Scientific Journals
Maritime University of Szczecin

Zeszyty Naukowe
Akademia Morska w Szczecinie

2012, 32(104) z. 2 pp. 148–151

2012, 32(104) z. 2 s. 148–151

Ramps for ro-ro vessels in Baltic Sea

Vytautas Paulauskas

Klaipeda University, Shipping Department
LT-92294, Klaipeda, Manto 84, e-mail: donatasp@takas.lt

Key words: pontoons, ramps, ro-ro vessels, ro-ro ship-to-shore links pan

Abstract
Ro-ro vessels use shipside and shore ramps as roll-on/roll-off loading facilities. Baltic Sea has not tidal effects and water level did not change very much. In same time water level fluctuations in ports areas make difficulties to establish proper access to shore for ro-ro vessels during loading and unloading operations. Flexibility of ro-ro vessel-to-shore links pan is one of the key elements for optimization of ro-ro operations in ports. Feasibility outline of pontoon ramp potential, calculation methods and practical usage is studded and presented further in the article.

Introduction

Ro-ro shipping lines is used to connect densest industrial and residential regions for years, serving as passenger and freight transport. All kind of vehicles like rail cars, trucks, cars, trailers, busses etc. load on and off ro-ro vessels using variety of ramp types: gravitation (concrete, sheet piles etc.), hydraulic, pontoons. There are bridge facilities like combined shore – ro-ro ramps, or only shore-based or ro-ro shipside/stern, or fore or bough links pans that connect a ro-ro vessel to the shore [1]. Pontoon ramps could be widely applied in sites of major and frequent water-level fluctuations. Meantime, optimization of ramps is very important in terms of minimizing investments required for implementation of such ramps, and in having flexibility in different conditions like berth for the ro-ro ships mooring changes.

Fig. 1. Ro-ro vessel "LISCO MAXIMA", length 199 m, ship's loading line 2700 m

Fig. 2. Ro-ro vessel "Tor Freesia", length 230 m, ship's loading 4000 m

Implementation and operation of different type of ramps require proper methodology and accurate calculations; many ports are in demand of mobile and flexible ro-ro loading facilities to enable easy shifting from one place to another. The concerned parties should undertake a good feasibility evaluation of ro-ro ship-to-shore linking which is important for the optimum solutions of such projects. Minimum investments for the ro-ro ship-to-shore linking during quay walls for ro-ro vessels and shifting from one place in port to another place in the port or in other port is important and in same time save linking facilities shifting time is really important especially in Baltic sea, which has very density ro-ro shipping network.

Ro-ro ship-to-shore links

Ro-ro vessels use diverse type of ramps or other links pans to facilitate connection to shore, like special bridges (special type of ramp), steel sheet piles or concrete ramps which cannot ensure level regulation possibility. Operation of above type of ramps would not involve hefty expenses, yet when exposed to considerable water-level tides, may complicate ro-ro loading and unloading due to incompatible angles between ship and shore ramps. Additional supports like wood blocks or bedding structures to be used in such situations consume extra time and otherwise hinder prearrangement.

Hydraulic ramps prove very flexible and are possible to use in many instances particularly in minor water level fluctuation areas, thus being quite popular within Baltic Sea region. Most of hydraulic ramps could be easily used by majority of ro-ro vessels. At the same time investment and operation costs of hydraulic ramps are much higher compared to concrete ramps; further hydraulic ramps are very conducive in operation, especially with regard to potential touching on shipside during mooring operations at contact speed higher than expected which makes very complicated leveling the angle at this stage, since ro-ro ships are often subject to mooring in adverse weather and unfavorable conditions [5]. Flexibility of the hydraulic ramps it is not enough for the fast development ports that means in case necessity change ramp location.

Fig. 3. Pontoon shore ramp linked with ro-ro vessel ramp (Port of Vlissingen)

Pontoon ramps are very popular in sites with prevailing high tidal effects. For example, pontoon ramps have been a great success in Northern Sea and English Channel ports and other locations [2]. At the same time, difference in pontoon ramp operating conditions, e.g. in the Baltic Sea, where water-level changes are not significant, yet ice conditions in winter time cause additional problems, request additional research.

