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OFFSHORE INDUSTRIES

DOCKLOCK©

# **Automatic** Magnetic Mooring

- Wouter van Reenen MSc - Mampaey Offshore Industries

# **Overview** docklock presentation:

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

**Optimizing** the process of mooring

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# CONCEPT INTRODUCTION

- **Introduction**
  - Mampaey Offshore Industries
  - Bunker operations
- **Project Synergy**
  - Bunker process
- **Prototype Development**
  - Project approach
  - Testing Waalhaven inland port



Introduction

# Mampaey Offshore Industries

## *Core Business*


"Specialized in the design, engineering, manufacturing & commissioning of integrated towing, mooring and berthing systems"

mampaey
OFFSHORE INDUSTRIES

Introduction

# **Bunker** operations

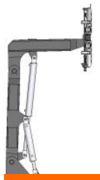
***overview***


# **Bunker** process

*Safety & Health : mitigating risks*

## Safety improvement by using docklock system

- No need for shore line personel, 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.



Project Synergy

# **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

Project Synergy

VT MARITIME LOGISTIC SERVICES

# 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 Development

# Prototype 1.0

## *Project approach*

- Partial prototypeing to analyse feasability 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

RSM Erasmus University

TU Delft
Delft University of Technology

VT
MARITIME LOGISTIC SERVICES

Prototype Development

# Prototype 1.0

## *Concept creation*


RSM Erasmus ERASMUS UNIVERSITY

TU Delft Delft University of Technology

VT MARITIME LOGISTIC SERVICES

# DESIGN CRITERIA

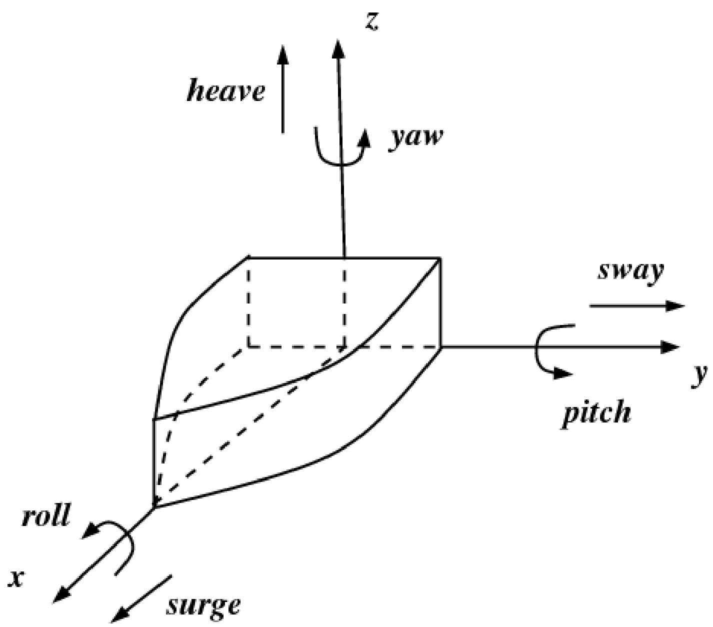
- **Worst Case Scenario’s**
  - Passing vessel motions
  - Wind force
  - Water current force
- **Simulations & Design**
  - 3D-modelling
  - Final concept
- **Industry Standards**
  - Involved institutions
  - Industry regulations



# Passing vessel motions

## *Criteria pilot project*

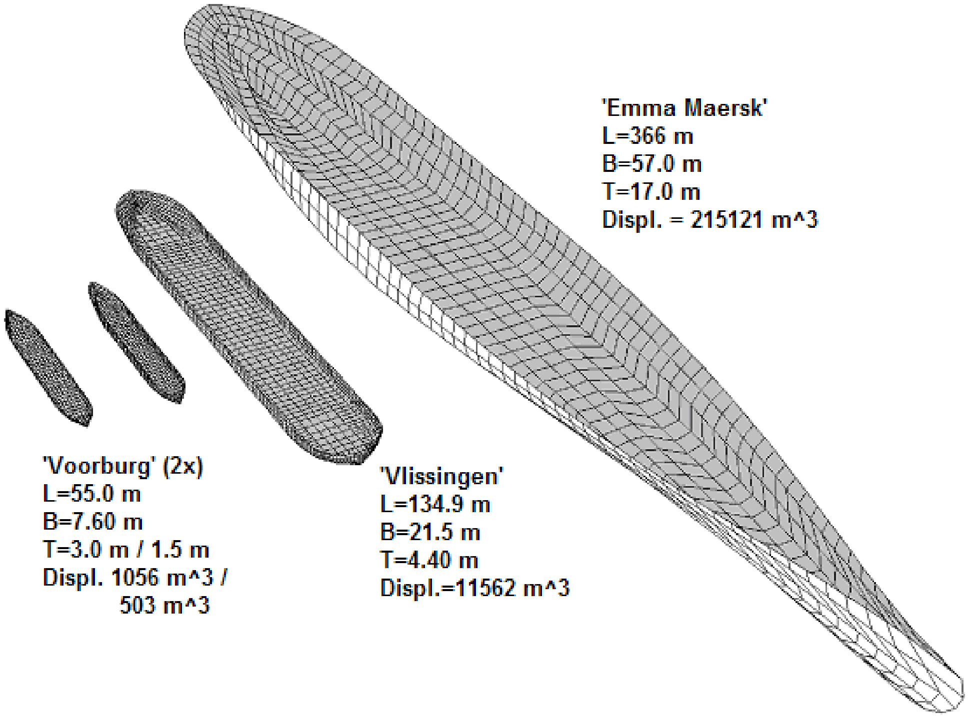
Worst case scenario's vessel dynamics bunker process:




