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Quantifying ship impact loads on fenders: Experimental approach

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ABSTRACT: Docking large vessels is a delicate operation as the kinetic energy associated with the large mass the vessel can result in high impact forces that can damage the vessel, fenders or even the quay. Berthing loads resulty quantified using design formulae based on kinetic energy and a single point of impact. Some correction then used to consider the hydrodynamic mass, the ship's angle with the quay, the softness of berthing the berth configuration. In this study, a scaled model experimental set-up was used to determine the impact teres of a ship on the fender system, including all fenders touched by the ship, during various docking maneu-The pattern and magnitude of the impact forces are different for each fender and are highly dependent on the reach trajectory and mass of the ship. A comparison was made of the measured values of the impacts and the the state of the s instructed forces using kinetic energy method and measured forces, suggesting it may underestimate the maximum most force in some scenarios.

INTRODUCTION

11 Quay and fender design

Fenders are protective structures mounted on the sides of guys to effectively absorb collision energy and prevent damage to vessels and structures. They are speally made of a resilient material, such as rubber, dastic, or foam. Rubber fenders are the most common age and are usually made from natural or synthetic nuber. Foam fenders are made from a cellular foam naterial often used in high impact applications.

When properly designed and installed, fenders on significantly reduce the risk of hull damage, which can be costly and time-consuming to repair, ed personal injury of crew and passengers.

It is important to correctly design berthing structers and select appropriate ship fenders. For this puppes, the impact forces of ships on the fenders dering docking procedures must be well quantified.

Regulation, recommendations issued by PIANC EMPL OCIMF (1992) and other norms such as Brit-Standard (BS 2014) or ROM2.0-11. (2012) prothe a set of recommendations for the design of science and mooring systems for commercial vesthe benching at quays, dolphins, pontoons, and other suctures. The methodology in such norms is similar.

To determine the impact energy, i.e. the maximum energy that the fendering system must absorb in the event of a collision, usually involves the following steps:

- (1) Determine the maximum impact speed.
- (2) Calculate the kinetic energy of the ship.
- (3) Establish a desired coefficient of restitution, CR.
- (4) Calculate the impact energy.
- (5) Select the appropriate fendering system.

The maximum impact speed is the maximum speed at which the ship could collide with the fendering system. This can be determined from the ship's displacement and easiness of the maneuver (ranked form a, easy berthing with good conditions to e, difficult berthing with bad conditions).

Kinetic energy is the energy of motion of the ship. It can be calculated using the following equation:

$$E_c = 1/2Mv^2 C_M C_E C_S C_C \tag{1}$$

where:

M is the mass of the vessel (in tonnes),

v is the maximum impact velocity or berthing velocity (in m/s),

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