Development of container handling in the Port of Rotterdam

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Abstract

During the last 60 years, the Port of Rotterdam has grown to be one of the major container ports in the world. The city of Rotterdam has changed from a fishing harbour to a Mainport in the last 600 years. The port facilities including the waterways, terminals and hinterland connections as well as the operating methods and handling techniques, have constantly adapted to the changing requirements over the years. The present position of the Port has been acquired through developments of design and construction techniques that cope with increasing loads and growing ship dimensions and through investments in infrastructure, information technology and logistics, all with due consideration for the environment. This paper describes the evolution of container handling in the Port of Rotterdam since the arrival of the first container in Rotterdam in 1966 up to the present.

1. Introduction

The Port of Rotterdam (PoR) is situated directly on the North Sea and is a gateway to a European market of 450 million consumers. It ranks as the sixth largest container port in the world. This paper describes the evolution of container handling in the port of Rotterdam since the arrival of the first container in Rotterdam in 1966.
Section 2 and 3 describe briefly, the Port of Rotterdam and the container sector in the port. The historical development of Waal-/Eemhaven and the Maasvlakte is sketched in Section 4. Section 5 goes into more details of different aspects of containerization i.e., container vessels, container market segments, container terminals, and quay walls, and gives some key statistics of the container terminals. Section 6 focuses on the future of container sector in the Port of Rotterdam.

2. Port of Rotterdam

Rotterdam is Europe's largest logistic and industrial hub. It is situated directly on the North Sea and handles some 35,000 seagoing vessels and 130,000 inland vessels every year. The tidal range in the active port area is generally about 1.5 meter, so that all parts of the port have free access to and from the ocean without the encumbrance of locks. Also, the port area has direct access to the sea as well as the Rhine river, Europe's and the world's most heavily used shipping artery. The historical development of Port of Rotterdam can be seen in Figure 1.

Figure 1 Historical development of Port of Rotterdam (Source: PoR)

The port and industrial area stretches over a length of 40 kilometer and covers 10,500 hectare, 5,100 hectare of which is rental industrial area. The area of water is approximates 3,440 hectare and the area occupied by infrastructure covers about 1,960 hectare. Further, the area is divided roughly as shown in Table 1.

Table 1 Area, Port of Rotterdam

Location	**Area (hectares)**
Maasvlakte	2500
Europoort	3900
Botlek	1250
1st and 2nd Petroleumhaven (Pernis)	780
Eemhaven and Waalhaven	1040
Remaining harbours on both banks	670

On the basis of 2007 figures, Rotterdam ranks worldwide as the nineth largest port (Table 2) and the fourth largest container port (Table 3).

Table 2 World's 20 major ports 2008

Ports	Gross weight (million metric tons)
Shanghai[1]	582.0
Ningbo	520,1
Singapore	515,3
Rotterdam	421,1
Tianjin	355,9
Gunzhaou	344,3
Quindao	300,3
HongKong[1]	259,4
Qinhuangdao	252,2
Busan	241,7
South Louisiana	233,7
Houston	227,0
Nagoya	218,1
Shenzhen	211,2
Gwangyang	200,0
Antwerp	189,5
Dalian	185,2
Los Angeles	170,1
Chiba	170,0
Rizhao	151,0

[1] Including rivertrade
[2] Freight tons
Validity of comparisons is limited due to difference in definitions

Source: Port Authorities

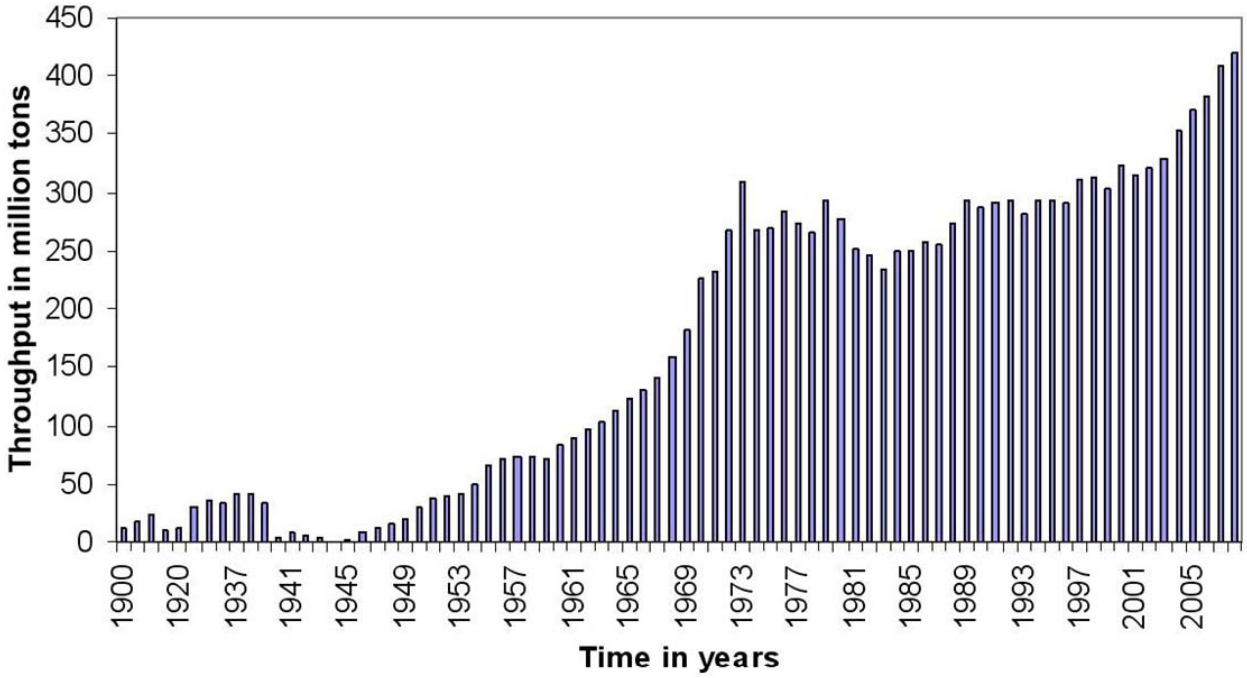


Figure 2 **Throughput development in Port of Rotterdam** (Source: PoR)

Figure 2 displays the throughput of Rotterdam since 1900. It clearly shows the effect of recession and wars and the enormous growth in throughput since 1950. The throughput in 2008 amounted to 421 million tons.

