Automatic Magnetic Mooring

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Overview docklock presentation:

1. Concept Introduction
2. Design Criteria
3. Physical Design

Optimizing the process of mooring
CONCEPT INTRODUCTION

• **Introduction**
  • Mampaey Offshore Industries
  • Bunker operations

• **Project Synergy**
  • Bunker process

• **Prototype Development**
  • Project approach
  • Testing Waalhaven inland port

Conception of the idea of automatic mooring
Mampaey Offshore Industries

Core Business

“Specialized in the design, engineering, manufacturing & commissioning of integrated towing, mooring and berthing systems”
Bunker operations overview
Bunker process

Safety & Health: mitigating risks

Safety improvement by using docklock system

- No need for shore line personnel, nor ship crew line handling
- No injury risks, less exposure time
- Live monitoring of mooring operation and external influences and conditions
- Faster response time to emergency situations
- No deterioration from UV, moisture and heat.
Bunker process

Efficiency: reducing bunker delays

Efficiency resulting from docklock system

- Secures ship in <1 min.
- Decouples ship < 20 sec
- Faster turnaround, better ship utilisation
- Shortening bunker time for client vessel
- Deck crew free for cargo handling operations
Bunker process

Sustainability: durable operations

Sustainability due to docklock system

- Less physical strain and manual handling of crew
- Reduced running hours engine/thrusters, so less emissions
Prototype 1.0

Project approach

- Partial prototypeing to analyse feasibility of concept
- Building for on-site live test
- Results of testing as a go / no-go decision factor
- Results led to building entire system for full scale testing at Rotterdam inland port Waalhaven
Prototype 1.0

Concept creation
Worst Case Scenario’s
- Passing vessel motions
- Wind force
- Water current force

Simulations & Design
- 3D-modelling
- Final concept

Industry Standards
- Involved institutions
- Industry regulations
Passing vessel motions

Criteria pilot project

Worst case scenario’s vessel dynamics bunker process:
Passing vessel motions

Simulations & calculations
Prof. Dr. Ing. J. Pinkster Technical University Delft

'Emma Maersk'
L=366 m
B=57.0 m
T=17.0 m
Displ. = 215121 m^3

'Voorburg' (2x)
L=55.0 m
B=7.60 m
T=3.0 m / 1.5 m
Displ. 1056 m^3 / 563 m^3

'Vlissingen'
L=134.9 m
B=21.5 m
T=4.40 m
Displ. = 11562 m^3
Passing vessel motions

Main results

Forces & movements:

- Max sway: 35 kN
- Max surge: 150 kN
- Max yaw: 650 kN/m
- Max heave (pads): 18 cm (Voorburg 55m)
Wind forces

Criteria pilot project

- Max worst case operating wind force:
  
  7 Bft.

- Max operating wind force in combination with worst case passing vessel motions:
  
  6 Bft.

- MTS Vlissingen moored alongside MARCOR bulk carrier [test-site prototype 1.0]
**Wind forces**

**Computational Fluid Dynamics (CFD) analysis**

Most critical angle:

45°
**Wind forces**

*Most critical angle:*

45°
Water current forces

Data

Operational Current Model Rotterdam Port Area
3D Modeling

Concept development

Simulations & Design
Final Concept

Simulations & Design
Simulations & Design
Involved institutions & companies

Research organizations

RSM
Erasmus University

Business Modeling

TU Delft
Delft University of Technology

Technical Development

Ropes
Research on Passing Effects on Ships

Passing Vessel Motions

MARIN

Wave Dynamics

Deltakres
Enabling Delta Life

Industry Standards
Involved institutions & companies

Companies

Bunker Operator
MAERSK Container Liner
Boskalis Dredging Expert
bp Oil & Gas Sourcing, Production & Supply

Industry Standards
Involved institutions & companies

Regulators & industry associations

Ministry of Infrastructure and the Environment

Inspectorate for Transport, Public Works and Water Management

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE
Industry Regulations

Standards

Explosion Proof

Electromagnetic Compatibility

Static Electricity
PHYSICAL DESIGN

- **Magnetic Modules**
  - Technology magnetism
  - Force validation
- **Framework**
  - Special components
- **Software & Hydraulics**
  - System architecture

Building the first live automated magnetic mooring system
Magnetic Modules

Technology magnetism

Magnetic flux
Magnetic Modules

Technology magnetism
Semi-permanent quad pole

- Perfect balance between North- en Southpole
- All poles are active poles
- High, controled flux
- No radiation flux
- No remaining magnetism in the hull
- Max magnet force (approx 14 kg/ cm²)
- No loss of magnetic force without electric power
Magnetic Modules

**Force validation**

_Fender control / Local pull-test_
Construction Framework

Special components
Suspension frame

Mechanical synergy
Construction Framework

**Special components**

*Suspension frame*

Mechanical synergy
System architecture

Philosophy (HAZOP, FMEA, SIL2)

- Software program written with HAZOP study as underlying guideline, followed by FMEA and SIL2 studies
- Control program is fully automatic, with monitoring function
- The system allows manual control
- Hydraulic system created around control program (software)
- Hydraulic components based on worst case forces needed in combination with the demanded functionality
- Hydraulic system created to continuously hold vessel at predetermined safe distance, while allowing heave movements
Installation on ships and quayside

Automatic Magnetic Mooring

- Safety
- Efficiency
- Sustainability
Questions for ADN safety committee

• Has the bunker procedure between a bunker vessel and a sea vessel to be considered “mooring” as in ADN 7.2.5.3? Or is this provision only relevant for a vessel mooring onto a regular pier?

• Are there other provisions of ADN relevant for the Dock Lock System other than ADN 7.2.5.3. or ADN 9.3.1.50-9.3.1.56?