

Design & construct contract for a deepsea quay wall in the Port of Rotterdam, case study Brammen terminal

Author:

Erik Broos

Port of Rotterdam,

Infrastructure & Real Estate projects

PO BOX 6622

3002 AP Rotterdam

The Netherlands

T +31 (0)10 252 1010

EJ.Broos@portofrotterdam.com

Abstract

On one of the last remaining plots in the existing port (without the 2nd Maasvlakte), the Port of Rotterdam designed a terminal for the handling of steel slabs (“brammen”). The terminal required a massive quay wall to accommodate the panamax vessels with their heavy cargo.

The quay wall is tendered under a design and construct contract. This paper will describe the tender procedure in which not only price was an aspect but also maintenance and especially Corporate Social Responsibility, a key issue at the Port of Rotterdam. Furthermore the design of the quay wall with its unconventional anchor system and some problems that occurred during the construction process, like breeding sea gulls, will be described.

Keywords: *Quay wall, Design & Construct, maintenance, sea gulls, lessons learned.*

1. Introduction

In 2006 and 2007 the Port of Rotterdam had a massive sand surplus (20 million m³) due to the fact that the Yangtze harbour should be dredged in front of the Euromax quay wall and that the permit to start construction of Maasvlakte 2 (reclamation of about 250 million m³) was not granted by the Dutch Supreme Court. At the southern part of the Maasvlakte, there was a former fresh water shipping channel, the Hartelkanaal. This channel had become useless because the separating dam was cut at both ends in the nineties (see figure 1). The Port of Rotterdam decided to store a part of the surplus of sand in this former channel to create new land for commercial activities.



Figure 1. Location of the former Hartelkanaal and the location of the Brammen terminal (yellow circle)

By the time that the reclamation had started, the first customer was already contracted. The first customer is C. Steinweg Handelsveem BV. Steinweg had won a tender together with the Port of Rotterdam to import steel slabs (“brammen” in German). These slabs (semi raw material) will be produced in a new constructed blast furnace in Brazil and will be transported to Germany towards Thyssen Krupp to be transformed via flat rolling and other processes in to high quality steel products.

As the project in Brazil was by that time still on schedule there was large time pressure on the Port of Rotterdam to construct the required quay wall. The first slabs were scheduled to arrive in Rotterdam in April 2009.

2. Preparation phase

The Port of Rotterdam was under severe time pressure to construct the quay wall and therefore decided to build the quay wall under a design and construct contract. In June 2007 Rotterdam Public Works was ordered to prepare the tender documents.

At the same time Port of Rotterdam started the open European tender procedure with the aim to select five competent contractors to join the design and construct procedure. Probably due to high work loads at that time only four, but high qualified, construction companies

registered. These were, after a check on their credentials, all invited to join the tender procedure.

By mid September 2007 the four contractors were officially selected and obtained the specifications. These specifications contained the tender manual, the conceptual D&C contract, the (technical) terms of reference, a thorough geotechnical (CPT's, SMTP's, triax, etc) and environmental survey both on land and water, an inventory of the minimum required permits and a historical analyses of the area with information on historic reclamation works, existing infrastructure, possibility of wrecks and not exploded ammunition. No reference design was made. The terms of reference were not based on systems engineering, but an attempt in that direction was made.

3. Technical terms of reference

Main specifications of the quay wall are:

Nautical length	500 m
Guaranteed bottom level	NAP -16.65 m
Construction depth	NAP -18.65 m
Deck level	NAP + 5.00 m
Terrain loads	first 20 m 40 kN/m ² , then 150 kN/m ²
Dredging volume	500,000 m ³
Bollards	single, 1500 kN each 17.5 m
Crane loads	2177 kN/m ¹
Maximum construction time	1 year
Eastern end	Quay wall easily extendable in eastern direction without hinder on commercial operations and without loss of investments
Western end	Quay wall extendable in western direction, but with hinder and loss of investment accepted.

4. Tender phase

The contractors had four months to prepare the bids. During this period there were two individual meetings with each contractor to discuss the progress and to offer them the opportunity to investigate the opinion of the Port of Rotterdam. These meetings were strict informal and no rights could be made out of the conversations. If formal answers were required, the contractors had put the question on (digital) paper.

The design period was lengthened until mid January and then each contractor provided the Port of Rotterdam with his final technical and financial bid. Two contractors offered two alternative bids, so there were six bids. The financial bids were locked up in a safe and first the technical bids were examined by Rotterdam Public Works. They had a tight five weeks to come to a final conclusion. Rotterdam Public Works had six specific research questions:

- Does the offer meet the specifications in the terms of reference?
- Is the design sufficient/ good enough (expert judgement)?
- Are there unacceptable risks?
- Are there unidentified risks ?
- Are there any incorrect issues

- Are there specific positive or negative aspects?