Table 3 World's 20 major container ports 2008

Ports	**1000 TEU's (Twenty Feet Equivalent Units)**
Singapore	29,918
Shanghai	28,010
Honh kong	24,494
Shenzhen	21,420
Busan	13,425
Dubai ports	11,827
Guangzhou	11,200
Zhoushan/Ningbo	10,920
Rotterdam	10,784
Qingdao	10,020
Hamburg	9,737
Kaoshiung	9,677
Antwerp	8,663
Tianjin	8,500
Los Angeles	8,081
Port Klang	7,970
Long Beach	6,488
Tanjung Pelepas	5,600
Bremen	5,529
New York/New Yersey	5,236
[1]Including river trade	

Source: Port Authorities

With about 10.8 million TEU passing through the port in 2008, Rotterdam is the biggest container port in Europe.

3. Container sector in Port of Rotterdam

3.1. Locations

Container handling in the Port of Rotterdam is concentrated in two areas: directly on the North Sea on the Maasvlakte, and closer to the city in the Waalhaven/Eemhaven (Figure 3). The two areas are connected with the North Sea via the New Waterway, a direct access route that was excavated in the 19th century utilizing in part, the previously existing channels.

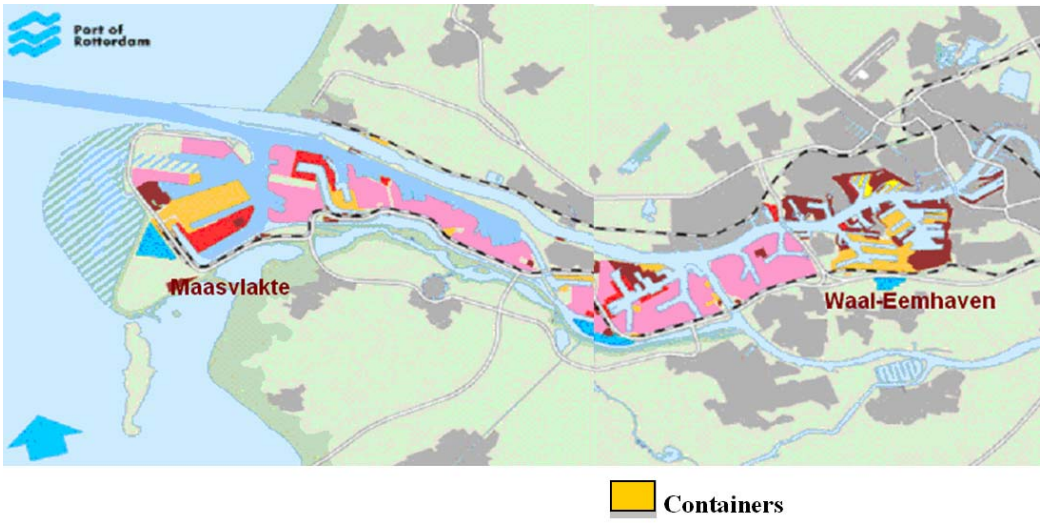


Figure 3 Map Port of Rotterdam (PoR)

Waalhaven en Eemhaven are today the last traditional harbor basins in the Port of Rotterdam. They were designed as bulk- and industry ports but developed into container ports. With the shifting of the deep sea container shipping segment to the Maasvlakte, Waalhaven is intended for small businesses and maritime industry and Eemhaven is used mainly for North-South services and intra-European short-sea shipping.

3.2. Container market segments

The container market can be divided into four segments: primary deep sea, secondary deep sea, short sea and feeders. Most shipping companies and container terminals focus on one segment since each has its own characteristics and method of handling. Primary deep sea sails mainly Far East - North America routes. The ships (fourth generation and higher) sailing this route are handled presently at Maasvlakte 1 and in future, will also be handled at Maasvlakte 2. Since 1992, the Waal-/Eemhaven area handles a smaller share of primary deep sea container transport. Secondary deep sea sails mainly the north-south route and the vessels (up to the third generation) can be effectively handled in the Waal-/Eemhaven, but it is difficult to predict if this will shift along with the primary segment. Short sea is the modern equivalent of coastal shipping, and gradually, this sector has become identified with containers. Short sea shipping companies, often intermodal transport companies offering door to door services have a good location in the Eemhaven. The hinterland transport takes place with shuttles, trucks or inland barges. Lesser area for storage is required due to faster handling. Feeders are an extension of deep sea liners and are mostly handled at deep sea berths. Feeders handle transport of intercontinental cargo from Far East as well as North American cargo to European destinations and vice versa. Along with the primary deep sea, the feeders are handled at the Maasvlakte, and to a lesser extent in the Waal-/Eemhaven region.

In the Hamburg-Le Havre range, Rotterdam has a container market share of approximately 35%. The throughput of containers in Port of Rotterdam has been steadily increasing as can be seen in Figure 4. The modal split for the year 2008 is given in Table 4.

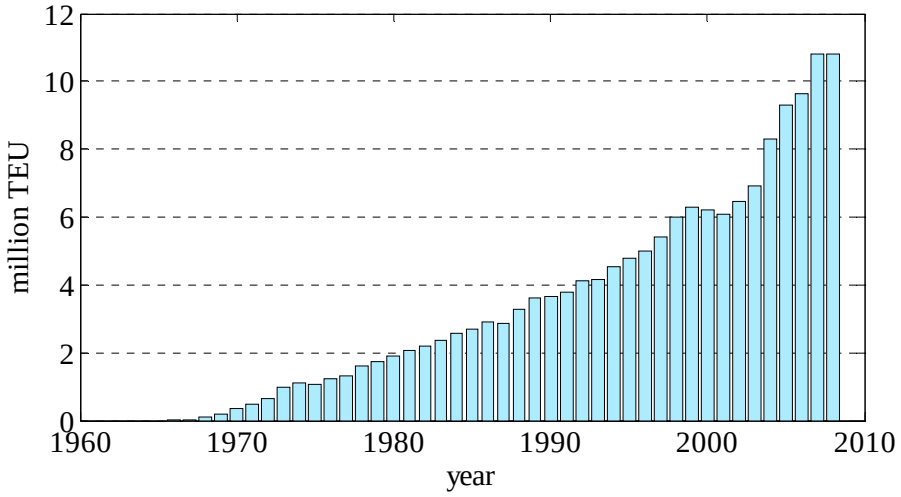


Figure 4 Throughput of containers Port of Rotterdam 1965-2008 (Source: PoR)

Table 4 Modal split 2008 (Source: PoR)

Mode of transport	% of hinterland transport
Barge	30.4
Road	58.5
Rail	11.1
Note: Throughput to and from hinterland is 74.6 % and via feeders, 25.4% of the total.	

