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Port Feeder Barge: Advanced Waterborne Container Logistics for Ports

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ABSTRACT: The Port Feeder Barge as a new type of harbour vessel has been designed – firstly for the operation within the port of Hamburg. Other major and even minor ports could benefit from the operation of this innovative type of vessel as well as it improves the efficiency and at the same time reduces the ecological footprint of intra-port container haulage. Additionally it can even facilitate container handling at places which are not suited at all for this kind of operation.

1 INTRODUCTION

Figure 1. Port Feeder Barge (artist impression)

The internationally patented Port Feeder Barge is a self-propelled container pontoon with a capacity of 168 TEU (completely stowed on the weather deck), equipped with its own state-of-the-art container crane mounted on a high column (Fig. 1). The crane is equipped with an automatic spreader, extendable from 20ft to 45ft, including a turning device. A telescopic over height frame is also carried on board. The barge is of double-ended con-figuration, intended to make it extremely flexible in connection with the sideward mounted crane. Due to the wide beam of the vessel no stability restrictions for the crane shall occur. The crane has a capacity of 40 tons under the spreader, at an outreach of 27 m (maximum outreach: 29 m). The unique vessel is equipped with 2 electrically driven rudder propellers at each end in order to achieve excellent manoeuvrability and the same speed in both directions. Hence the vessel can easily turn on the spot. While half of the containers are secured by cell guides, the other half is not, enabling the vessel to carry also containers in excess of 40ft length as well as any over-dimensional boxes or break bulk cargo. 14 reefer plugs allow for the overnight stowage of electrically driven temperature controlled containers.

Table 1. Port Feeder Barge - Main Data

Type:	self propelled, self sustained, double-ended container barge
Length o.a.:	63.90 m
Beam o.a.:	21.20 m
Height to main deck:	4.80 m
Max. draft (as harbour vessel):	3.10 m
Deadweight (as harbour vessel):	2,500 t
Gross tonnage:	approx. 2,000 BRZ
Power generation:	diesel/gas electric
Propulsion:	2 x 2 electrical rudder propeller of 4 x 280 kW
Speed:	7 knots at 3.1 m draft
Class:	GL ✠ 100 A5 K20 Barge, equipped for the carriage of containers, Solas II-2, Rule 19 ✠ MC Aut
Capacity:	168 TEU (thereof 50% in cellguides), 14 reefer plugs
Crane:	LIEBHERR CBW 49(39)/27(29) Litronic (49 t at 27 m outreach)
Spreader:	automatic, telescopic, 6 flippers, turning device, overheight frame
Accommodation:	6 persons (in single cabins)

The vessel shall fulfil the highest environmental standards. A diesel- or gas-electric engine plant with very low emissions has been chosen to supply the power either for propulsion or crane operation. The vessel can be operated by a minimum crew of 3 whereas in total 6 persons can be accommodated in single cabins.

