to be poured and will be removed when the structure is to be relocated.

As in the previous case, they consist of a series of concrete blocks placed on top of the permanent counterweight with a total weight of 12tons.

Figure 10: Supporting and Transport Carriage

3.4. FRONT CLOSING PANEL

For the front closing panel it was not possible to use a closed common panel for two reasons.

The first is the steel reinforcing bars for the connection with the next section protruding from the section in which the formwork is being used on.

The secondly it will reduce programme time by installing the steel reinforcing for the beams before the formwork is installed.

A perimeter metal plate is installed on top of which a series of horizontal beams are placed.

These are attached either to the outer or the inner panel at one end and are attached to the pile wall in the opposite side.

This metal plate will have a series of windows or gaps coinciding with the different levels of the reinforcing bars to help the correct positioning and support of the reinforcing bars.

In addition, the horizontal beams will serve as support for the phenolic panel, wire mesh, or other element that will serve as a frontal closure for the containment of poured concrete.

Figure 11: Front closing structure and reinforcing bars

Video 5: Front Closing Panel

Click on the image to watch the video

4. LOADS TRANSMITTED TO THE SUPPORTING ELEMENTS (PILE WALL, EXISTENT QUAY, ETC.)

As important as it is to ensure that the equipment is strong enough, it is also necessary to ensure that the external elements on which it is going to act are able to withstand the imposed loads from the equipment.

The value of these loads need to be determined by Rubrica and then approved by the client during its design.

The loads acting on the supporting structure (inverse value of the calculation reactions), are divided into reactions during the concrete pouring and reactions during the carriage movement.

↓ *Table 1: SLS Loads at support, (-) compression*

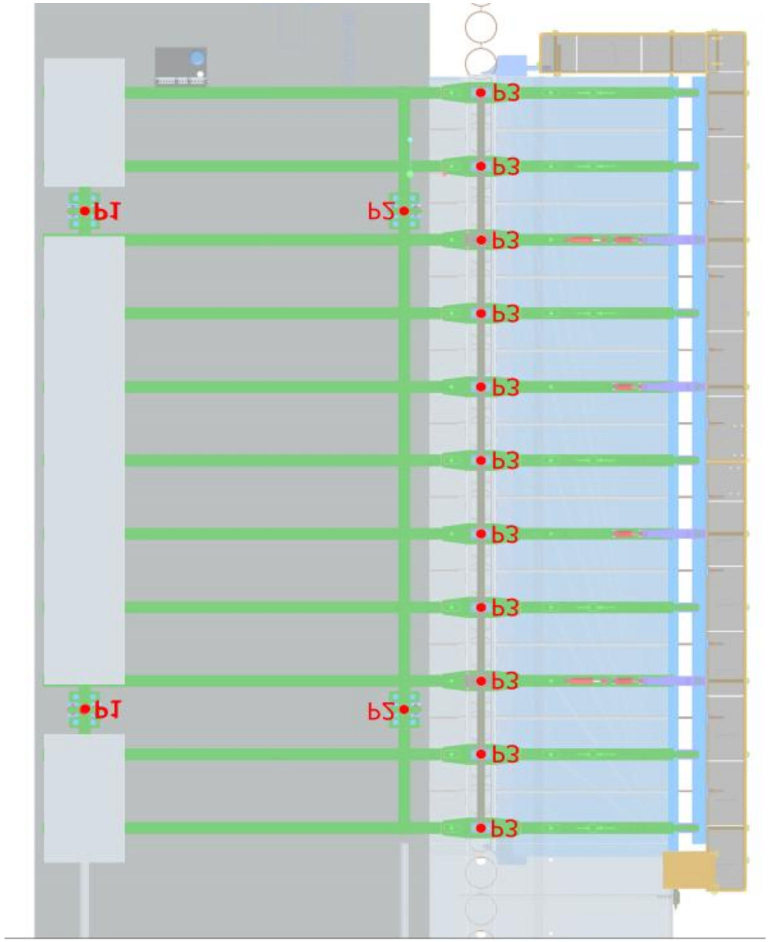
Position	Advance mov.	Pouring
P1	-47 kN	-47 kN + (-1,5 x 38) kN = -104 kN
P2	-102 kN	-
P3	-	-264 kN
P4	-	max -185 kN - min -83 kN [8]
P5	-	max -122 kN - min -63 kN [9]
P6	-	-