3.3. Container terminals in the Port of Rotterdam

In 1966, when containers were introduced in Rotterdam, existing quay walls were used for handling containers. From 1983 onwards, quay walls were specially designed to meet the specific needs of container handling (section 5.3). Some key statistics of the major container terminals are given in Table 5.

Table 5 Statistics major container terminals

Harbour	Terminal	Year of construction	Quay length in meter	Terminal area in hectare	Depth along -side in meter
Yangtzehaven	Euromax terminal phase 1	2007	1500	84	16.65, max. 19.65
Europahaven	APM Terminals Rotterdam	1984	1650	92.7	max. 16.0
Europahaven/ Amazonehaven	Europe Container Terminals	1992/1993/ 1996/1997	3570	265	max. 16.65
Hartelkanaal	Inland shipping terminal	1994/1997	180		max. 6.0
Beerkanaal	Delta barge and feeder terminal phase 1	2007	840	7.2	10.65
Hartelhaven	Kramer Rotterdam Container terminal	2007	400	70	10.0
Alexanderhaven	ECT Home Terminal	1971	1400	59.3	14.15
Waalhaven	[1]ECT Hanno Terminal	1963	1200	31	14.15
Waalhaven	[1]Uniport Multipurpose Terminals	1989/1992	800	22	14.0
Prinses Beatrixhaven, Eemhaven	Rotterdam Short Sea Terminals	1963/2001	1500	36	11.65

[1] takeover by Steinweg 2007

4. Historical development of containers transport in Port of Rotterdam

4.1. Establishment of Waalhaven and Eemhaven

The development of the port over the years has been dynamic. In early 1900's, Rotterdam was a transit port for bulk cargo. Throughout the 19th century and up to 1920, the port was principally urban in nature. The 1920-1945 period saw the emergence of Waalhaven and Eemhaven. In terms of surface area, they were larger than the entire Rotterdam city centre. The terrain of Waalhaven comprised of small piers with large water surface and encompassed an area of 219 hectare. The cargo in Waalhaven consisted initially of dry bulk (coal, ore and grain), and it was at that time, the largest harbour basin in the world. By 1926, this fast growing port was the largest on the European continent.

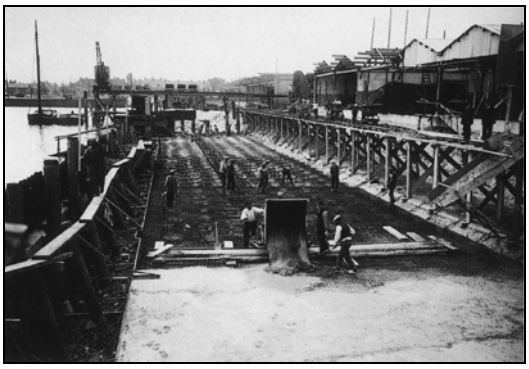


Figure 5 Construction of quay wall, Waalhaven north west, 1921

While undergoing repairs after being bombarded in the Second World War, Waalhaven was modernized. Quays walls were shifted forward to create more land area, new cranes and loaders were acquired, new sheds and warehouses constructed and the basin dredged deeper for bigger ships. Waalhaven soon began to lose its nature of a specific bulk port.

The original concept of Eemhaven was put forward in 1913, but the actual construction was commenced in the 1930's only to be halted during the Second World War. Around 1946, various industries had settled along the first harbour basin (also known as 1st Eemhaven). Later, the basins proved to be suitable for containers and 1st Eemhaven developed into a general cargo port. In 1961, budget was made available for the 2nd (nowadays John Frisohaven), the 3rd and 4th basins of Eemhaven, and finally in 1963 the construction of quay walls was complete.

Meanwhile, from 1950 onwards, the Botlek area had began to take shape, followed in the 1960's by Europort. In 1962, Rotterdam was the biggest port in the world. The expansion of general cargo transport resulted in the construction of the Prinses Beatrixhaven (1962-65) and the Prinses Margriethaven (begun in 1963). Together with the Prins Willem Alexanderhaven, this harbour complex, with modern sheds and handling facilities was accessible to the very largest freighters at that time.

4.2. Container transport in the Port of Rotterdam

The container entered the scene in the mid-sixties. On 3 May 1966, Fairland with 266 35-foot containers for Sea-Land was unloaded at the Beatrixhaven (Figure 6). The containers were handled with a ship crane. Rotterdam was the first harbour to receive a fully equipped container ship. After Sea-Land other container companies started to arrive in Rotterdam.

Figure 6 Container ship at Prinses Beatrixhaven, 1966

In 1968, the company Unitcentre was established as a container company. The bulk cargo terminal Pier 7 in the Waalhaven was transformed to a container terminal, and the ore crane on Pier 7 was modified into a container crane. Forklift trucks and pallets appeared in the 1970's, and the transition from man-load to unit-load (60 to 500 kilos) was made.

Figure 7 Unitcentre in Waalhaven, 1971

The container revolution led to the formation of ECT, the Europe Container Terminus, with its Home Terminal at the Margriethaven in the Eemhaven. The ECT terminal received its first ship, the 'Atlantic Span' of shipping company ACL, on 31 August 1967 at this terminal. The increasing salaries and shortage of labour stimulated the conversion of ships into a container ship. Due to a greater capacity and a smaller turnaround time, a container ship could make more trips. For the Port Authority the appearance of container ships meant heavier and faster handling equipment and another layout and design of the terminal. Container traffic developed rapidly. By 1968, the Port of Rotterdam was handling around 65,000 containers, in 1969, this was 121,000 and in 1971 around 250,000.