In this period several questions arose. Actually each contractor had to explain some items and had to make some small changes in its design, mainly due to undesired (by meaning of Port of Rotterdam) interpretation of the terms of reference. For instance all contractors were asked to change the design of their wooden fender configuration. It was very difficult for Port of Rotterdam and Rotterdam Public Works to verify whether the designs met the actual required specifications. The requested statement by the contractor about the compliance with the specifications was a sham to all contractors. Working with system engineering would have made this period easier and shorter and should make this sham impossible.

Parallel with the technical check by Rotterdam Public Works, the Port of Rotterdam judged the bids on 3 other aspects.

- Project management plan
- Maintenance and residual risks.
- Contribution Corporate to social responsibility targets Port of Rotterdam

These aspects were awarded with points. The best bid received the maximum score, the worst zero points and the other bids received points with a similar interval (maintenance: best 50 points, second best 40 point, last 0 points) even if the bids were almost similar. Only if the bids were identical, they would get the averaged score (so not 50 and 40 points, but 45 points each).

After Port of Rotterdam and Rotterdam Public Works had cleared the technical bids, the separately offered and stored financial bids were opened. At this point it was possible for the Port of Rotterdam not to open a financial bid and to return it to the bidder. But all technical bids were judged positively. After opening of the financial data a final ranking was made with the following maximum scores.

Criteria	Max. score
Lump sum price	400 points
Project management (PM)	25 points
Maintenance and residual risks (M&R)	50 points
Contribution Corporate Social Responsibility (CSR) targets	25 points
TOTAL	500 points

5. Negotiations & selection

After the intermediate ranking, PoR started negotiations with the number one and two of the ranking. This was a negotiation about risks, technical details and other points. It was not a negotiation about price. Although the involved contractors were offered the possibility to adjust their prices based on adapted design details or relocated risks.. This actually also happened with a few percentages upward.

Bid	A	B	C	D	E	F	Max. score
Front wall	Dia	Combi	Dia	Dia	Dia	Combi	(Dia = diaphragm wall ,Combi = combi wall)
PM	25	25	15	20	10	10	25
M&R	10	-	40	50	30	20	50
CSR	15	15	5	10	20	20	25
Cost	330	345	308	358	360	400	400
Total	380	385	368	438	420	450	500
rank	5	4	6	2	3	1	

After the negotiations the final ranking was made (see table above). Although the points were changed a little, the ranking remained the same. April 8th 2008 the Port of Rotterdam signed the contract with company behind bid F, Ballast Nedam to design and construct the quay wall with a total contract value of € 25,385,000.

It is interesting that Bid E is exactly the same design as F, but with a diaphragm wall in stead of the combi wall. The difference in points indicates a price difference of over 2.5 million Euros. As it is expected that the front wall determines only 40% of the costs, the diaphragm wall is roughly 25% more expensive than a combi wall.

6. Reference design

The design made by Ballast Nedam is shown in the figure below.

