

AUTOMATION IN THE CONTAINER TERMINALS OF THE PORT OF HAMBURG

Andrej Dávid¹, Jiří Tengler²

Summary: The port of Hamburg is the largest German seaport lying on the banks of the Elbe River, 115 kilometres from its estuary into the North Sea. Within container transshipment, it is on the third rank among European ports beyond the Dutch port of Rotterdam, and the Belgium port of Antwerp. Hamburg belonged to the first European ports that started handling containers at the end of the 1960s. In 1990, the port handled 1.696 mil. TEUs, in 2017, it was already 8.815 mil. TEUs. The port of Hamburg has four container terminals, two of which are automated or semi-automated terminals. The terminals differ in technical equipment, transshipment technology, handling systems.

Key words: port of Hamburg, container terminals, handling systems, automated terminals

INTRODUCTION

The port of Hamburg is one of the oldest European ports which began transshipping containers in the late 1960s. The first container ship, the American Lancer, entered the port of Hamburg on 31 May 1968. This ship had already had a cellular structure of cargo hold. Between 1968 and 2017, a total of 186 million of standardized containers were handled in the port.

Nowadays, Hamburg is the third largest European seaport in the transshipment of containers after the port of Rotterdam and the port of Antwerp. In 2017, 8.815 million TEUs were handled in the port that represents a decrease of 1.03% compared to 2016. Among the twenty world container ports, Hamburg was nineteenth in the transshipment of containers. (2)

The port of Hamburg has four container terminals, two of them use automated transshipment systems to increase their terminal throughput, reduce handling equipment downtime, or downtime of container ships in the port during transshipment of containers or waiting for transshipment operations. (3)

1. THE PORT OF HAMBURG

1.1 General information about the port of Hamburg

The port of Hamburg lies on the banks of the Elbe River, 115 kilometres from its estuary to the North Sea. The total port area of Hamburg is 7 083 ha, of which the port area is 4.243 ha, water area is 2.839 ha and the rest of the territory is intended for further development of the port.

¹ doc. Ing. Andrej Dávid, PhD., University of Zilina, Faculty of Operation and Economics of Transport and Communications, Department of Water Transport, Univerzita 8215/1, 010 26 Zilina, Tel.: +421 41 513 3565, Fax: +421 513 1527, E-mail: andrej.david@fpedas.uniza.sk

² Ing. Jiří Tengler, PhD., University of Zilina, Faculty of Operation and Economics of Transport and Communications, Department of Communications, Univerzita 8215/1, 010 26 Zilina, Tel.: +421 41 513 3121, Fax: +421 513 1527, E-mail: jiri.tengler@fpedas.uniza.sk

The port of Hamburg transships bulk, general, liquid cargo, including intermodal transport units. In 2017, the port transhipped about 136.5 million tonnes of cargo, which represents a decrease of 1.23% (1.7 million tonnes) compared to the previous year. In export about 58.1 million tons of cargo were handled, in import 78.4 million tons of cargo were transhipped. Rail transport (46.6%) accounted for the largest share of freight transport between Hamburg and the hinterland (97.8 million tonnes of freight), followed by road (42.4%) and water transport (11.0%).

The port is directly connected to the public road network by the motorways and local roads. The E 45 (A 7) motorway passes through the west part of the port, while the E 22 (A 1) motorway runs near the east part of the port. Road transport plays the most important role in cargo transport between the port and hinterland.

Rail transport links the port with twenty countries around the world. Every day around 200 trains (most of them are container trains) go to / from the port. There are three main railway stations in the port, the total length of railway tracks is 375 kilometres. Each container terminal has its own railway transshipment station.

The Elbe River connects the port of Hamburg with a number of German canals (Mittellandkanal, Elbe-Seitenkanal and others) and the network of European waterways. Water transport is involved in the transport of all types of cargo by motor cargo ships or pushed convoys. (4, 6)

1.2 Transshipment of containers

The port of Hamburg belongs to the oldest European ports that started transshipping containers at the end of the 1960s. The development of container transshipment in Hamburg can be divided into several development stages.