In 1970, Sea-Land ships were handled at the new Sea-Land terminal on the north side of the newly excavated Prins Willem-Alexander haven. In 1972, the south side quay wall was constructed. In 1974 Sea-Land containers were handled

at the Margriethaven instead of the Prinses Beatrixhaven where on the south side a quay wall had been constructed with ample storage space and a new container crane. Until the mid eighties Margriethaven was the largest container terminal in the world. Sea-Land began with short sea service to eight North European ports in 1973. Container handling needs a lot of space. At first, this space could be found in Eemhaven and Waalhaven. However as the ship sizes continued to increase, there was a need for deeper harbours and basins, as well as larger quay and terminal areas. In the early 1970s, the container industry shifted to the Maasvlakte.

Figure 8 ECT city terminal at Prins Wiilem Alexanderhaven

4.3. Maasvlakte

The construction of Maasvlakte represented a remarkable reversal in the development process of the port: for the first time, water had had to make way for land. The construction started in 1965, and was finally realized in 1973, albeit in a revised version. In August 1974, plans for a 400 hectare container terminal at the Maasvlakte for ships with a draught up to 15 meter received a lot of opposition. The Maasvlakte concept was always going to encompass container terminals, but no-one could have predicted the dramatic development of this market segment. Back in the early 1980's, when ECT decided to establish a new container terminal along the Europahaven at the Maasvlakte, called the Delta terminal, the move was labeled as the logistical blunder of the century. Later it emerged to have been a master stroke. The terminal had an annual capacity of 600,000 containers and handled ships of different companies.

Just a few years later, ECT closed a deal with Sea-Land for a dedicated terminal. The Delta/Sea-Land terminal opened in January 1992. A part of the handling was automated: the transport between quay and stack took place with Automated Guided Vehicles (AGV's) and the storage and removal of containers from the stack with Automated Stacking Cranes (ASC's). By means of sensors implanted in the surface of the quay, the AGV knows exactly where containers need to be taken and deposited. This almost total robotization of container activities belonged to the third generation container handling facilities. (The first generation could be found in the Eemhaven, where the employees did a relatively large amount of the work and the second generation was developed at ECT's Delta terminal on the Maasvlakte),

The north side of the ECT peninsula was reaching its capacity. The increasingly large container ships forced ECT to invest not only in cranes with a far greater range but also in technology for fast transfer of containers to their destination. A technologically highly advanced terminal concept was devised to handle the anticipated container growth. The plan was called Delta 2000-8 which stood for the construction of eight container terminals which would be ready in the year 2000. In 1996 and 2000 respectively, two new terminals, i.e., the Delta Dedicated East (DDE) and the Delta Dedicated West Terminals (DDW) were realized in the framework of this project.

4.4. Present day Developments

The present day situation at the Delta peninsula, (after some changes in ownership), can be seen in Figure 9. The four deep-sea terminals can receive the largest containerships without tidal restrictions: a classic container terminal operated by APM Terminals and the three automated Delta Dedicated Terminals of ECT. Together, these facilities at Maasvlakte handle over 4 million TEU per year, which amounts to about half the container throughput realized by the whole port of Rotterdam.

Figure 9 Delta Peninsula with the ECT and APM container terminals

Meanwhile the container sector continued to grow and possibilities for expansion were sought. Two options were available: increase in the area productivity by intensifying land use, and area expansion. In 2006, start was made with the construction of a container terminal, in the Yangtzehaven, on the Maasvlakte 1's most northerly point. The first phase of the Euromax terminal which opened in September 2008, is operated by ECT. It is fully-automated and the third of its kind after the ECT Delta Terminals and the Container Terminal Altenwerder in Hamburg. It has an initial capacity of around two million TEU per year, which may subsequently be increased in two phases up to five million TEU.

Figure 10 Euromax terminal, Maasvlakte

The Delta Barge Feeder terminal, located at the far end of the Delta peninsula, was opened in 2008. It is reserved for inland barges and for feeder vessels, i.e. small seagoing ships that carry containers to and from smaller seaports. In its first phase, the terminal will be able to accommodate 330,000 barge and feeder moves a year. In 2007, the Kramer Group opened Rotterdam Container Terminal at the Hartelhaven, also intended for feeder services and inland barges. The Hartelhaven has been deepened to 10 meter in order to receive feeder ships up to 1800 TEU.

5. Developments in the container sector

5.1. Container vessels

In 2008, approx. 7300 full container ships called in Rotterdam. The development of container ship size from 1960 up till present can be seen in Figure 11. Emma Maersk with an overall length of 397 m, beam of 56.40 m, draft of 16.0 m and a capacity greater than 12,500 TEU, is likely to be followed by bigger ships. For the design of Maasvlakte 2, ships bigger than 15,000 TEU as well as ships with a length of 450 m have been considered during the nautical studies.

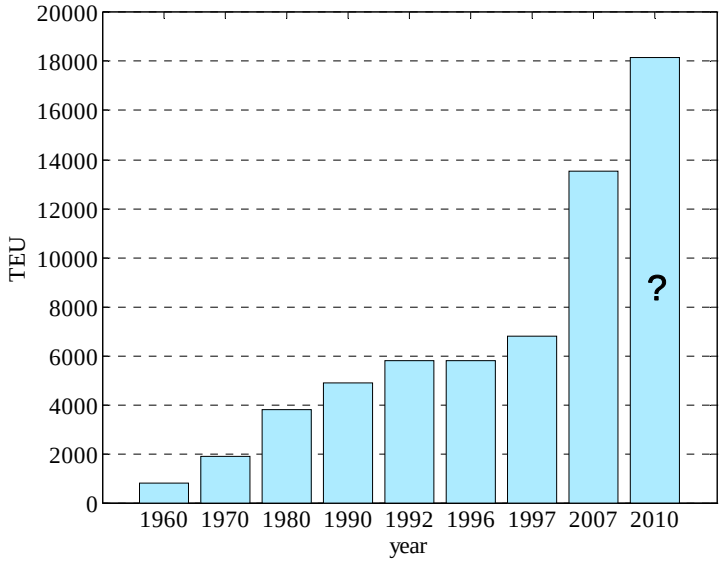


Figure 11 Development of ship size (TEU capacity)

Figure 12 Container ship Emma Maersk

5.2. Container handling

Rotterdam 1978 (Photo David Pinder)

Euromax 2008 (www.ect.nl)

Figure 13 Two generations of container cranes

Container terminals have witnessed a series of innovations aimed at improving quay and yard productivity. Container gantry cranes now have longer outreaches (up to 22 containers wide), more lifting capacity (ZPMC developed cranes with up to 120 tons of lifting capacity) and the spreaders have become more sophisticated (double lift, twin lift and tests by ZPMC for quad lifts are being carried out). Table 6 shows the capacity of the container terminals in Rotterdam while Table 7 highlights some key characteristics of a container terminal in each evolution phase.