[8] See Figures 12 and 13

[9] See Figures 12 and 13

→ *Figure 12:*

Plan of support elements position



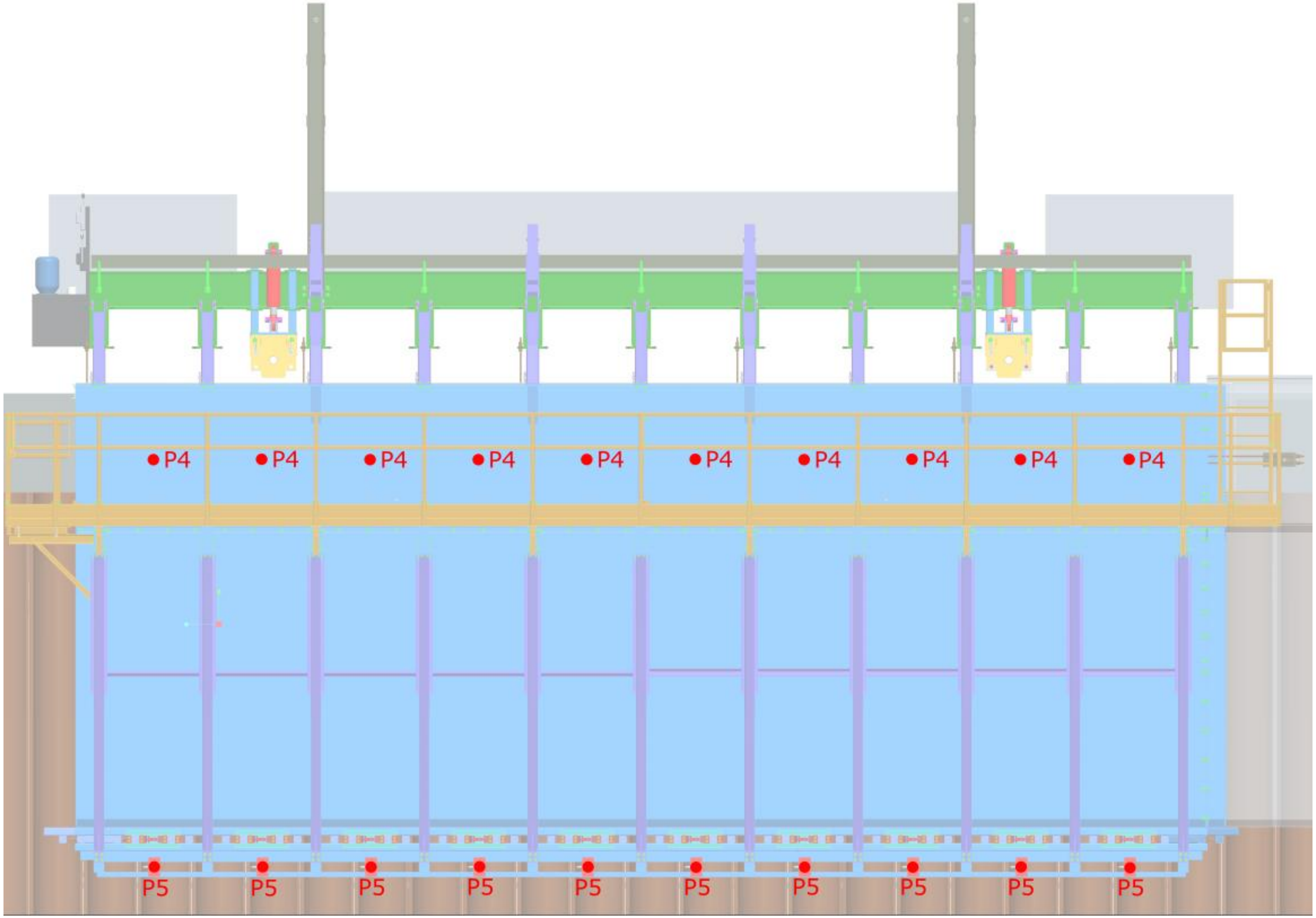


Figure 13: Elevation of sea-side anchors

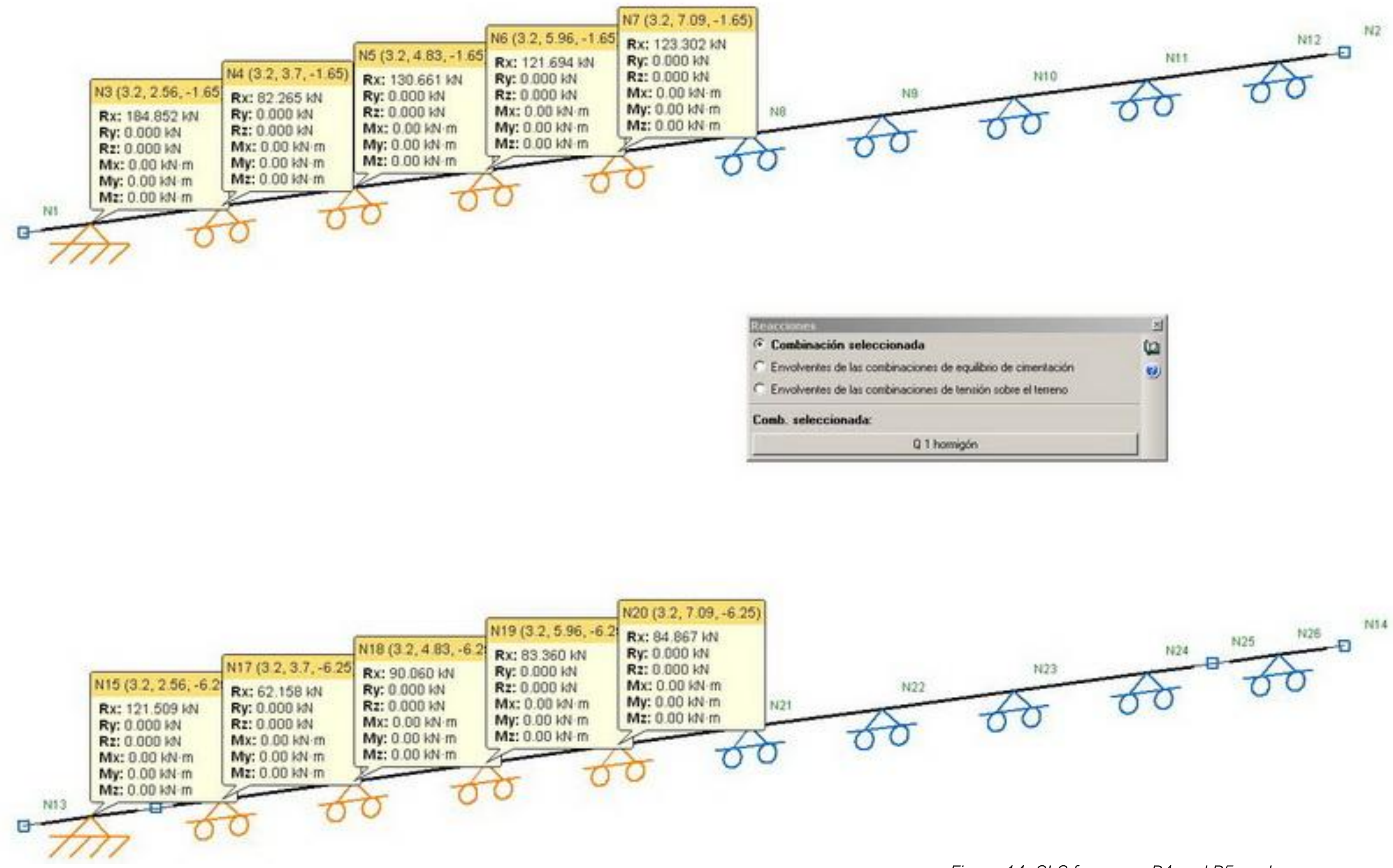


Figure 14: SLS forces on P4 and P5 anchors

5. ELEMENTS FOR ADAPTATION OF THE EQUIPMENT TO THE SECOND WORKING PHASE

As commented at the beginning of the article, the first working phase will consist of constructing a capping beam attached to an existing quay, while in the second phase 160m of cantilever beam will be built with the same geometry as in the first phase but without having any dock on the land side.

In the first phase the transport carriage drives on top of the old quay at +2.94m while in the second phase it moves on top of a filling area, finished with a concrete layer at +1.75m in the driving area of the equipment.

These factors make it necessary for a supplementary structure for the transport carriage that allows the wheels to be lowered by 1.19m which is the difference between the two driving levels.

In addition a closing panel on the land side will also be necessary to cover the 0.98m difference between the driving level and the top level of the new capping beam.