In 1966, the first containers that were transported as deck cargo by a multi-purpose vessel were unloaded in Burchardkai (part of the city of Hamburg). In that time there were no ship to shore gantry cranes for transshipment of containers, therefore gantry cranes for transshipment of bulk and general cargo were used for handling operations.

In 1967 the construction of the container terminal Burchardkai began. For the transshipment of containers, the first ship to shore gantry cranes were built in the terminal. Containers were transported by multipurpose ships to the port.

The first container ship of cellular construction (American Lancer) arrived in Hamburg port on May 31, 1968. The container ship had a carrying capacity of 1.200 TEU, it was 213 metres long and 26 metres wide. The first container train had arrived in Burchardkai a few months earlier on 5 February 1968. In 1969 the Container Terminal Eurogate was put into operation. As the result of cargo containerisation two shipping companies (HAPAG - Hamburg-American Line) a NDL - North German Lloyd) were established in 1970.

In 1969 the Container Terminal Eurogate was put into operation. As the result of cargo containerisation two shipping companies (HAPAG - Hamburg-American Line) a NDL - North German Lloyd) were established in 1970.

In 1971 the first straddle carriers were used for handling of containers in the Container Terminal Burchardkai. In 1972 a regular container transport began by cellular container vessels

between Europe and Asia once a week. In 1974 a tunnel under the Elbe River and the Köhlbrand Bridge were completed due to a better connection of the Container Terminal Burchardkai for a public road transport of the city of Hamburg. In 1977 the second container terminal (Container Terminal Tollerort) was put into operation. Nowadays it is under the control of HHLA (Hamburger Hafen und Logistik).

In 1984, it was the first time when the port of Hamburg handled more than 1.0 million of TEUs.

In 1999, the latest fairway adjustment (deepening of the Elbe River) was implemented so that larger container vessels could approach into the port.

In 2002, the port of Hamburg transhipped 5.0 million of TEUs, a new automated container terminal (Container Terminal Altenwerder) was also put into operation. Nowadays, it is one of the most modern container terminals in the world. In 2004, HHLA started the modernization of its largest container terminal (Container Terminal Burchardkai) for the capacity 5.2 million of TEUs per year.

In 2013, the first tandem ship to shore gantry cranes equipped with double spreaders were transported to Burchardkai. In 2017, the first container ship (MOL Triumph) with a capacity of more than 20.000 TEUs entered the port of Hamburg. In the first 50 years of container transshipment, 186 million standardized containers were transhipped in the port of Hamburg (see Tab.1). (1)

Tab. 1 - Transshipment of containers for selected years

Year	Container transshipment [TEUs]
1968	37 000
1990	1 696 000
2000	4 248 000
2010	7 890 600
2015	8 821 481
2016	8 906 817
2017	8 815 469

Source: (2)

In 2017, about 8.815 million of TEUs were handled in the port, it was a decrease of 1.03 % compared to the previous year. Each third container that was handled in the port came from China. About 3.4 million of TEUs that were loaded on smaller container vessels were transported to other sea ports located in the North or Baltic Seas (feeder service). About 5.5 million of TEUs were transported by different modes of transport to the hinterland. Road transport had the biggest share in container transport (about 55.0 %), it was followed by railway transport (42.8 %) and water transport (2.2 %). (4)

2. CONTAINER TERMINALS OF THE PORT OF HAMBURG

Transshipment of containers is carried out in four container ports. Three of them (Container Terminal Altenwerder, Container Terminal Burchardkai and Container Terminal Tollerort) are operated by HHLA (Hamburger Hafen und Logistik, AG), one of them (Eurogate Container Terminal) is operated by Eurogate. Container terminals differ handling equipment, transshipment technology, and handling systems. As the result of increase of the output, decrease of downtimes of handling equipment or container vessels two container terminals of the port of Hamburg (Container Terminal Altenwerder and Container Terminal Burchardkai) use automated system of container transshipment. (3, 5)

2.1 Container Terminal Altenwerder

The Container Terminal Altenwerder (CTA) was put in operation in 2002 (Fig. 1). The total costs for its construction were about 650 million EUR, of which 300 million EUR were spent for the construction of quay and infrastructure of the terminal. Four Post-Panamax ships can anchor at the quay that is 1,400 metres long.