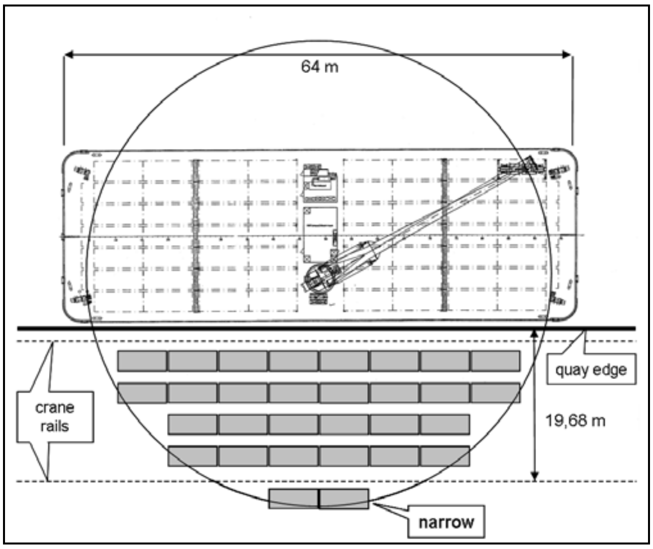

Figure 2. Turning cycle of crane

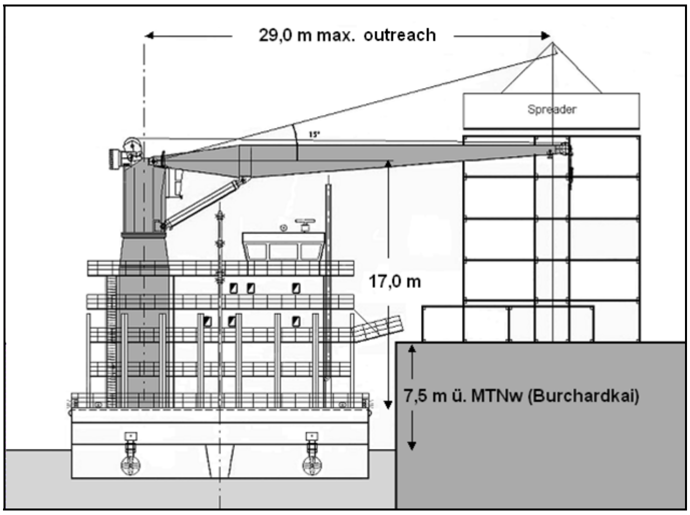

Figure 3. Outreach of crane

The key element of the worldwide unique Port Feeder Barge concept is its own full scale heavy duty container crane. All its mechanical components have been especially designed for continuous operation – unlike standard shipboard cranes, which are designed for operation only every few weeks when the vessel is in port. Due to its nature the load cycle requirements of the Port Feeder Barge are even higher than for many quayside cranes, which has significant consequences on the layout of the mechanical components.

When berthed, the Port Feeder Barge is able, without being shifted along the quay, to load or discharge 84 TEU in three layers between the rails of typical quayside gantry cranes (Fig. 2). This is more than sufficient, with a total loading capacity of 168 TEU. That is why the full outreach of the crane is not always needed. Berthing the vessel with the crane on the opposite side of the quay (Fig. 3 and 4) would speed up crane operation as the turning time of the outrigger is reduced. The height of the crane column is sufficient to serve also high quays in open tidewater ports even at low tide while stacking the containers in several layers (or to serve even deep sea vessels directly, Fig. 7). Due to its short length of 64 m the Port Feeder Barge needs only a small gap between two deep sea vessels for selfsustained operation (Fig. 4).

The operation of the Port Feeder Barge is not limited to inside seaports. As the hull is classified according to DNV-GL's class notification for seagoing vessels the operation in (sheltered) open waters off the coast is also possible which opens some interesting opportunities for additional employment.

The design of the vessel has been developed by PORT FEEDER BARGE GmbH[5] in close co-operation with Technolog GmbH, both of Hamburg.

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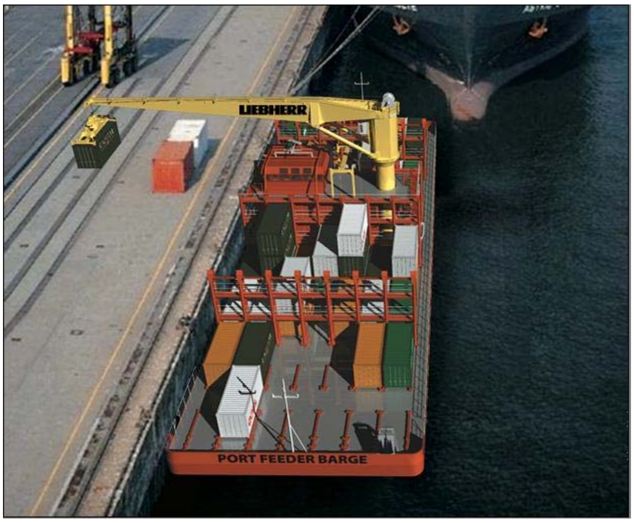

Figure 4. Port Feeder Barge is working independently from quayside equipment at a deep sea terminal requiring only a small gap between two deep sea vessels

Within the Port of Hamburg the Port Feeder Barge shall ply between all the major waterfront container facilities, including a dedicated berth to meet with the inland waterway vessels.