Concrete and hydraulic ramps are studded many years, advantages and disadvantages are well known, and very often ports and terminals did not analyze possible new solutions, especially flexibility possibilities and finally has big losses in case of changing situation in ro-ro business.

Advantages and disadvantages of the different type ramps should be studded before taken decision in concrete ports and terminals that will be possible increase investments for the ramps implementation effectiveness.

In this article mainly take in account possible flexibility of the ramps for the ro-ro vessels, as well as worst weather conditions during ro-ro vessels mooring and unmooring operations, which are very actual for the such type of the vessels because they should as much as possible keep stable timetable.

Pontoon ramps advantages and disadvantages, calculations and evaluation

Pontoon ramps advantages link with flexibility, low exploitation costs, possibilities easy relocate from one place to other place, relatively low maintenance costs. In same time in ice conditions, pontoon ramps necessary additionally fixed because big ice resistance (big contact area).

Pontoon ramps calculations mainly oriented on ramp's capacity and ro-ro vessel mooring contact speed restrictions. Pontoon ramp capacity should be sufficient to withstand maximum possible payloads caused by boarded vehicle [4]. As basic parameter could be taken change in pontoon draft during vehicle(s) move along pontoon ramp, as well as rolling angle in case of non-symmetric vehicles are passing over the ramp.

For calculations of pontoon ramp draft changes a following scheme could be used that comprises link point, pontoon bridge (ramp) and pontoon itself (Fig. 4).

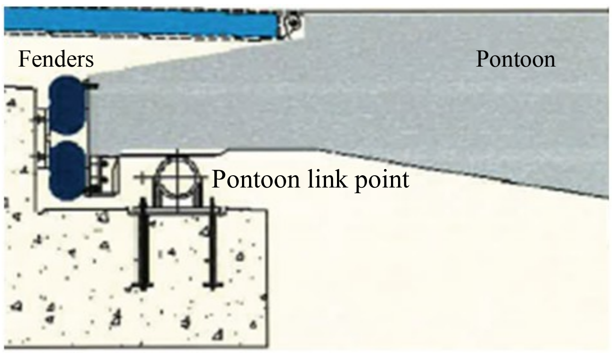

Fig. 4. Main pontoon ramp elements for calculation

Fig. 5. Link point of the pontoon

In long-span pontoon bridges at some periods, all vehicle weight affecting pontoon and pontoon draft can be calculated as follows:

$$\Delta T_P = \rho \cdot \delta_P \cdot L_P \cdot B_P \cdot P \qquad (1)$$

where: ρ – water density; δ_P – pontoon block coefficient; L_P – pontoon lenght; B_P – pontoon width; P – vehicle weight.

In case of short pontoon ramp bridges, every time part of vehicle crosses pontoon ramp weight influence on pontoon link point or ship's ramp or deck (Fig. 6).

Fig. 6. Loading operation, part of the vehicle located on ramp and part on shore

In such case pontoon is exposed to ca 60–70% of the total vehicle weight. Pontoon draft changes could be calculated as follows [6]:

$$\Delta T'_P = k \cdot \rho \cdot \delta_P \cdot L_P \cdot B_P \cdot P \qquad (2)$$

where: k – weight decreasing coefficient, acting on pontoon, which can be calculated as follows:

$$k = 0.9 \cdot \frac{L_B}{L_{TU}} \qquad (3)$$

where: L_B – length of the pontoon bridge; L_{TU} – lenght of the vehicle.

Pontoon ramp's rolling angle could be calculated based on Ship's Theory methods, especially in pontoon ramps that contain two or three loading lines (Fig. 7).

Fig. 7. Pontoon ramp with two loading lines

Pontoon ramp's rolling angle exposed to non--symmetric loads could be calculated as follows:

$$\Theta = \frac{P \cdot y}{\Delta_P \cdot H_P} \qquad (4)$$

where: y – vehicle position on ramp from pontoon central line; H_P – pontoon metacentric height, can be taken as equal to pontoon width; Δ_P – pontoon displacement could be calculated as below:

$$\Delta_P = \rho \cdot \delta_P \cdot L_P \cdot B_P \cdot T_P \qquad (5)$$

where: T_P – pontoon draft.