Table 6 Capacity container terminals

Terminal / Location	Total container capacity in TEU
APM Terminals Rotterdam Europahaven Expansion 2007	2,700,000 700,000
Euromax terminal phase 1 Yangtzehaven	2,300,000
Europe Container Terminals Europahaven / Amazonehaven	5,000,000
Europe Container Terminals Inland shipping terminal Hartelkanaal	
Europe Container Terminals Delta Barge and Feeder terminal Beerkanaal	900,000
Kramer Rotterdam Container terminal (RCT) Hartelhaven	500,000
ECT Home Terminal Alexanderhaven	1,100,000
[1]ECT Hanno Terminal Waalhaven	600,000
[1]Uniport Multipurpose Terminals BV Waalhaven	
Rotterdam Short Sea Terminals BV Prinses Beatrixhaven	

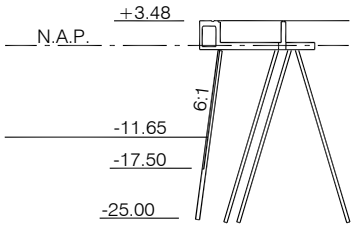
Source: www.ect.nl/ Annual Report 2007, PoR

Table 7 Characteristics of container terminal development (de Gijt 2009)

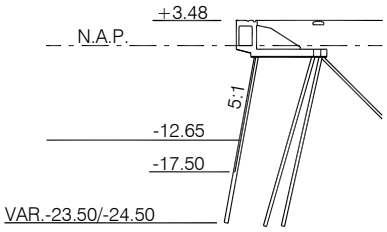
Year	Berth length (m)	Crane capacity (kN)	Crane outreach (m)	Depth (m)	Area (ha)
1955	175	50	24	175	3
1965	250	400	35	230	5.7
1985	375	650	50	400	16
2009	500	1000	70	600	30

5.3. Quay walls for container handling

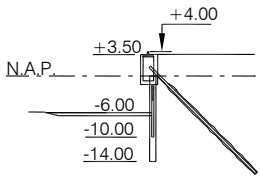
Since the introduction of the container, the design of quay walls is continuously being optimized for handling of containers from ship to shore and vice versa. This optimization has been realized by providing more nautical depth, increasing the berth length, strengthening the quay walls to support the increasing loads of container cranes, and adapting the dimensions of harbour basins. Figure 13 shows the schematic cross sections of container quay walls built between 1979 and 2007. Table 9 lists the characteristics of the various container quay walls.



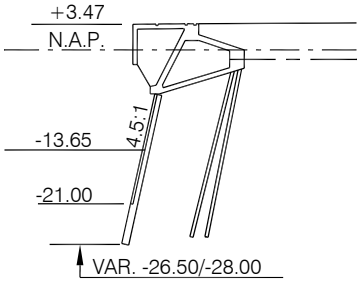
QUICK DISPATCH 1979
Europoort - Brittanniëhaven



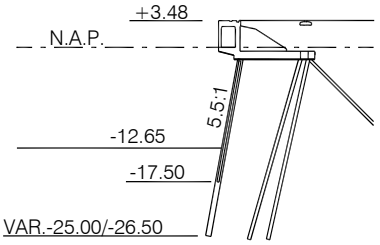
SEAPORT TERMINAL 1st PHASE 1983
Europoort - Brittanniehaven



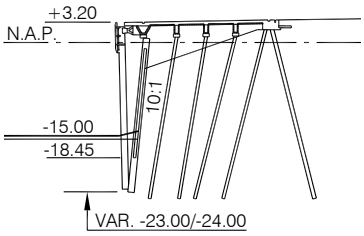
E.C.T. INSIDE QUAY 1984
Maasvlakte - Hartelhaven



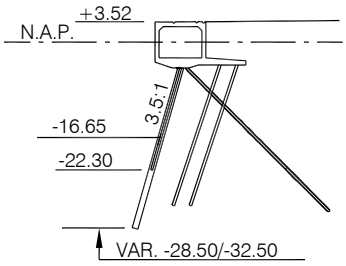
E.C.T. Delta 1 1984
Maasvlakte - Europahaven



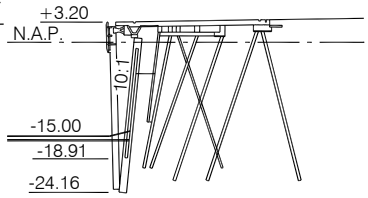
SEAPORT TERMINAL 2nd PHASE 1986
Europoort - Brittanniehaven



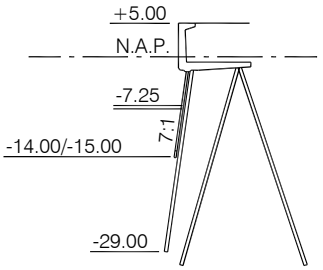
UNITCENTER 1st PHASE 1989
Waalhaven



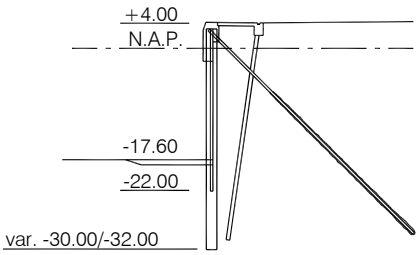
E.C.T./Sea-Land 1992
Maasvlakte - Europahaven