2 BUSINESS FIELDS

2.1 *Intra-port haulage*

The Port Feeder Barge shall serve as a 'floating liner truck' in the course of its daily round voyage throughout the port, i.e. shuttling containers between the various container facilities. Hence container trucking within the port can be substantially reduced [1].

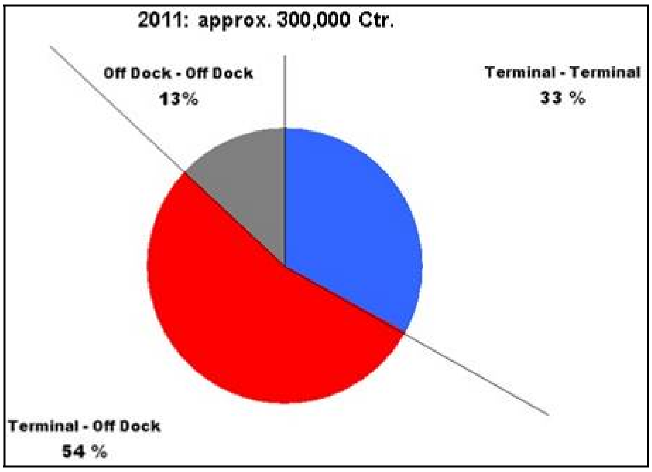

Figure 5. Split of intra-port container haulage by truck within the Port of Hamburg

Figures on port's internal box movements which are predominantly carried on the road are generally difficult to obtain. It is estimated that in 2011 within the port of Hamburg approx. 300,000 containers, i.e. approx. 85% of the anticipated entire volume, have been carried by truck (which is corresponding to approx. 450,000 TEU).[6, 7] The remaining was carried on the water by ordinary barges. The reason for the poor share of barge transport is very simple: Conventional inland barges or pontoons employed in intra-port container transportation are dependent from the huge quayside gantry cranes for loading/discharging. However one move by gantry is already exceeding the costs of the entire road haulage. Naturally two moves are needed and the barge has to be paid as well. Hence in most cases intra-port barging of standard containers is not competitive unless the liftings by the quayside gantries were subsidised by the terminals.

According to industry sources 1/3 of road haulage is of terminal-to-terminal nature while more than half is between a terminal and an off dock facility (depot, packing station, repair shop etc.) of which many in Hamburg have their own water access (Fig. 5).[7] Hence the present cargo potential for the Port Feeder Barge is estimated to roughly 150,000 containers p.a. (corresponding to approx. 225,000 TEU). Approx. 50% (!) of all intra-port container trucking is presently passing the notoriously congested Koehlbrand bridge (Fig. 6). Hence the Port Feeder Barge would offer a viable and more environmentally friendly alternative compared to trucking.

Figure 6. Typical view on Hamburg's Koehlbrand bridge linking the port's eastern and western part (photo: dpa)

2.2 *Feeder operation*

In multi terminal ports common feeder services have to accept and deliver containers from/to all facilities where deep sea vessels are berthing. For this reason the feeder vessels have to call at all terminals within the port – sometimes even if only a few boxes have to be handled. E.g. in Hamburg each feeder vessel has to call in average at 4 different facilities (incl. waiting berths) [2] [3]. That is why the feeder lines are already a major customer of the road hauliers. Otherwise the number of berth shiftings within the port would have been even higher.

