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Transportation Research Procedia 14 (2016) 123 – 132

Transportation Research Procedia

www.elsevier.com/locate/procedia

6th Transport Research Arena April 18-21, 2016

Ship and quay wall mooring system capability evaluation

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Abstract

Ship mooring in adverse conditions is very important for ports and terminals, which work with big ships and ships with big wind surface areas what as a result create high hydrodynamic and aerodynamic forces on a ship and quay wall mooring systems. Traditional ship mooring systems are safe, but quay wall mooring systems sometimes are not capable enough depending on inertia and other acting forces, therefore, new solutions for increasing quay wall mooring system capability should be found.

The article presents the analysis of complicated ship mooring situations and methods, which can assist to calculate loads, acting on quay wall mooring systems in complicated conditions; the mathematical basis of calculations of ship mooring in complicated conditions and practical recommendations. The suggested methods can be used in many ports and terminals for practical application.

Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)

Keywords: Ships mooring; complicated mooring conditions; aerodynamic forces; mooring system capability; rope tension

1. Introduction

Ship and quay wall mooring systems must guarantee safe ship mooring to a quay wall in any practical situation. The capability of ship mooring systems is defined by the regulations of the Classification Associates and this insures keeping ships near quay walls in most practical cases.

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Peer-review under responsibility of Road and Bridge Research Institute (IBDiM)
doi:10.1016/j.trpro.2016.05.048

Quay wall mooring systems are designed and constructed according to particular national or international standards and regulations, such as BS (2003), EAU (2012), etc. but sometimes quay wall mooring equipment is not strong enough in adverse hydro meteorological and other internal and external factors affecting ship conditions. Limitations of the quay wall mooring equipment should be known in advance to avoid incidents and accidents on ships and quay walls, therefore, adequate ship mooring schemes have to be prepared or other relevant precaution measures taken.

Standards and regulations in many countries do not take into account all possible forces, created by hydro meteorological conditions, especially the periodical inertial forces (PIANC 1984; 2002), (BS 2003), (EAU 2012), hydrodynamic interaction between moored and passing ships in cases when the quay wall location is close to the navigational channels (PIANC 1995), (Paulauskas et al. 2014), as well in the case of wave penetration from the open sea to the port quay wall area (Wijffels et al. 2009).

In this paper the capability of the ship and quay wall mooring equipment and their evaluation methods; practical testing in real ship mooring conditions and testing results by calibration on the basis of real data and simulators are presented and discussed; practical recommendations on internal and external factors, such as wind, current, ships passing close to moored ships are presented and could be used for the ship and quay wall mooring equipment planning and design, the evaluation of the existing quay wall mooring equipment; evaluation of ship mooring schemes and readiness to guarantee safe ship mooring to quay walls in particular hydro meteorological and other adverse conditions to avoid incidents and accidents with the ships moored to quay walls and the quay walls themselves.

Ship mooring to relatively open quay walls in open port areas (Zalewski et al. 2007), especially for the ships with big wind surface areas, and possible ship movement as the result of periodical acting forces must be taken into account (Wijffels et al. 2002). A high board of the ships, such as Ro-Ro, container, bulk in ballast and some other types of ships, have big vertical mooring rope angles and not all mooring ropes can be used effectively, which decreases the mooring system capability (Paulauskas et al. 2008).

Theoretical basis for ship mooring in complicated conditions is necessary for preparation of correct practical solutions and recommendations to insure safety of ship mooring and minimize any risks.

2. Analysis of ship mooring systems

Ships usually are moored along quay walls (container, bulk, etc.), or along quay walls and ramps (Ro-Ro ships), when mooring ropes are fastened on quay walls and ramps at big angles (Wijffels et al. 2009), (Paulauskas 2013) (Fig. 1, Fig. 2). Fig. 1 shows a typical ship mooring scheme. The mooring line numbers are clarified in Table 1.

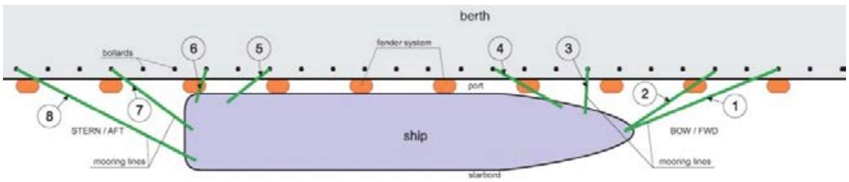

Fig. 1. Typical mooring scheme.

The mooring capacity is defined by:

- Allowable mooring line load
- Capacity of the mooring line winch
- Allowable bollard load.
- Configuration of the mooring line winches and hawseholes (fairleads) on the ship
- Variation of the mooring lines' lengths

As a consequence of external influences: wind gusts, angled wind impact, inertia, current, wave loads, the ship will surge, sway, heave, pitch, roll and yaw (Wijffels et al. 2002). The restrictions of the mooring lines, bollards and fender system will create the addition to the constant loads: the periodical aerodynamic, hydrodynamic and inertia loads (Catmac et al. 2007; Paulauskas 2004; Wijffels et al. 2009).