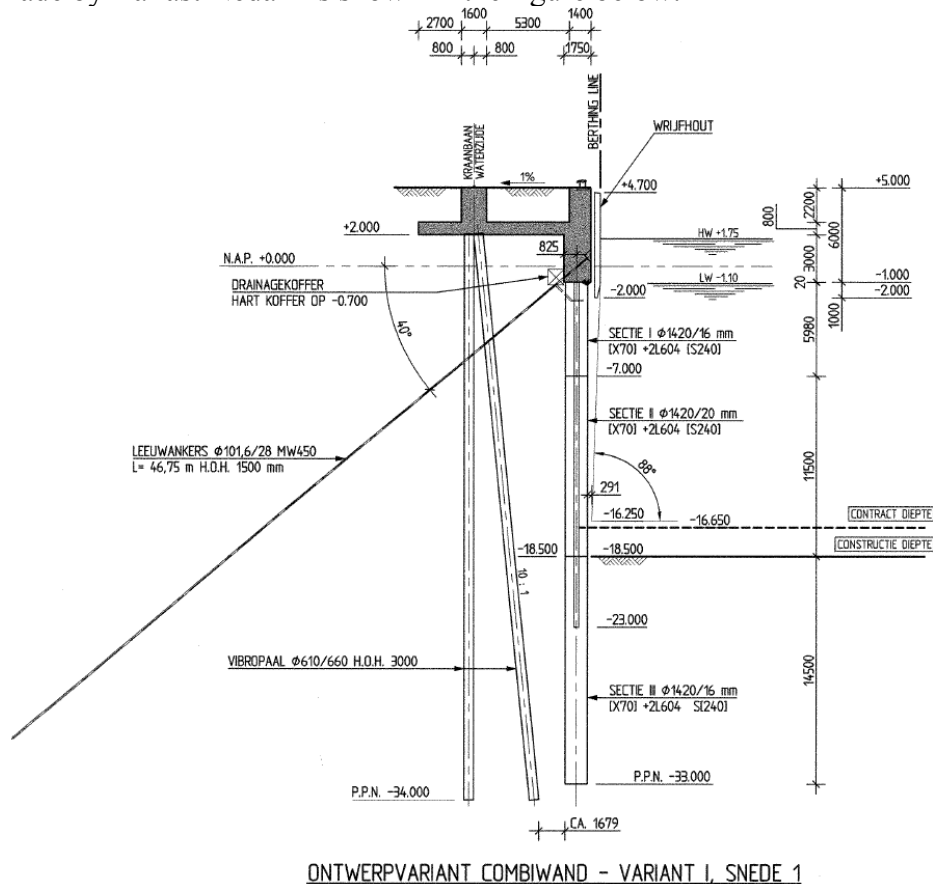


Figure 2. Cross section of quay wall Brammen terminal

Main specifications are:

Front wall combi wall 1420-16/20 mm tubes (L= 33m) with PU18 intermediate sheet piles (L= 21 m), cathodic protection with aluminum anodes

Anchoring Leeuw screw injection (SI) anchor 101.6 – 28mm (1 each 1.9 m, L=45 m, 35° and 40°), maximum anchor force 2500 kN

Fendering Azobe beams with FSC certificate

Relatively high placed relief floor

Crane rail supported by double vibro piles 610 en 740 mm (center distance 3560 mm)

The anchoring system is new for this type of quay walls. Usually so called MV piles are used to provide horizontal stability. This would have required a jack up platform in the Mississippi harbor to install these piles. Using a jack up was possible within the nautical restrictions, but would be expensive and time consuming. Using the SI anchors resulted in a serious financial advantage and rapid construction, all contractors offered a similar type of anchor system.

The possibility to extend the quay wall in eastern direction was designed smart but simple. The quay was continued sufficiently with the entire cross section to bear the loads (concrete section in figure 3 without fender beams). After that point only the combi wall was placed and finally a light sheet pile that shall be recycled at the end of the next quay wall extension. In stead of building the entire cross section, a temporary slope was constructed. See figure 3. By creating a new construction pit, the quay wall can be lengthened and there will only be very limited loss of investment.



Figure 3. Eastern end of the quay wall before inundation and dredging

7. Construction phase

The construction phase started at April 8 2008. The contractor immediately needed to do the detail engineering and after a few weeks the contractor started with site preparations.

7.1 Delay due to breeding sea gulls

The former dam in the area in which the quay wall is constructed, used to be a large breeding location for sea gulls and other birds. As breeding birds are protected by law, this was defined as a major risk. It is not allowed to remove nests and eggs; therefore the only solution is to prevent the birds from building nests. Since a sea gull only needs a small shallow pit in the sand with some grass, a nest is rapidly created. To prevent the sea gull from creating this nest, they should be disturbed permanently. The feasible solution for this problem is a tractor, with a large steel H-beam behind it, driving around on a surface of which all vegetation is removed. The beam has to cover every square meter, every hour during day time for the entire breeding season (1st of March till mid August).

Special attention has to be paid to obstacles (see figure 4) on site that can't be removed, since they attract nesting birds but they can't be treated like the normal site. Therefore additional equipment or people should be activated to prevent the birds from nesting.

Keeping the site free of nesting birds is an expensive activity. The Port of Rotterdam spend 500,000 euro only at the Brammenterminal project. 2% of the quay wall construction contract.

The handover of the construction site was at April 8th, weeks after the start of the breeding season. The actual start of the contractor was scheduled in May 2008 and the Port of Rotterdam agreed to continue its disturbing activities until that moment. Unfortunately the birds chose to breed on the slope of the area and were not disturbed effectively. This resulted in some broken eggs, an official crime under the Flora and Fauna law. Since more damage could not be avoided, the contractor stopped its activities and restarted mid September 2008. A massive and unexpected delay on the 51 weeks construction schedule.



Figure 4. Sea gull breeding on heap of sand, between the two gates of the construction site.

7.2 Problem with groundwater dewatering permit

In the Netherlands the time to obtain a permit to dewater groundwater is around 7 months. In a design & construct contract this should always be the responsibility of the contractor because design and dewatering plan are inevitable related. With a construction time of only one year this could not be the case. Therefore the Port of Rotterdam started the procedure to obtain the dewatering permit parallel with the design by the contractors. One week before the contract was signed, the permit was obtained. Unfortunately, the soil did not act as predicted and the permit had to be adjusted. This took a long time due to the fact that (looking backwards) the requested permit was too tight for the required D&C flexibility. Fortunately this delay in obtaining the permit ran parallel with the delay of the breaching sea gulls. Otherwise this permit would have delayed the project for at least 4 months.