# Worst Case Scenario's

# Passing vessel motions

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



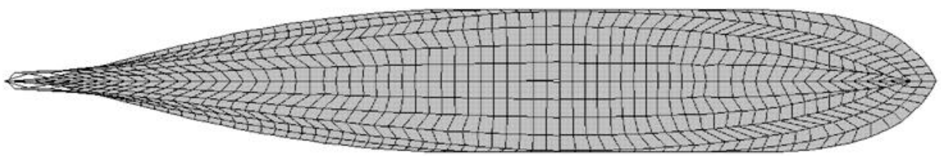

# Worst Case Scenario's

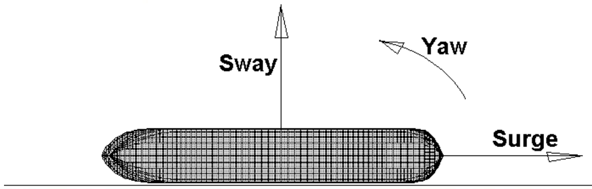
# Passing vessel motions

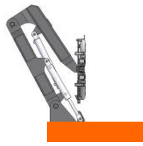
## *Main results*

Forces & movements:

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





Worst Case Scenario’s

# 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.

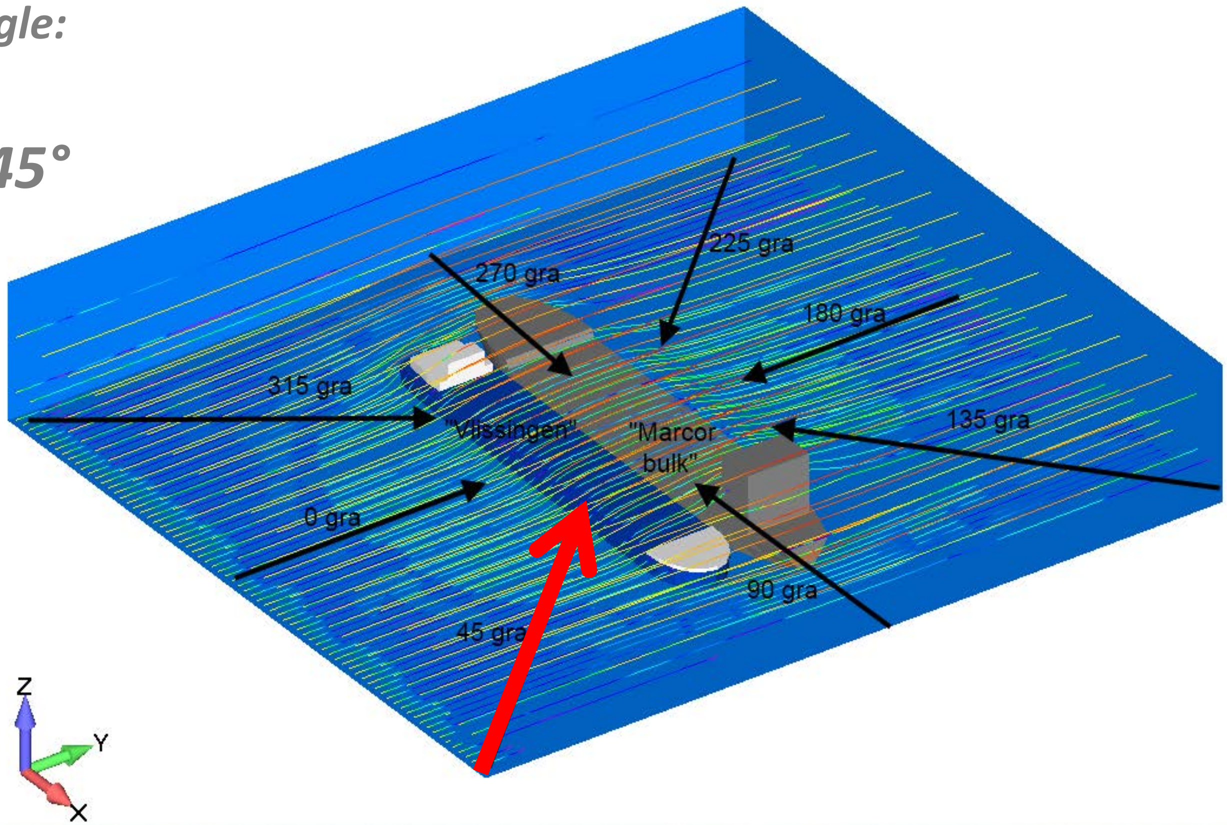
- MTS Vlissingen moored alongside MARCOR bulk carrier [test-site prototype 1.0]