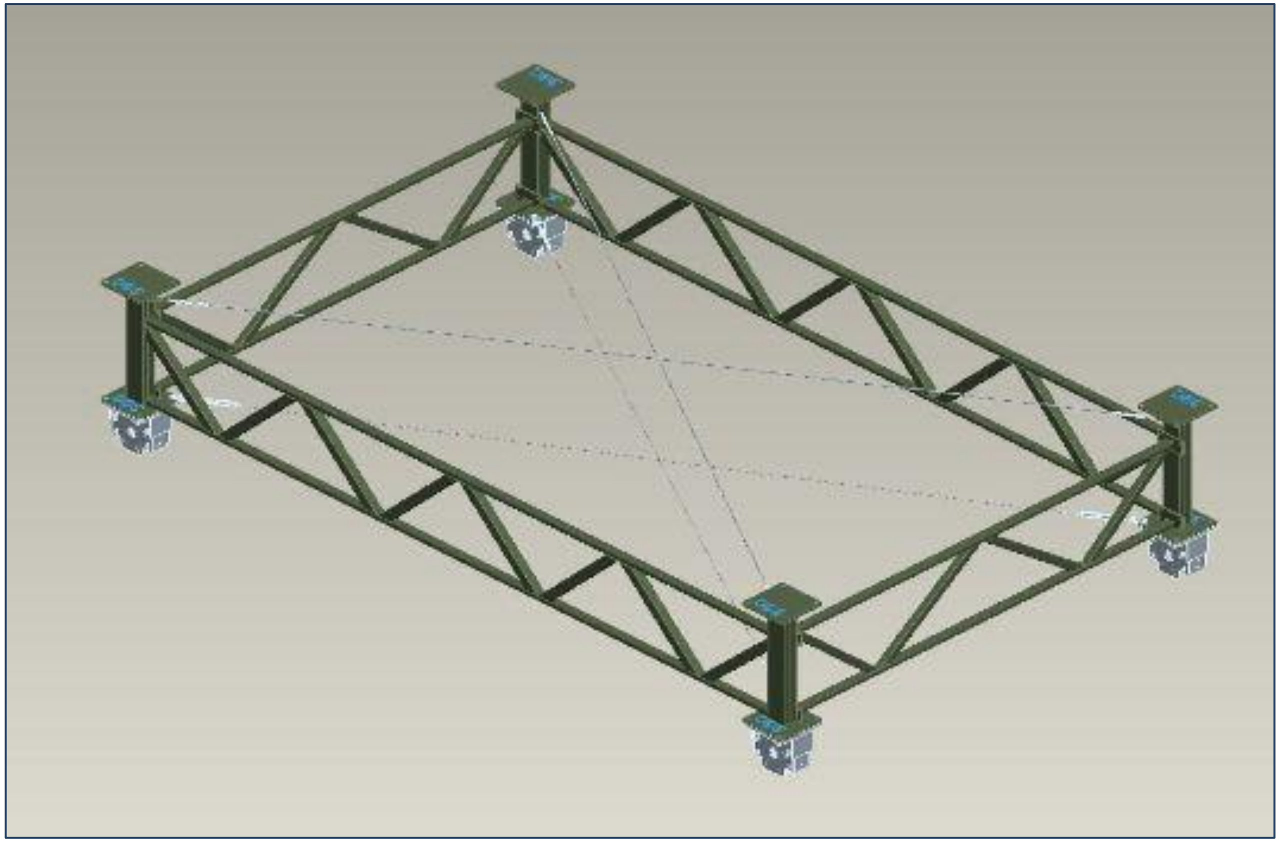
The supplement structure for the wheels is made up of 4 stiffened lattices by means of an upper and lower cross formed by Ø8mm cables.

The land side panel is formed by a 5mm thickness metal sheet stiffened with IPE80 horizontal profiles and a second level of vertical beams consisting of two UPN120 profile 1.15m apart.

The panel hangs on three of these vertical beams of the carriage's transverse beams and on the rest of the vertical beams there are a series of upper props to horizontally tie the land side panel to the sea panel at its top.

Finally, and coinciding with the position where the sea panel is attached to the existing quay in the first phase, a through bar will be placed to tie both panels at the bottom.

(See Figures 16 and 17)