7.3 Possible group dynamics by SI anchors

The screw injection (SI) anchors are placed very close to each other (1.9m interval). This introduced the risk of so called group dynamics. This means that the anchors obtain their strength from the same area in the ground. An individual test will not show this effect. Only testing all the anchors at once will show this effect. This is virtually impossible; in fact only full use of the quay wall will show this mechanism and then nothing can be done. By spreading the anchors in two different directions (35° and 40°) this risk is reduced significantly, but not completely.

During the construction the Port of Rotterdam came in to contact with Inventec that had developed a new monitoring device, called SAAF. This is a chain of sensors that monitors continuously its location in 3D. Since the SI anchors are hollow, this device can be pushed into the anchor rod. In this way the alignment of the anchor in the ground can be actually measured with only a few centimeters tolerance. This makes it possible to check where the anchor actually is deep in the ground and more important what the interval is between the different anchor heads. If this interval distance is sufficient large (7 x diameters of anchor head, in this case 2.1 m) and the individual strength of the anchor is sufficient, the risk of group dynamics does not longer exist.

7.4 Economies of scale

When finally started, the execution of the quay wall ran very smoothly and nothing special happened. The contractor only complained about the fact that 500 m is relative short, at the end of the 500m the processes were executed much faster and smoother than at the start of each process. This effect was also seen at Euromax quay wall (2005 – 2007). The Euromax contractor spend a year on the first 500 m and a year on the next 1400 m. This suggests that long quay walls (> 1km) will be cheaper per m¹ than shorter quay walls due to higher efficiency and better construction logistics.

7.5 Delivery to the client

After a year, the quay wall was handed over to the Port of Rotterdam at the 1st of September 2009 with still some things to be done. Within two weeks, C. Steinweg Handelsveem BV placed the first two 70m wide cantilever bridge cranes on the quay.

8. Lessons learned

As the Port of Rotterdam accepted the quay wall, the Port of Rotterdam declared that the quay wall met the specifications within the contract. There remained however an internal Port of Rotterdam discussion about the quality of the works, especially on the wooden fender system and the safety ladders. The actual conclusion was that the technical specifications in the contract for some specific aspects should be more detailed.

There should always be an almost endless freedom in design of the main structure, but the quay furniture should be described in more detail. This furniture only forms a minor part of the investment, but determines the maintainability of the structure heavily. Since maintenance is always done by the Port of Rotterdam, this is advised to future projects. Especially because it is a minor investment, contractors will not focus on these details during the tender and will try to minimize investments after contract signing. As an alternative life cycle costing instead of construction prices can be used as selection criterion. This is easily done when the maintenance is actually handed over to the contractor for a long period (>20 years) in a design construct & maintain (DCM) contract. This long period is essential to incorporate serious maintenance (like replacement of fender beams) in the contract and therefore in the design. Awarding a contract on lowest life cycle costs without awarding the maintenance is more difficult, but can be done. The Port of Rotterdam does its own maintenance because much of the maintenance is damage repair that results in endless discussions with the DCM contractor (real experience). Besides that the costs of separately contracted maintenance are much lower than maintenance contracted inside a D&C contract. Therefore the Port of Rotterdam will award future D&C contracts on lowest Life Cycle Costs. An exemption is made for Maasvlakte 2.

9. Conclusions

- The Terms of Reference for a design and construct contract should be made using System Engineering to ensure that the bids really meet the specifications and to smoothen the evaluation phase;
- Details that determine the maintainability of the structure heavily, but don't influence the price, should be dictated in more detail OR maintenance should be awarded directly to the contractor for a long (>20 years) period to obtain high quality;
- To obtain low life cycle costs it is also possible to determine the maintenance costs as principal and to award the contract on the lowest LCC bid (investment by the contractor + maintenance by the principal);
- In 2008 a combi wall appeared to be almost 25% cheaper than a diaphragm wall;
- Breeding birds can delay projects for many months;
- Obtaining a dewatering permit by the principal in a design & construct contract should be avoided. If this is not possible due to a tight time schedule, the permit should be as flexible as possible;
- It is possible to measure the position of a SI anchor head in situ with the SAAF. Together with the individual tests, group dynamics can be excluded as a risk and screw injection anchors can be used on heavy quay walls;
- The longer the quay wall, the lower the price per m¹ due to optimized processes in the construction pit.