The handling system of CTA consists of gantry container cranes, automated guided vehicles, automated stacking cranes on rails and semitrailers. Container gantry cranes, which tranship containers between the ship and the terminal, serve container vessels Post-Panamax. They have got two trolleys. The first trolley (water side trolley) drops containers on the platform that is situated inside of the crane portal. The second trolley (land side trolley) loads containers on automated guided vehicles that transport containers to the block of the container yard. Each block is equipped with two automated stacking cranes on rail with the different gauge. The first one transfers containers between automated guided vehicle and the block of the container yard. The second one transfers containers between the block of the container yard and semitrailer. In the land side there is also a railway station where containers are handled by transtainer cranes between semitrailers and wagons. (3, 5)



Fig. 1 – Container Terminal Altenwerder, photo: authors

2.2 Container Terminal Burchardkai

The Container Terminal Burchardkai (CTB) is the oldest and largest container terminal (Fig. 2) in the port of Hamburg. The first containers were transferred in the terminal in 1968. Up to 10 container vessels can anchor at the quay that is 2,850 metres long. The maximum allowable draught for ships is 15.3 meters. For the transshipment of containers between ships and the terminal, ship to shore gantry cranes are used which can handle ships that are up to 400 metres long with 24 rows of containers on board.

CTB has two handling systems for container transshipment. The first handling system of the terminal consists of straddle carriers that handle containers between container gantry cranes and the blocks of the container yard, or between the blocks of the container yard and other modes of transport (railway wagons or semi-trailers). It is one of the oldest handling systems that we can find in the container terminals of sea ports. The second one consists of container gantry cranes (ship to shore gantry cranes), straddle carriers, automated stacking cranes on rails, semi-trailers / rail-mounted gantry cranes and railway wagons. Container gantry cranes equipped with double spreaders tranship containers between container vessels and the terminal. Straddle carriers that are operated by port workers transport containers between cranes and the blocks of the container yard. Each block has got three automated stacking cranes. The first one moves containers between straddle carriers and the block, the second one moves containers within the block and the third one between the block and semi-trailers. The part of containers is transported by railway transport between the terminal and hinterland, transtainer cranes move containers between semi-trailers and railway wagons. (3, 5)



Fig. 2 – Container Terminal Burchardkai, photo: authors

2.3 Container Terminal Tollerort

The container terminal Tollerort (Fig. 3) is the smallest container terminal of HHLA. The terminal area is 70 hectares. The quay is 1,205 metres long. The handling system of the terminal is based on straddle transporters that handle containers within the terminal. Ship to shore gantry cranes can handle container ships with a capacity of up to 20,000. TEU and a length of 400 meters. The maximum allowable draught for vessels is 15.2 metres. In the land side transfer area of the terminal containers are loaded onto railway wagons. (3, 5)