From the terminal's perspective all vessels with less than approx. 100 boxes to handle are critical with

[6] In Hamburg the average TEU ratio is approx. 1.5 TEU/box

[7] Extrapolated information provided by CTD GmbH (HHLA), November 2009

respect to profitability anyhow. However, in Hamburg almost $^{2}/_{3}$ of all terminal calls by feeder vessels are below that figure! Smooth and efficient feeder operation is essential for the port's economic well-being as its entire container throughput relies to more than $^{1}/_{3}$ on transhipment.

As the feeders are already big customers of the trucking companies for intra-port haulage the Port Feeder Barge can also replace trucking for collecting and distributing their containers. The Port Feeder Barge will offer a more competitive service than the trucks can do, especially for lots of many or over-dimensional boxes (flats with overwidth/-height). Hence the Port Feeder Barge can be used by the feeders more intensively than the trucks at present enabling the feeders to concentrate on the major terminals only, thus reducing the number of berth shiftings, reducing their time in port and related costs, increasing terminal and berth efficiency as well as improving safety (collisions).

2.3 *Inland navigation*

Inland navigation is facing a dilemma as far as the hinterland transport of containers to and from seaports is concerned. On the one hand there is a common understanding that its share in hinterland transport has to be substantially increased – for capacity and environmental reasons. On the other hand in sea ports inland waterway vessels have to berth at the facilities which are tailor made for the biggest container vessels sailing on the seven seas (with a capacity of 14,000 TEU and even more). Hence the efficiency of the big gantry cranes is rather low when serving the small vessels. Not surprisingly but most disadvantageous inland navigation enjoys the last priority when it comes to berth allocation.

Figure 6. The Port Feeder Barge is serving an inland waterway vessel midstream (artist impression)

Inland barges suffer more than feeder vessels as they have to call at even more facilities. E.g. Rotterdam has approx. 30 terminals and depots which are frequently served by inland container barges. The average number of terminal calls per vessel is about 10 whereas in about 50 % of the calls only less than 6 containers are handled [4]! This kind of inefficient and not coordinated 'terminal hopping' is very time consuming and each delay at a single terminal results in incredible accumulated waiting time during the entire port stay. Not surprisingly only $^{1}/_{3}$ of the time in port is used for productive loading/ unloading [5].

In Hamburg where inland navigation has still only a poor share of less than 2% (!) in hinterland container transport the inefficient operation has been identified as one of the major reasons for such small share [6]. Some Dutch and German studies regarding the problems of transhipment procedures between inland navigation and deep sea vessels have been already published [4] [5] [6]. One common result is that container handling for inland navigation and deep sea vessels should be separated from each other. In other words: Inland vessels should not call at the deep sea facilities any more.

It is claimed that dedicated inland waterway berths have to be introduced at deep sea terminals. However most terminals do not have any shallow draught waterfront left where such berths could be meaningfully arranged. Transforming existing valuable deep sea quays to exclusive inland navigation berths with dedicated (smaller) gantry cranes does not pay off for the terminals as such a measure would reduce their core revenue earning capacity.

The erection of a central and dedicated inland navigation terminal within a port, where all inland barges call only once, has also been proposed to spare the inland barges their inefficient 'terminal hopping'. However this would burden the most environmentally friendly mode of hinterland transport with the costs of two further quayside crane moves and one additional transport within the port (either on the water or even by truck). The opposite of more waterborne container hinterland transport would be achieved. Hence increasing the share of inland navigation in hinterland transport of containers is really facing a dilemma in many major container ports.

The Port Feeder Barge could act as a dedicated 'floating terminal' for inland navigation. During its daily round voyage throughout the port the vessel is collecting and distributing the containers also for inland navigation. Once a day, the Port Feeder Barge will call at a dedicated berth to meet with the inland barges where the containers shall be exchanged ship-to-ship by the vessel's own gear, independently from any terminal equipment (virtual terminal call). Not even a quay is required but the transhipment operation can take place somewhere midstream at the dolphins (Fig. 6).