Fig. 8. Pontoon ramp pile anchor with possible ramp movement

Presented pontoon ramp calculation methodology could be easy used in real conditions, because all parameters content in formulas (1) – (5) could be received very easy from pontoon and vehicle parameters. In same time, it is necessary to take into account substandard situations when are loaded or unloaded very heavy units (oversize and overweight cargo). In case of oversize or overweight cargo loading and unloading pontoon ramps could be adopted by pontoon ballast changing.

On basis real vehicle weight and position on pontoon ramp could be calculate request pontoon ramp capacity and possible draft and rolling angle.

Fenders are used to absorb kinetic energy generated at the pontoon-to-shore link point, as induced by ship when contacting pontoon ramp [7]. For ro-ro vessel mooring contact speed calculation could be made according PIANC recommendations [3, 8], including safety coefficient. In same time part of the ship's created kinetic energy absorb pontoon ramp itself. Kinetic energy exposed onto pontoon link point fender could be calculated as follows:

$$E'_P = \frac{m \cdot v_k^2}{2} \cdot f_m \cdot f_e \cdot f_{mt} - \frac{m_P \cdot v_k^2}{8} \qquad (6)$$

where: m – ship's mass; v_k – ships mooring (contact) speed; m_P – pontoon together with link bridge mass; f_m – added water mass, for the ro-ro vessels move alongside could be evaluate as 2–4% of the ro-ro vessel mass; f_e – fenders elastic coefficient, for the rubber materials fenders, could be taken as 0.9; f_{mt} – materials production accuracy coefficient, according PIANC 2002 recommendation could be taken as 1.1.

Pontoon link point fender's parameters, in case if ro-ro vessel mooring (contact) speed is taken according PIANC 2002, including safety coefficient, can be calculated on basis presented methodology and selected from fenders producers information as nearest bigger.

Pontoon ramp case study calculation

As a case study practical pontoon ramp calculation for a ro-ro vessel at Klaipeda port is taken into consideration. Main data used in pontoon ramp calculation:

- ramp capacity – 1500 kN;
- possible draft changes during loading operation – 0.3 m;
- pontoon ramp link point fender's absorbed energy – 1000 kNm;
- fender deflection – 0.3 m;
- ro-ro vessel mass – 16,000,000 kg;
- ro-ro vessel width (ramp width) – 28 m;
- safety coefficient [8] – 2.0.

Pontoon ramp parameter calculation results for the conditions presented above are: length 21 m, height 5 m, possible draft up to 3 m, maximum possible mooring contact speed 0.15 m/s.

Conclusions

Pontoon ramps for ro-ro vessels are more flexible as hydraulic or concrete ramps and do not involve big operation costs. In emergency situations, higher mooring speed as request pontoon or other type of the ramps furniture, it is only pontoon ramp fender system that may suffer damage (other type of the ramps could receive more complicate damages or damage in all; replacement of pontoon ramp fender's is considerably cheaper than repair of hydraulic system on hydraulic ramps). Pontoon ramps can be easily shifted to any other required place without much investment (preparation works takes just few days). Methodology presented in this article could be used for the new pontoon ramps evaluation and for the existing ramps can be used for the calculation limitations. Pontoon ramps could be successful used in Baltic sea as request less investments for the implementation, have less exploitation and maintenance costs and more flexible.

References

1. ALDERTON P.M.: Sea transport. Blackwell, Cambridge 1995.
2. BS 6349: 2000. British Standard Maritime Structures. Part 1: Code of Practice for General Criteria (British Standard Institution, July 2003).
3. PIANC – 1995. Criteria for Movements of Moored Vessels in Harbours.
4. EAU 2004. Recommendations of the Committee for Waterfront Structures – Harbours and Waterways (Ernst & Sohn, 2006).
5. KUTZ M.: Handbook of Transportation Engineering. McGraw–Hill, New York 2004.
6. PAULAUSKAS V.: Laivo valdymas ypatingomis sąlygomis. KU leidykla, Klaipėda 1999.
7. PAULAUSKAS V., PAULAUSKAS D., WIJFFELS J.: Ships mooring in Complicated Conditions and possible solutions. Transport Means, 2008, Kaunas, Technologija, 2008, 67–70.
8. PIANC – 2002. Mooring system calculation.