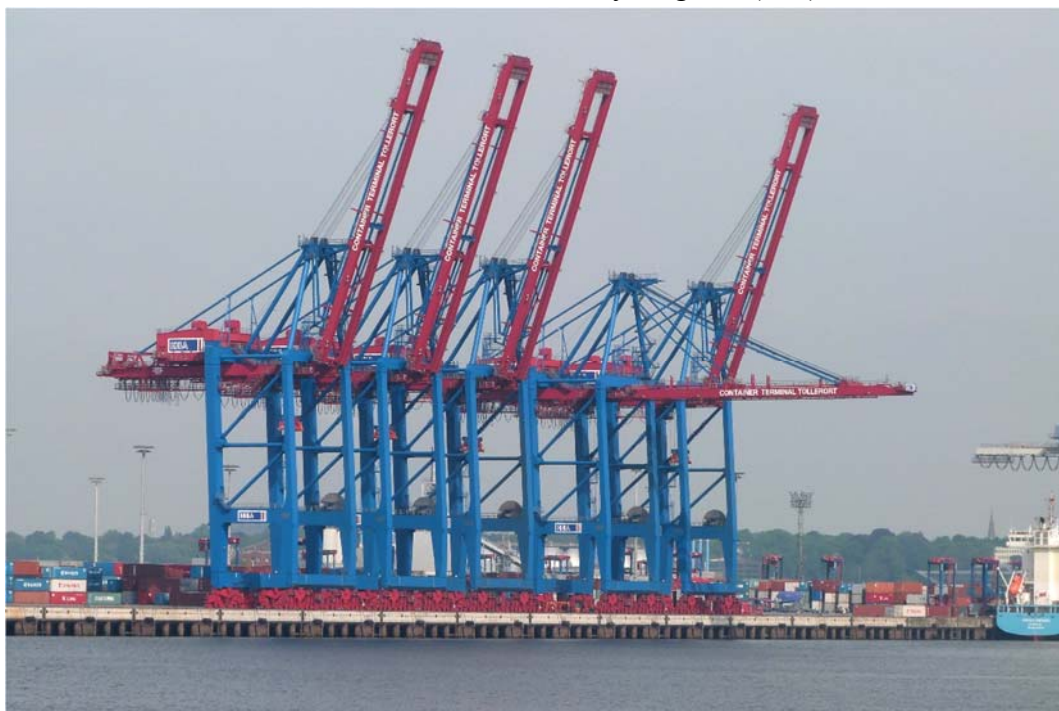


Fig. 3 – Container Terminal Tollerort, photo: authors

2.4 Eurogate Container Terminal

The Eurogate Container Terminal (Fig. 4) is located opposite the Burchardkai Container Terminal. This terminal is owned by Eurogate. It covers an area of 140 hectares. The quay of the length of 2,080 metres consists of six anchors equipped with ship to shore gantry cranes. These cranes can handle ships with a capacity of up to 19 thousand of TEU, 400 metres long with 23 rows of containers on board. The maximum draught for vessels is 15.3 metres. The containers are handled by straddle carriers as in the Tollerort Container Terminal. Behind the terminal there is the Waltershof railway station with a siding connection to the terminal. (3, 5)



Fig. 4 – Eurogate Container Terminal, photo: authors

CONCLUSIONS

As the results of the increase of cargo containerization, enlarge of the dimensions of container vessels, the container terminal of the port of Hamburg have begun to implement different methods how to increase their throughput and to decrease the downtimes of handling devices or container vessels in the port. On one hand the Container Terminals Eurogate and Tollerort have used straddle carriers for handling of containers, the Container Terminal Altenwerder (partly Burchardkai) have used automation handling system that is based on semi-automated ship to shore gantry cranes, automated guided vehicles, automated stacking cranes on rails. This automation brings a lot of advantages such as the increase of the throughput of container terminals, the decrease of the downtimes of handling devices, vessels, port workers who participate in transshipment and storage of containers.

REFERENCES

- (1) *50 Years of Change*. In: Port of Hamburg Magazine, March 2018, Hamburg
- (2) *Hamburg Port Authority* [online], [2019-26-08], <<https://www.hamburg-port-authority.de/en/themenseiten/50-years-of-container-handling>>.
- (3) *Germany's largest container port* [online], [2019-26-08], <<https://www.hafen-hamburg.de/en/container-terminals>>.
- (4) *Port of Hamburg, Facts and Figures 2018* [online], [2019-26-08], <<https://www.hafen-hamburg.de/en/press/media/brochure/facts-figures---37993>>.
- (5) ŠIROKÝ, J.: *Progresivní systémy v kombinované přepravě*. Univerzita Pardubice, Pardubice 2010, 184 s., ISBN 978-80-86530-60-4.
- (6) The paper is supported by the VEGA Agency by the Project 1/0791/18 "The Assessment of Economic and Technological Aspects in the Provision of Competitive Public Transport Services in integrated Transport Systems", that is solved at Faculty of Operations and Economics of Transport and Communication, University of Žilina.