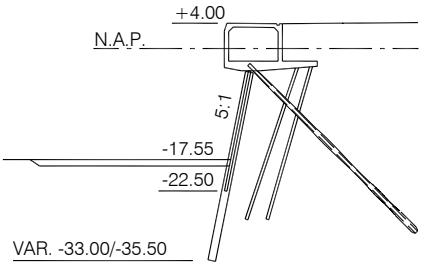
UNITCENTER 2nd PHASE 1992
Waalhaven



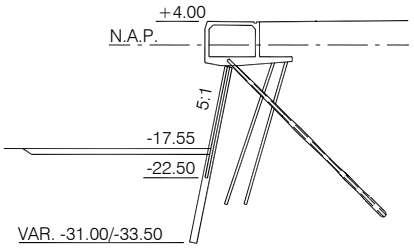
DISTRIPARK BOTLEK 1993
Seinehaven



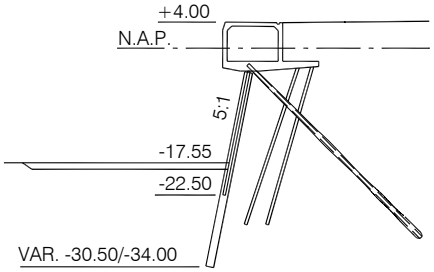
PLAN DELTA 2000-8 PHASE 1A 1993
Maasvlakte Amazonehaven



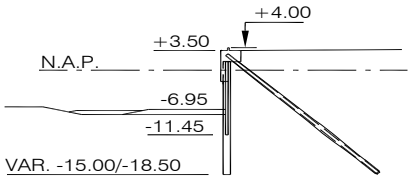
PLAN DELTA 2000-8 PHASE 1B 1996
Maasvlakte Amazonehaven



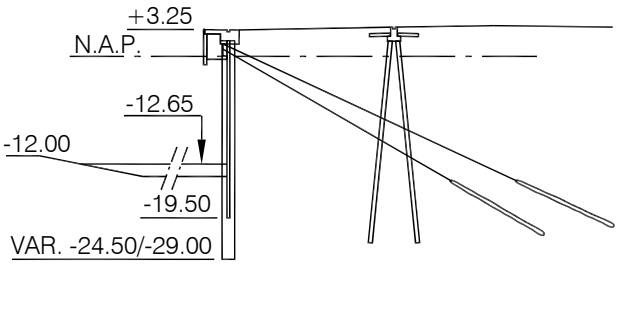
PLAN DELTA 2000-8 PHASE 2A 1997
Maasvlakte Amazonehaven



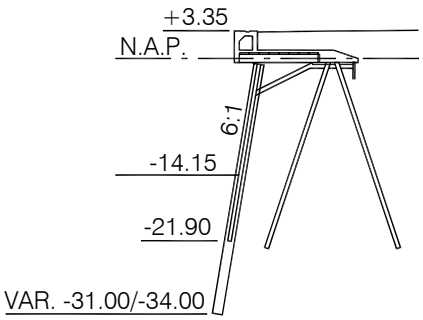
PLAN DELTA 2000-8 PHASE 2B 1997
Maasvlakte Amazonehaven



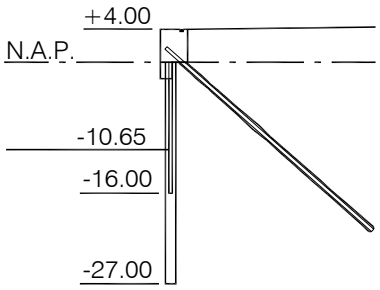
PLAN DELTA 2000-8 PHASE 4 1997
Maasvlakte Hartelhaven



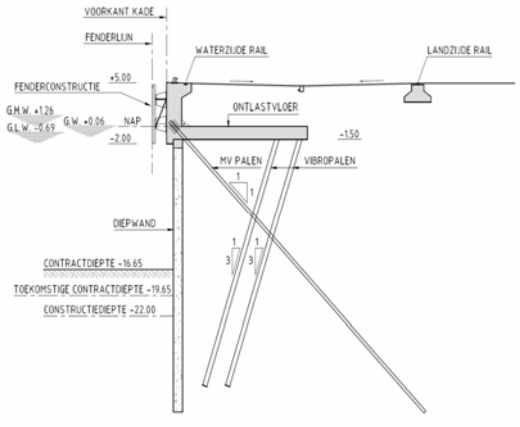
WAALHAVEN PIER 5 2000
Waalhaven



PLAN 2000 SHORT PHASE 1 2001
Eemhaven



QUAY KRAMER/ECT 2002
Maasvlakte Amazonehaven



Maasvlakte, Euromax terminal, 2007

Figure 14 Schematic cross sections of container quay walls built between 1979 and 2007 (de Gijt 1998 and 2009)

Table 8 Characteristics of container quay walls (de Gijt 1998 and 2009)

Year	**Owner**	**Location**	**Length(m)**	**Nautical depth (m – NAP)**
1979	Quick Dispatch	Brittaniehaven	600	11.65
1983	Seaport terminal 1st phase	Brittaniehaven	300	12.65
1984	Inland quay wall	Hartelhaven	250	6.00
1984	ECT Delta 1	Europahaven	1100	13.65
1986	Seaport terminal 2 sec. phase	Britanniehaven	300	12.65
1989	Unit Centre 1 phase	Waalhaven	400	15.00
1992	ECT/Sealand	Europahaven	1500	16.65
1992	Unit centre 2 phase	Waalhaven	400	15.00
1993	Distripark	Seinehaven	350	14.50
1993	ECT 1a phase	Amazonehaven	800	17.60
1996	ECT 1b phase	Amazonehaven	600	17.55
1997	ECT 2a phase	Amazonehaven	600	17.55
1997	ECT 2b phase	Amazonehaven	600	17.55
1998	ECT 4 phase	Hartelhaven	500	10.65
2000	Pier 5	Waalhaven	400	12.65
2001	Short sea	Eemhaven	2300	14.15

2002	Kramer /ECT	Amazonehaven	250	10.65
2007	Euromax	Yangtzehaven	1900	16.65/19.65

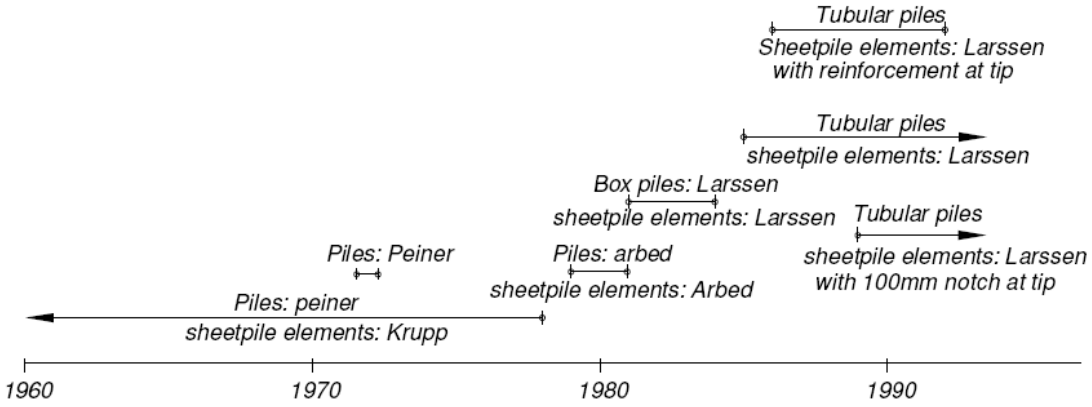


Figure 15 Use of different combi-wall systems in Rotterdam (de Gijt 2009)