← *Figure 15: Wheels supplement*

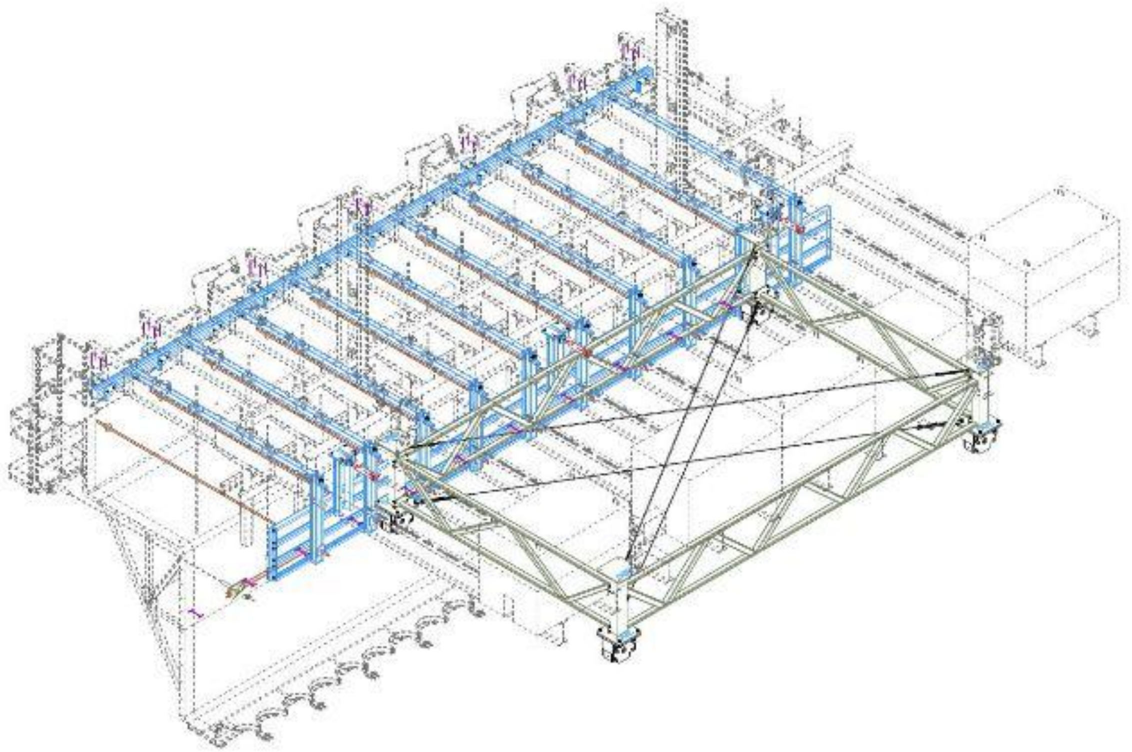


Figure 16: Additional Elements for second phase – Isometric view

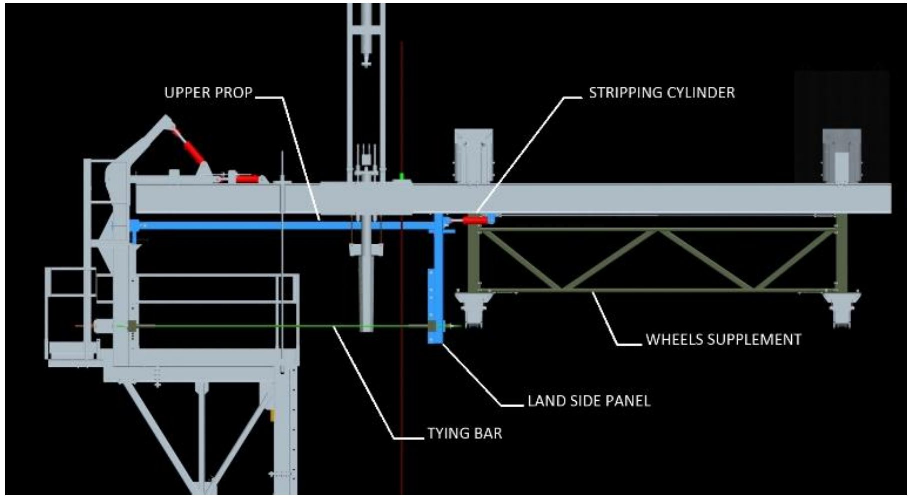
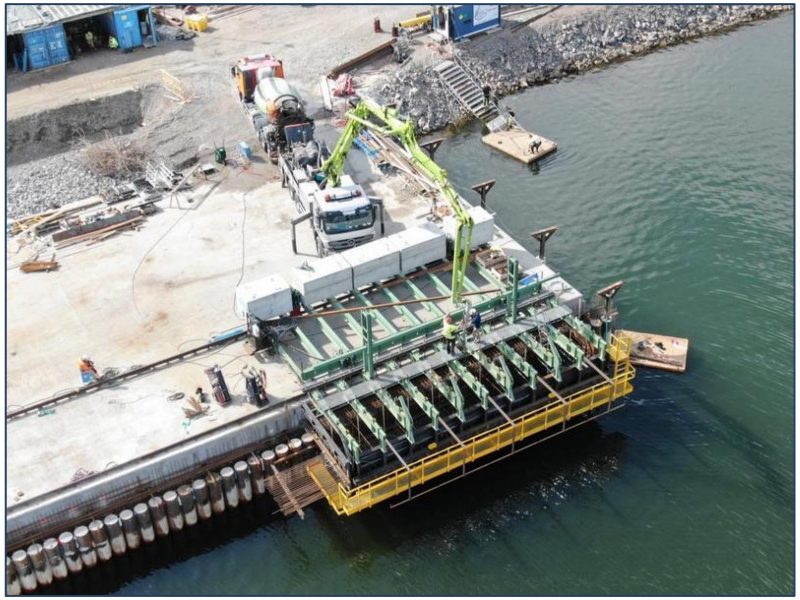
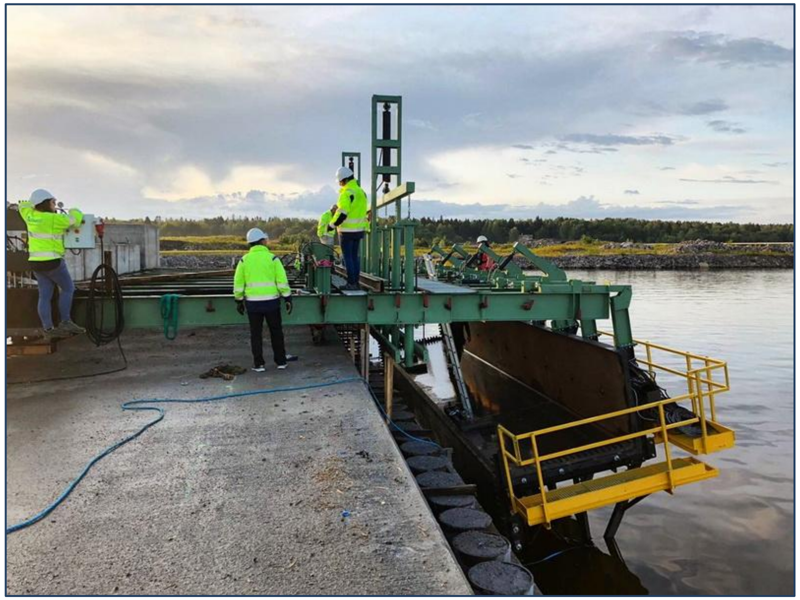
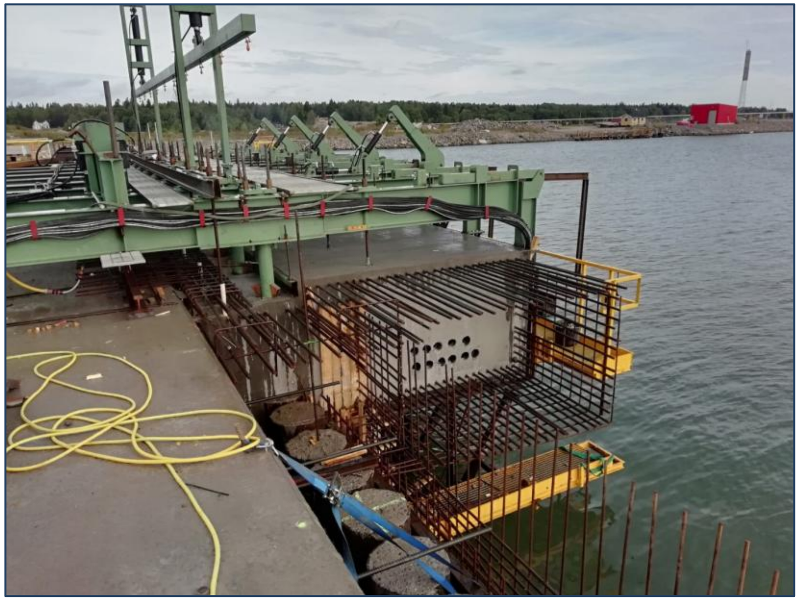


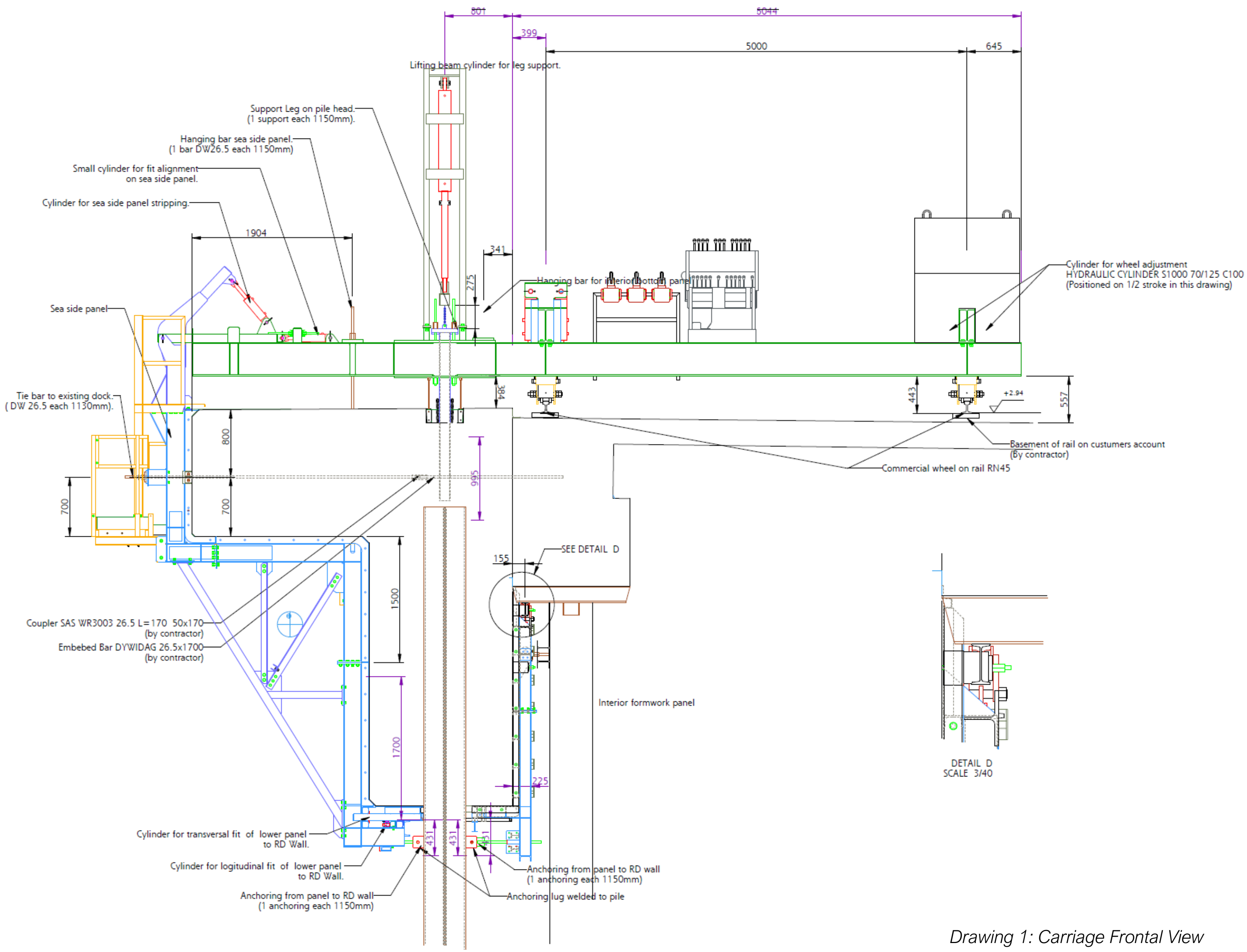
Figure 17: Additional Elements for second phase – Front View