Such kind of operation will strengthen the competitiveness of inland navigation and contributes to increase the share of the most environmentally friendly mode of hinterland transport. Employing one or more Port Feeder Barges as a 'floating terminal' is less costly and much quicker and easier to realise than the erection of adequate quay based facilities (not to mention that less parties have to be involved for approval).

3 FURTHER APPLICATIONS

3.1 *Emergency response*

The Port Feeder Barge can also help to keep consequences of maritime averages at a minimum. When container vessels are grounded in coastal zones they mostly have to be lightered very quickly to set them afloat again in order to avoid further damage to the vessel, the environment and in extreme cases to sustain even the accessibility of the port at all. However it has honestly to be conceded that most container ports are not prepared for such situation and do not have suitable floating cranes (if any) available to quickly lighter big container vessels.

Unlike some other heavy floating equipment, the Port Feeder Barge can navigate in very shallow waters due to its light ship draught of only 1.2 m. Despite its small size the Port Feeder Barge can quickly lighter grounded container vessels with more than panamax beam by working from both sides (Fig. 7).

3.2 *Hong Kong style midstream operation*

In Hong Kong approx. 1/3 of the huge port's container throughput, which is still more than the total volume of Hamburg, relies on floating units serving deep sea vessels directly while laying at anchor (Fig. 8)! These traditional but unique midstream barges are equipped with their own cargo gear, but the handling method is far from being sophisticated. The A-frame derricks have a single beam just controlled by wires and are not even fitted with a spreader, but instead rely only on steel wires being fitted manually to the comer castings of the containers. In fact this is cargo handling technology from the 1950s and complies hardly with inter-national port labour safety standards. Such mid-stream barges are only operating in Hong Kong (except a few in Angola and Vietnam). In average 4 fatal accidents are officially reported each year. Quite apart from the health and safety issues, they are not self-propelled (not even pushed but towed). A replacement by Port Feeder Barges would significantly improve such operation with regard to safety, efficiency, speed and accessible ship sizes.

Figure 8. Typical midstream operation in Hong Kong

At other places throughout the world where terminal facilities are insufficient or congested and/or water depth is limited advanced midstream operation by Port Feeder Barges could be a viable alternative to the construction of costly terminal facilities.

3.3 *Floating crane*

With a capacity of 49 t under the hook (40 t under the spreader) the Port Feeder Barge can also be employed as a flexible floating crane with sufficient deck space for any kind of cargo other than containers.

4 URBAN ISSUES

Operating Port Feeder Barges is also beneficially affecting urban issues as ports can supersede with heavy land based investments to improve their intermodal connectivity for inland navigation. With respect to investment, availability of land reserves, construction approval, flexibility and not to forget environmental and townscape issues a 'floating terminal' is much smarter than any land based facility.