Figure 15 illustrates the development of combi-wall in relation to the other available systems. The Peiner and Larssen profiles have been in the market since 1960 and 1970 respectively. The use of the combi-wall system has evolved over time. The most commonly used combi-wall system is the combination of open steel tubular piles with three sheet pile wall elements in between, and is used since 1986. The quay wall in the Brittanniehaven (Figure 14) shows a high relieving platform on concrete piles and a combi-wall construction. In this case, the horizontal force is transferred to the subsoil by an open pile trestle system. The quay wall in the Amazonehaven is also a combi-wall with a relieving platform on vibro piles anchored by means of an MV pile.
For the first time in the Port of Rotterdam, a reinforced concrete diaphragm wall has been built as a retaining wall for the recently opened Euromax terminal at the Maasvlakte. The choice was made because of the vulnerability of steel for corrosion. The wall is 1.50 meter thick and has a length of 39.0 meter. The reinforced concrete relieving platform has an L-form and is supported on vibro-piles. The wall is anchored by means of a 50 meter long MV pile.

5.4. Some statistics

Table 10 shows some characteristics of the container terminals in Rotterdam.

Table 10 Some characteristics of the container terminals

Characteristics container terminals	Average values	Source
Area productivity Waal-/Eemhaven 2005	14,200 TEU/ hectare	PoR
Area productivity Maasvlakte 2005	17,800 TEU/ hectare	
Productivity Maasvlakte 2005	ca. 1000 TEU/meter quay length	
Area productivity Waal-/Eemhaven 2020 (prognoses)	16,600 TEU/hectare	
Area productivity Maasvlakte 2020 (prognoses)	27,700 TEU/ hectare	
Area productivity short sea 2020 (prognoses)	28,000 TEU/ hectare	
Import dwell vessel - truck	6.4 days	Dekker 2005
Export dwell truck - vessel	4.6 days	
Import dwell vessel - train	6.5 days	
Export dwell train - vessel	4.7 days	
Import dwell vessel - barge	4.1 days	
Export dwell barge - vessel	4.3 days	

The Euromax terminal is 84 hectare in area with a quay wall 1500 meter long. The capacity of the terminal is 2.3 million TEU which means that maximum area productivity is 27,000 TEU/hectare and the maximum productivity per meter quay wall is ca. 1,500 TEU/m.

6. Future of container sector

6.1. Maasvlakte 1 and 2

After the completion of Maasvlakte, the rapid post-war expansion of Rotterdam came to a temporary standstill. The original plans for a second Maasvlakte were tabled in 1992 but progress has been slow as environmental concerns and budgetary constraints led to a complex social and political debate that took twelve years to resolve. At the end of 2007 the port and industrial area included 5,102 hectares of industrial sites of which 90% (about 4,583 hectares) was let out either for rent or in tenure. The explosive growth in cargo traffic and economies of scale in ship sizes made it mandatory to have space for constructing port infrastructure. Maasvlakte 2 needed to be built in order for the Rotterdam port to continue to meet the future demands.

The construction of Maasvlakte 2 is an integral part of the Rotterdam Mainport Development Project which encompasses three components: (1) the land reclamation for Maasvlakte 2 including compensation measures (2) the implementation of a number of projects in the current port and industrial area aimed at a better use of available space and an improvement of the quality of the living environment and finally (3) the creation of 750 hectare of new nature and recreational zones in the Rotterdam area. The total cost of the Mainport Development Project is in excess of 3.6 billion euro about 900 million of which shall be made available by the Dutch government. The construction of the sea defense commenced in 2008. Customers have already been found for the: 167 hectare-site for APM Terminals, 156-hectare terminal for the consortium 'Rotterdam World Gateway' and a site for the expansion of the existing Euromax terminal. Thus 40% of Maasvlakte 2 has already been allocated. Some details over the project can be seen in Figure 16.

1. **First client: Rotterdam World Gateway**
   156-ha container terminal, housing a combination of stevedore DP World and four shipping companies: New World Alliance (MOL, Hyundai and APL) and CMA CGM. Capacity: ca. 4 million TEU*. Operational: 2013.
2. **Second client: APM Terminals**
   167-ha container terminal, accommodating APM Terminals. Capacity: ca. 4.5 million TEU*. Operational: 2014 (First phase).

*(*TEU is a standard unit for measuring container capacity)*

3. 625 ha of space for container terminals
4. 210 ha of space for the chemical sector
5. 165 ha of space for the distribution sector
6. 4 km of hard seawall (dikes)
7. 8 km of soft seawall (beach and dunes)
8. Yangtzehaven (width 600 m)
9. Beerkanaal
10. 'Old' Maasvlakte
11. Slufter (dredged material depot)
12. Nature beach
13. Leisure beach
14. Activity beach
15. Spotting beach
16. Space for wind turbines
17. 35-ha Delfland dune compensation project
18. 25,000-ha seabed protection area
19. Nieuwe Waterweg
20. Calandkanaal
21. Oostvoornse Meer
22. Hoek van Holland
23. Oostvoorne
24. Voornse Duinen
25. Landtong Rozenburg

Figure 16 Maasvlakte 2 in 2033 (source: PoR)

Meanwhile the developments in Maasvlakte 1 are not standing still. Increasing the nautical width of Amazonehaven at the Maasvlakte to handle 9000 TEU ships at the north side of the Delta Peninsula is being considered (Figure 17).

Figure 17 Widening Amazonehaven. Delta Penisula

The possibility of dredging Europahaven alongside quay walls Delta 1 en Delta 2 located at the Maasvlakte is also being investigated. The present contractual depth is NAP -16.00 m; the new contractual depth will be NAP -18.65 m (construction depth will be NAP -21.65 m).