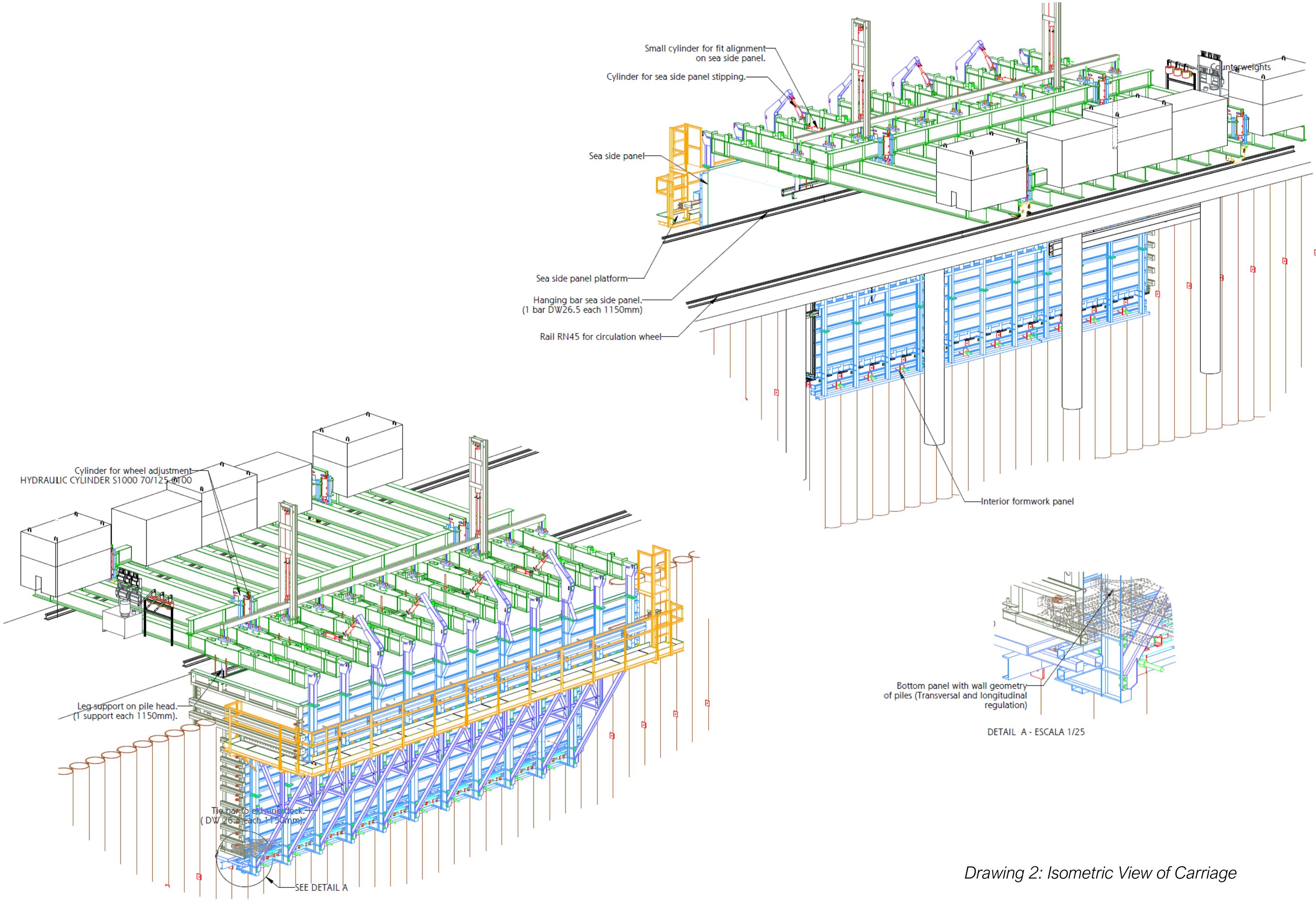




Figures 18 - 21: Formwork

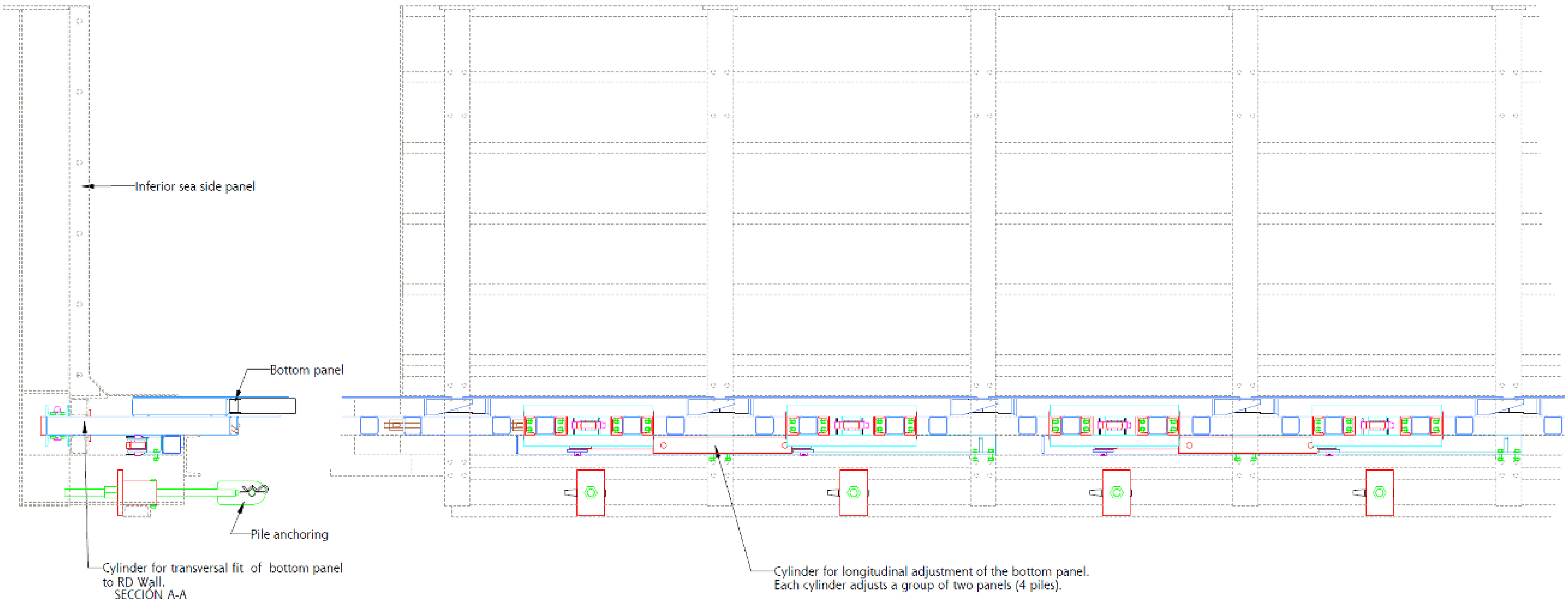


Drawing 1: Carriage Frontal View

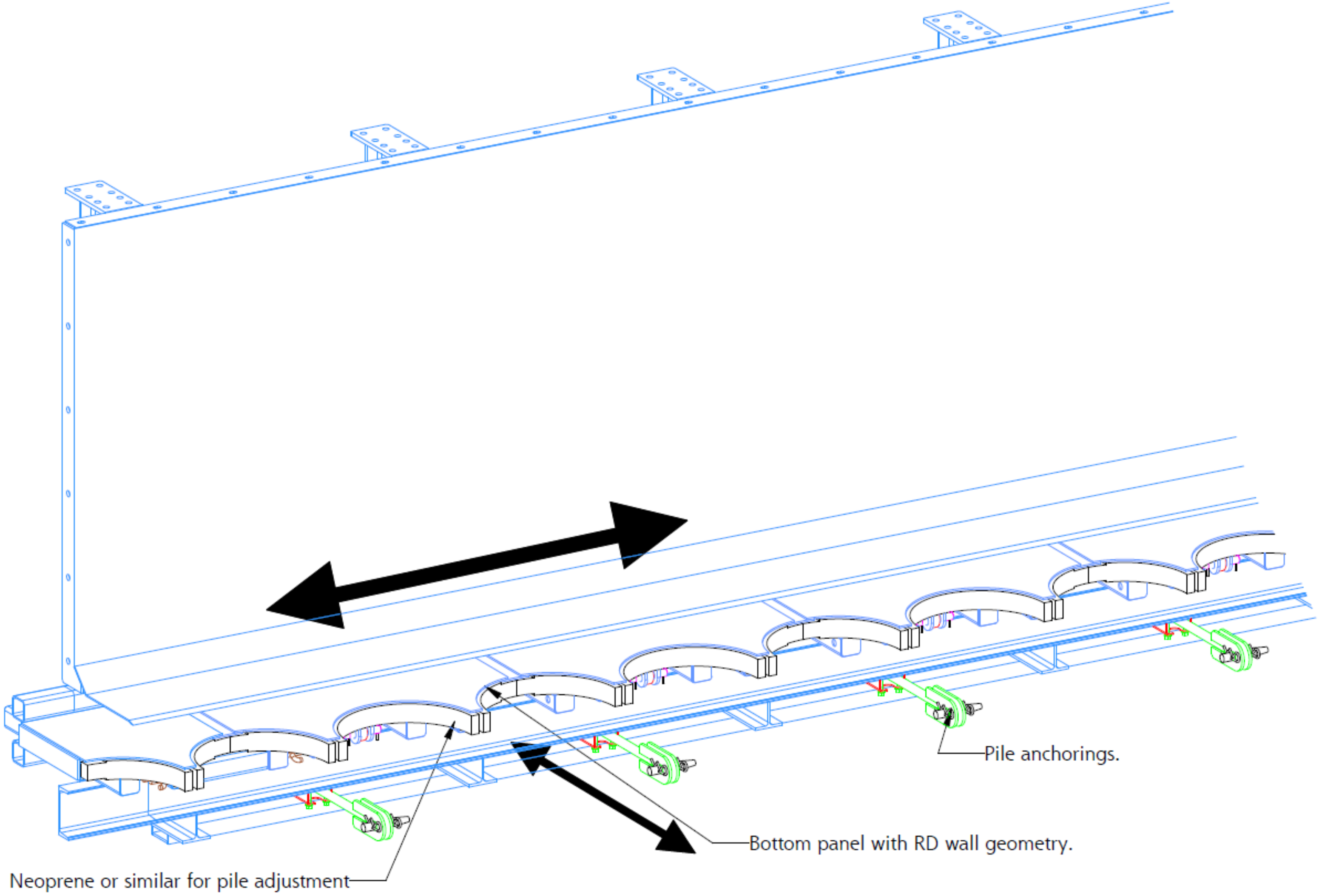


Drawing 2: Isometric View of Carriage

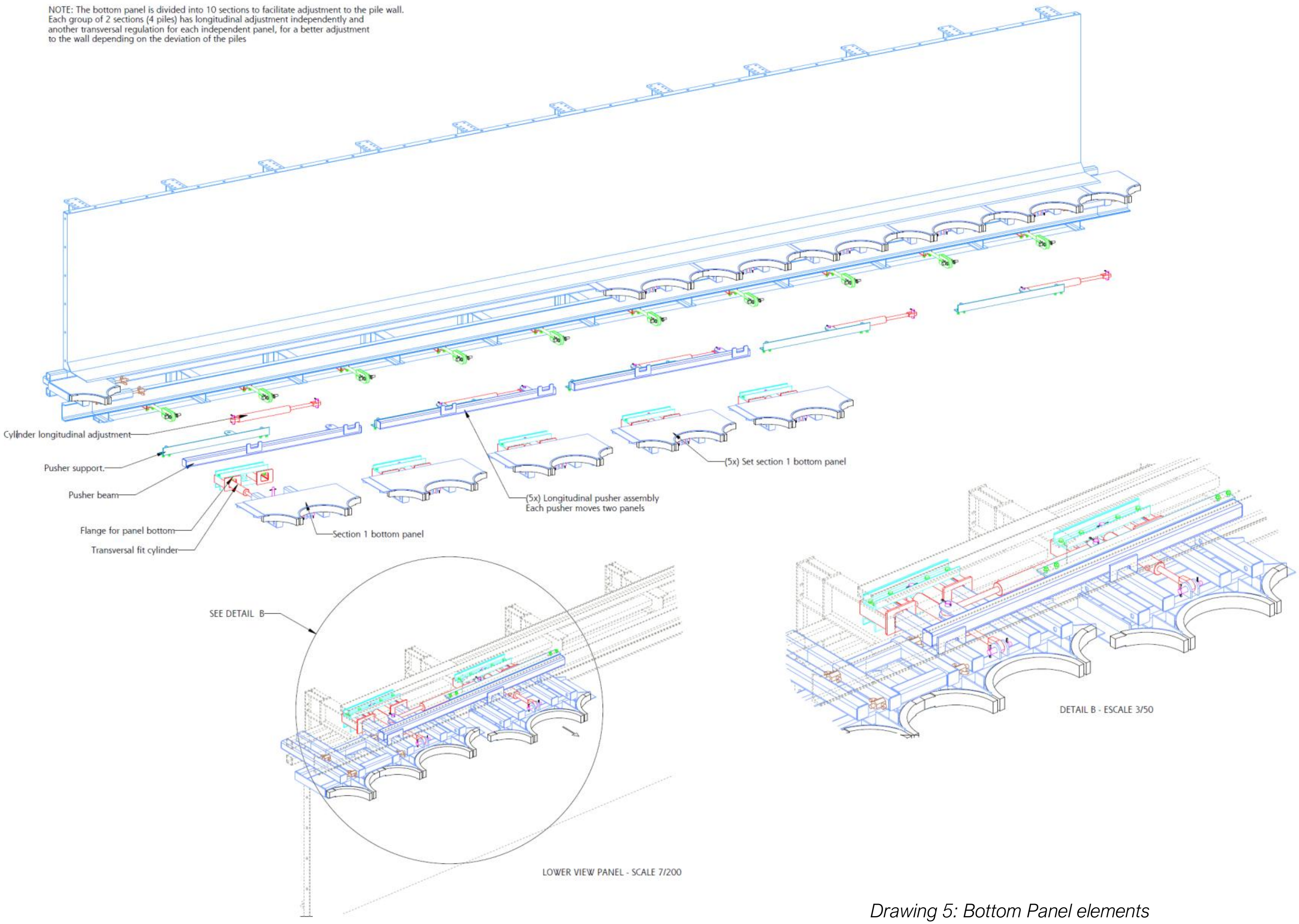
November 2019



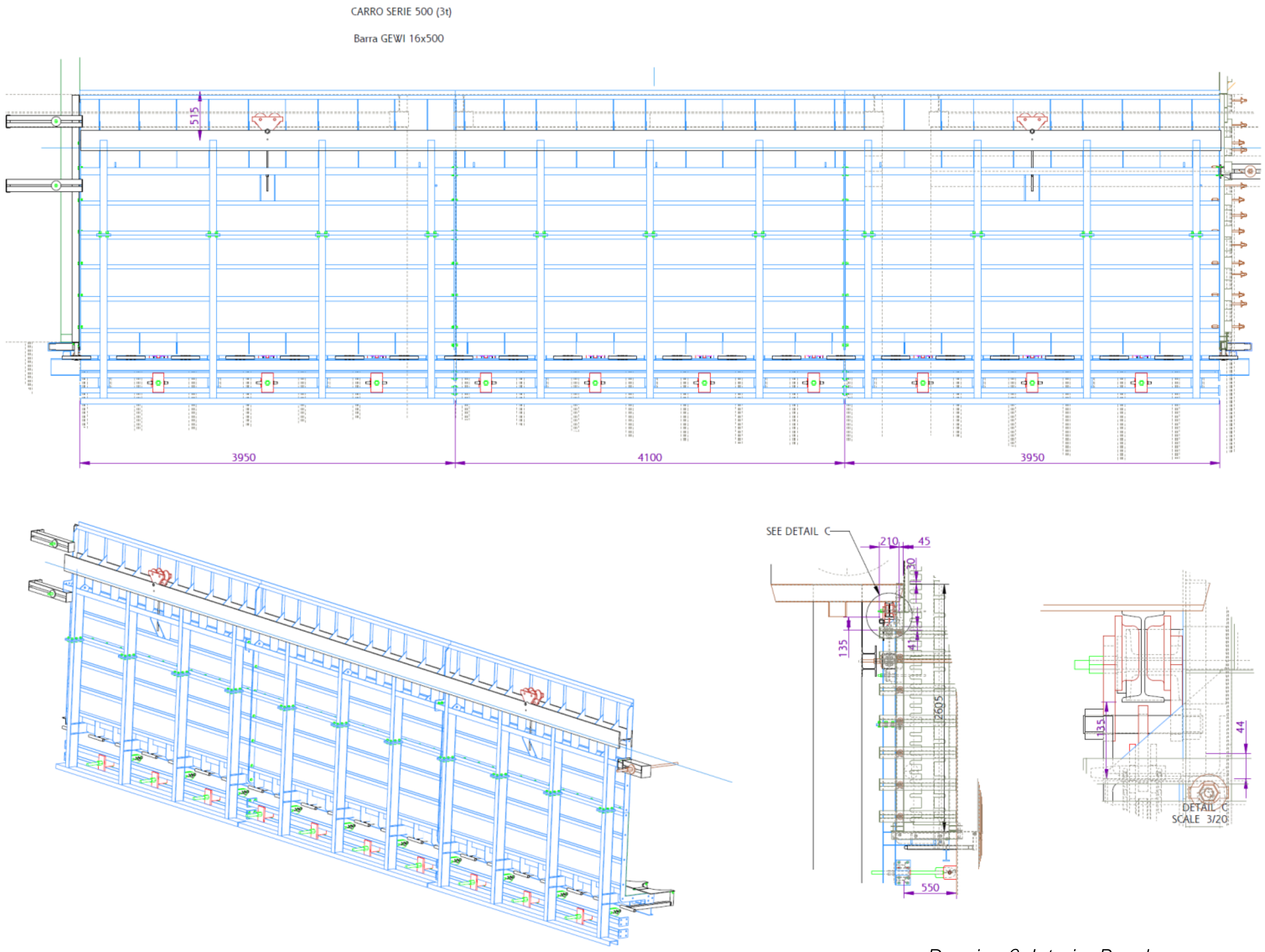
Drawing 3: Bottom Panel



Drawing 4: Bottom Panel

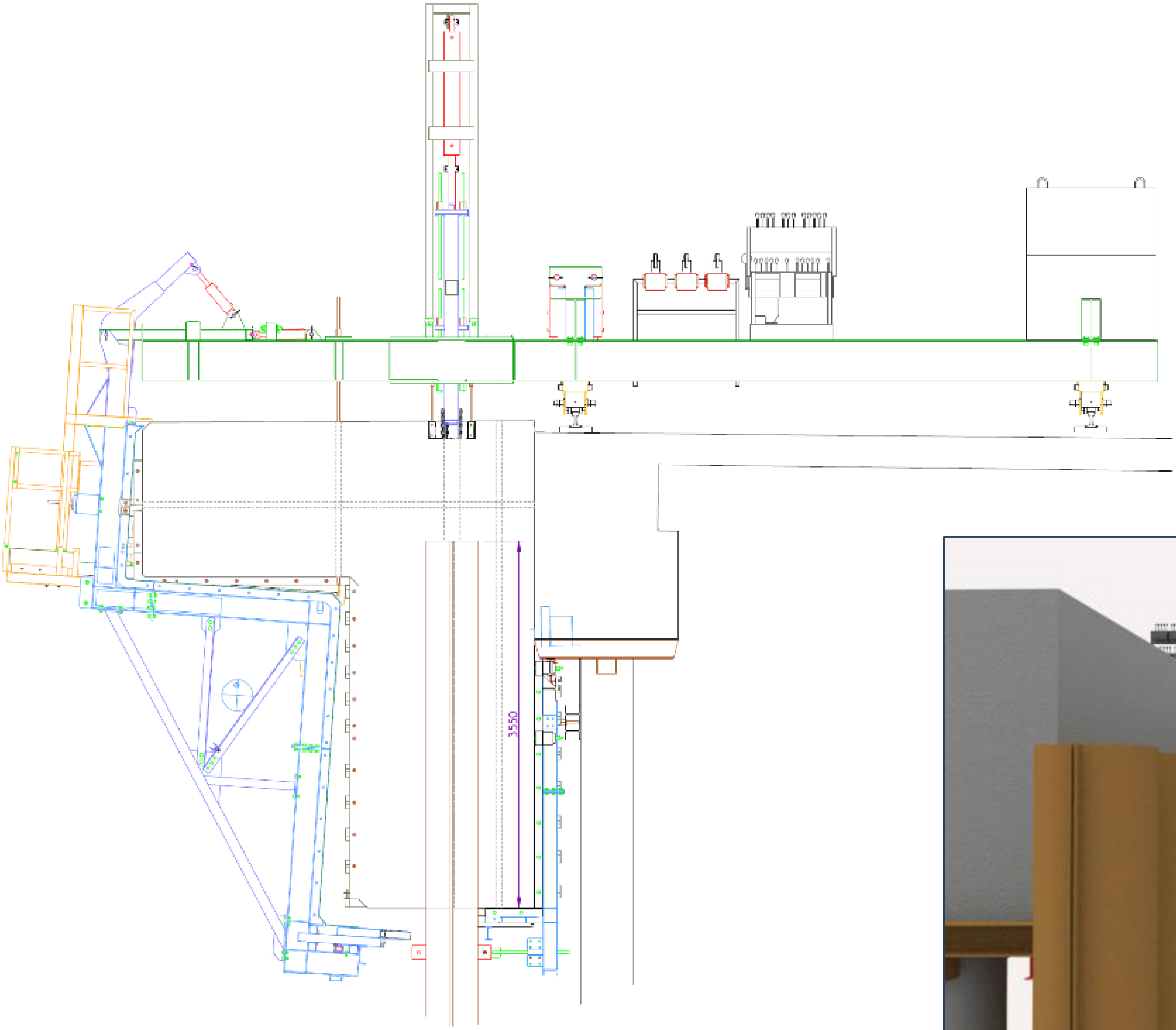


Drawing 5: Bottom Panel elements



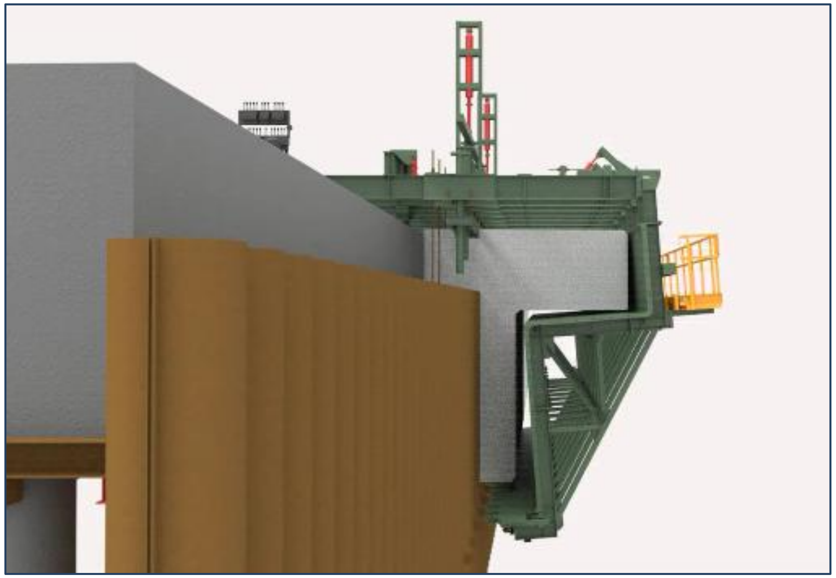
Drawing 6: Interior Panel

← *Drawing 7: Stripping Manouevre*



↓ *Video 6: Stripping Manouevre*

Click on the image to play the video



e-maritime

Editorial Plan

We are working on some special issues of e-maritime and e-mosty magazines.

If you and your company have been involved in related projects and are interested in cooperation and preparation of an article for our magazines, please contact us.
We welcome your articles and will be happy to publish them.

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Release 30 March 2020

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November 2019

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We can also agree on partnership covering only one specific issue.

The partnership scheme typically involves:

- Your **logo on the main page** of our website.
- 1 page interactive **presentation of your company in every issue.**
- Your logo and / or the name of your company on **every publication and output we release.**
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Both **the price and the extent of cooperation are fully negotiable.**