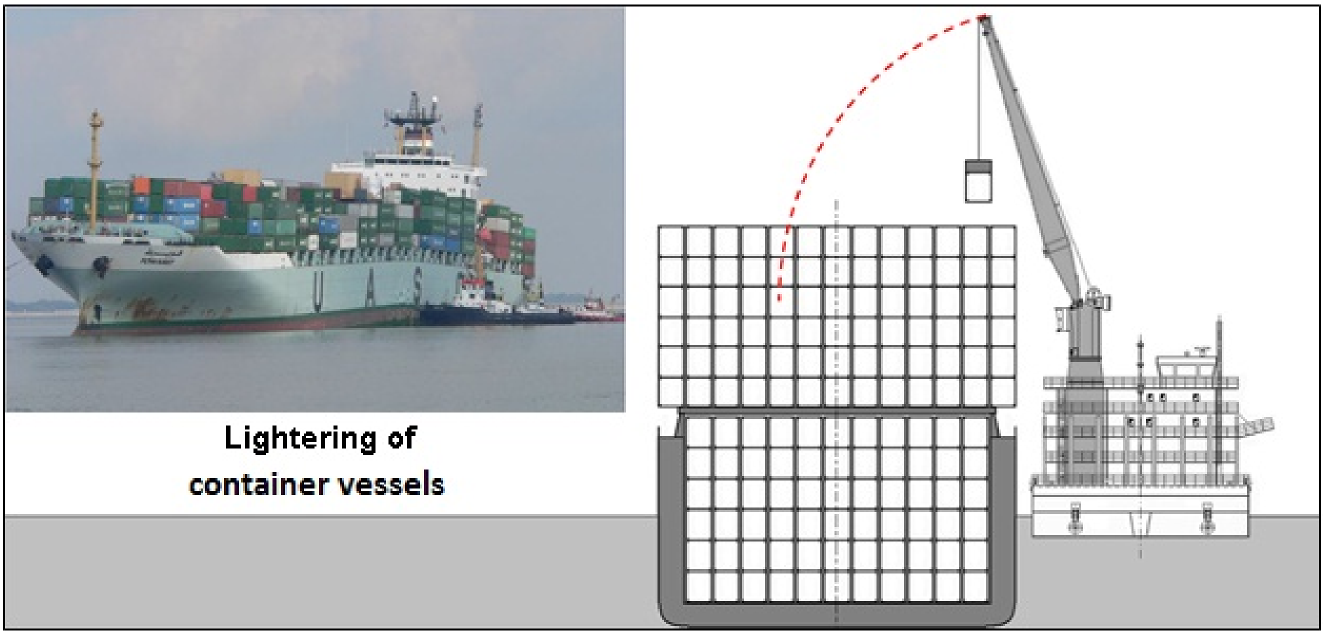

Figure 7, Grounded panamax container vessel on Schelde river in 2005 and how it could have been quickly lightered

5 OPTION: LNG AS FUEL

All costly measures to be taken to keep the exhaust emissions of the diesel-electric engine plant at an envisaged minimum (e.g. exhaust scrubbers, urea injection, filters etc.) could be saved when choosing LNG as fuel. The Port Feeder Barge would be an ideal demonstrator for LNG as ship fuel:

– As a harbour vessel it does not rely on a network of bunkering stations. Only one facility is sufficient. At the initial stage the vessel could even be supplied out of a LNG tank truck (a standard 50 m^3 truck load is sufficient for approx. 14 days of operation).
– Due to its pontoon type there is plenty of void space below the weather deck. Hence the accommodation of the voluminous LNG tanks would not be a problem at all which is not the case with all other types of harbour vessels. Approx. 500 m^3 of tank capacity could be theoretically installed which is by far more than sufficient (Fig. 9).

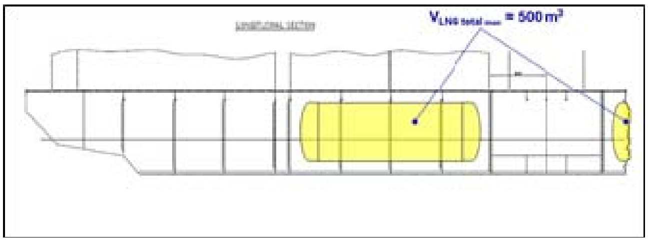

Figure 9. LNG tank arrangement

6 CONCLUSION

As there is no doubt that container volumes will certainly continue to increase ports have to prepare to ease already experienced bottleneck situations and to reduce the environmental impact of container transhipment procedures.

The Port Feeder Barge concept is a 'green logistic innovation' for sea ports (whose inherent beneficial effects to the environment can even be further increased by using LNG as fuel) that helps to…

– shift container trucking within sea ports from road to waterway,
– ease feeder and transhipment operation within multi terminal ports,
– improve the intermodal connectivity of inland navigation within sea ports,
– be prepared for grounded container vessels.

At places with insufficient or congested terminal facilities and/or shallow water restrictions the Port Feeder Barge could facilitate the handling of deep sea container vessels at all.

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