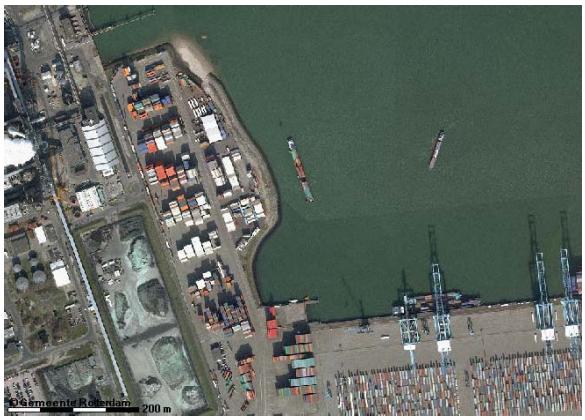


Figure 18 Location of the new APM barge terminal. Europahaven

Due to shortage of storage space APMT is considering constructing a berthing facility for barges. The terrain will be primarily used for storage of containers. Further, in order to improve the accessibility of the container terminals at the Maasvlakte. Container Transferia will be set up at locations in the immediate hinterland of Rotterdam in order to receive container flows from the sea terminals by means of inland ships.

6.2. Waal- en Eemhaven

There is an increasing requirement of land in the Waal-/Eemhaven not only for growth of container sector, short sea sector, fruit sector and other port related activities but also for residential and office space. The ports areas are being transformed into innovative and modern work and living areas, terrain is being reclaimed and investments made in expensive infrastructure modifications (Figure 19).

Figure 19 The Rotterdam City-Ports Area in 2007 (Daamen. T.)

6.3. Change in container capacity

Intensification of use, filling in unused port basins, removing the hidden reserves of unused sites from the letting market and creating new port area of Maasvlakte 2 are some of the steps being undertaken in the port of Rotterdam. The change in container capacity in Port of Rotterdam in 2013, when phase 1 of Maasvlakte 2 is operational, can be seen in Table 9.

Table 9 Changes in container capacity PoR (in million TEU)

Terminal	Capacity 2007	Capacity 2013
Delta Peninsula (ECT Delta and APM terminals. and two new barge/feeder terminals)	6.3	9.0
Euromax terminals	Operational 2008	2.9
Waal-/Eemhaven area	3.0	3.0
Other Rotterdam port area	1.0	1.0
RWG Maasvlakte 2 APMT Terminal 2 Maasvlakte 2 Euromax expansion		4.0 4.5 3.0

Until the financial crisis and the subsequent economic crisis the container transport has shown an enormous growth rate in all ports in the world and also in Rotterdam.
Due to this economic crisis it is expected that for several years a reduction in all transport and also in the container transport will take place. This period of reduction in transport may last 2 to 4 years.
However it is anticipated that after the recovery of the financial markets the economic growth will continue. This means also an increase in sea world trade and for container transport.
The expected container throughput for the Port of Rotterdam for the period 2010 to 2030 is presented in figure 20.
This figure shows an increase in TEU capacity of a factor 2,5 compared to the year 2008 . Further this indicate that in the existing area in the port(BRG) the container capacity is around 10 to 11 million TEU while the other container will be handled on the Maasvlakte 2 (MV2)area which is now under construction and will be operational in 2013.

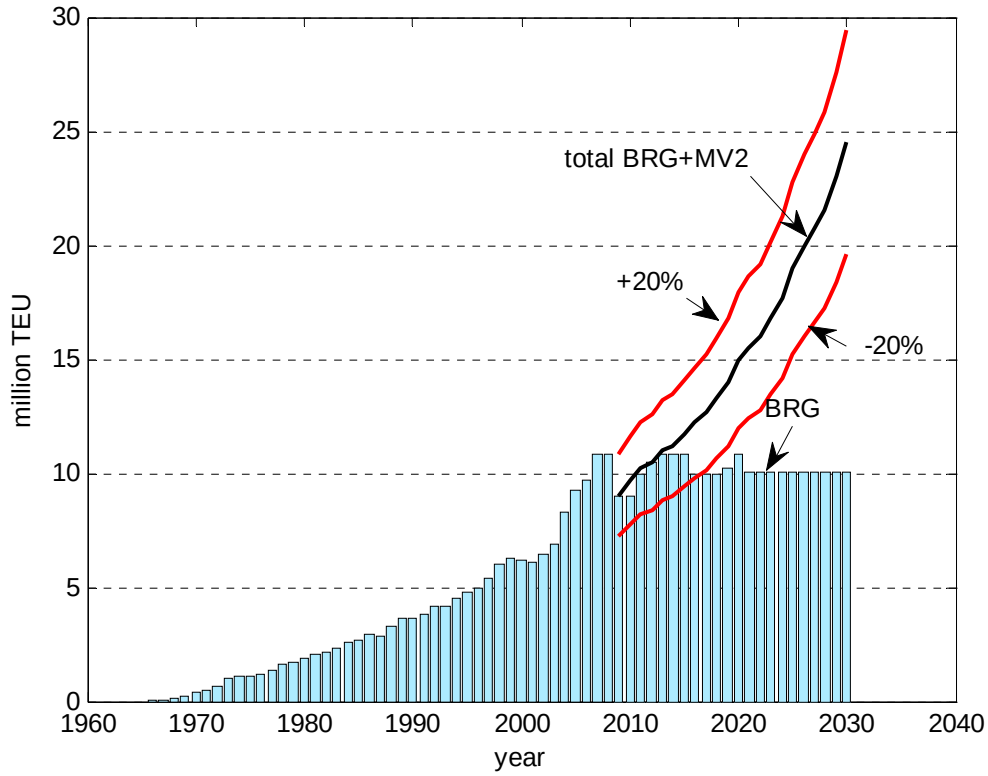


Figure 20 Forecast container transport ,TEU,in the Port of Rotterdam

7.0 Conclusions

-The present position of port of Rotterdam has been acquired through developments of design and construction techniques to accommodate the increasing loads and increasing ship dimensions and investments in infrastructure, information technology and logistics with due consideration for the environment.

-Due to the prevailing uncertainty,2009, in the port and shipping sector nobody can predict how the port of Rotterdam will develop beyond the present expansion program.

- However economic growth will again take place after this unsecure period and so will the growth of container transport.

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