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e-mosty

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e-maritime

Vessels, Ports, Docks, Maritime Equipment

The magazine e-mosty was established in April 2015. Its first issue was released on 20th June 2015 as a bilingual English – Czech magazine aimed mainly for Czech and Slovak bridge engineers.
Very quickly it reached an international readership.
In 2016 we extended the Editorial Board by two bridge experts from the UK, and since then four more colleagues – from the USA, Australia and The Netherlands – have joined us.
Since December 2016 the magazine has been published solely in English.
Each issue now has thousands of readers worldwide.
Many of our readers share the magazine in their companies and among their colleagues so the final number of readers is much higher.
Most importantly the readership covers our target segment – managers in construction companies, bridge designers and engineers, universities and other bridge related experts.

The magazine e-maritime was established in 2018 and its first issue was released on 30th March 2019.
The magazine is published in English. It is going to cover a vast range of topics related to vessels, maritime equipment, ports, docks, piers and jetties – their design, construction, operation and maintenance, and various maritime and construction related projects.
The Editorial Board already has two members – from the UK and the Netherlands.

Both magazines are with Open Access with possibility to subscribe (free of charge).
In January 2019 we established their own pages on LinkedIn with constantly increasing number of their followers. Number of subscribers of both magazines is also increasing.
We also know that the readers usually go back to older issues of both magazines.

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BUSINESS OPPORTUNITIES IN THE CZECH REPUBLIC

The Czech Republic ranks among countries with a strong economy and good potential. According to recent data, industrial production in the Czech Republic has increased by 5.7% year-on-year, and the value of new orders has increased by 6.6% year-on-year. The employment rate has increased by 2% and the unemployment rate is currently around 2.5%

The economic situation of the Czech Republic is very good and gives opportunity to invest in both state and public sectors. State-run organizations are creditworthy and cooperation with them is sought-after.

In the area of public investment, there has been an obvious and long-term effort to open up the market as much as possible and to allow participation of entities with a registered office or place of business outside the Czech Republic. The basis of this trend is given both at the level of the European Union and at the level of national legislation where it is stipulated mainly by Act No. 134/2016 Sb., on Public Procurement.

Due to the simplification of participation in the tender procedure (introduction of a uniform European Certificate, the contracting authority's obligation to accept documents issued under foreign law), there is no restriction on participation in tenders in the Czech Republic provided the participant fulfils the conditions of the tender. The market is open to companies from the whole world.

The participant shall be well acquainted with the legislation to be able to submit a perfect offer in compliance with any procedure given by the contracting authority – especially in the case of above-the-threshold public tenders which might be of interest due to their financial volume (supplies and services with an estimated value of more than 443,000 EUR or equivalent; construction works with an estimated value of more than 5.548,000 EUR or equivalent).
Due to the fact that the procedure in above-the-threshold public tenders is relatively rigid, and even the minor non-compliance with the conditions by the participant may lead to their disqualification, it is necessary to be familiar with this area or to contact a reliable partner.

To conclude, the Czech market offers many possibilities and is open to foreign investors. Czech legislation does not impose any significant restrictions on participation in public tenders, however, it is worthwhile to cooperate with a company which is familiar with the local market, legislation and local customs, and is able to find suitable opportunities.

In the case you are interested in the public tender market in the Czech Republic and intend to apply for public contracts, if you search for answers to your questions or for regular monitoring of relevant opportunities – our company KGS legal s.r.o. as a leading law firm with a focus on public procurement law is always at disposal for you.

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