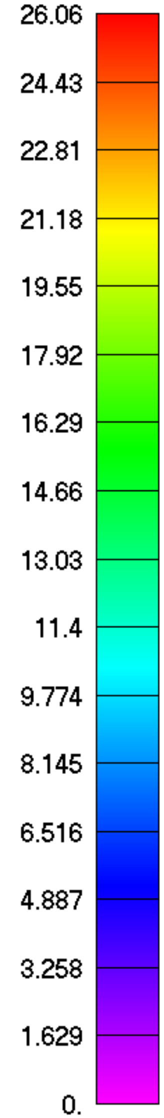
# Wind forces

*Computational Fluid Dynamics (CFD) analysis*

*Most critical angle:*

*45°*



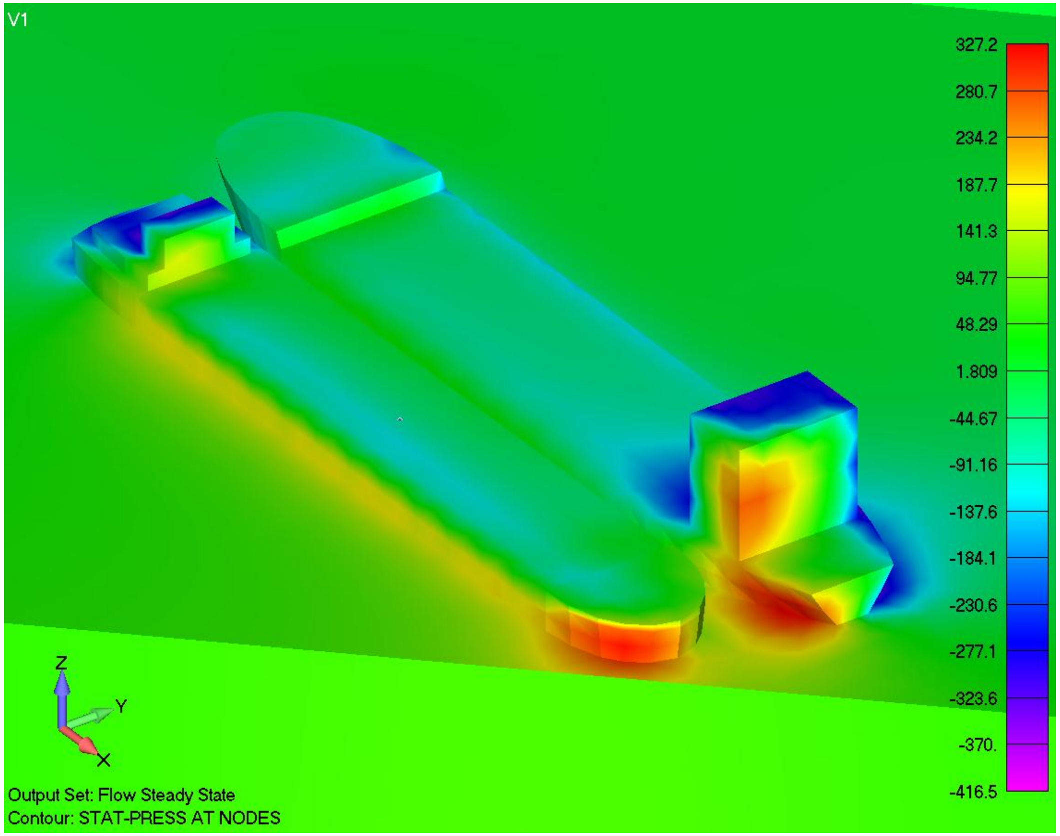




## Worst Case Scenario's

## Wind forces

*Most critical angle:*

*45°*

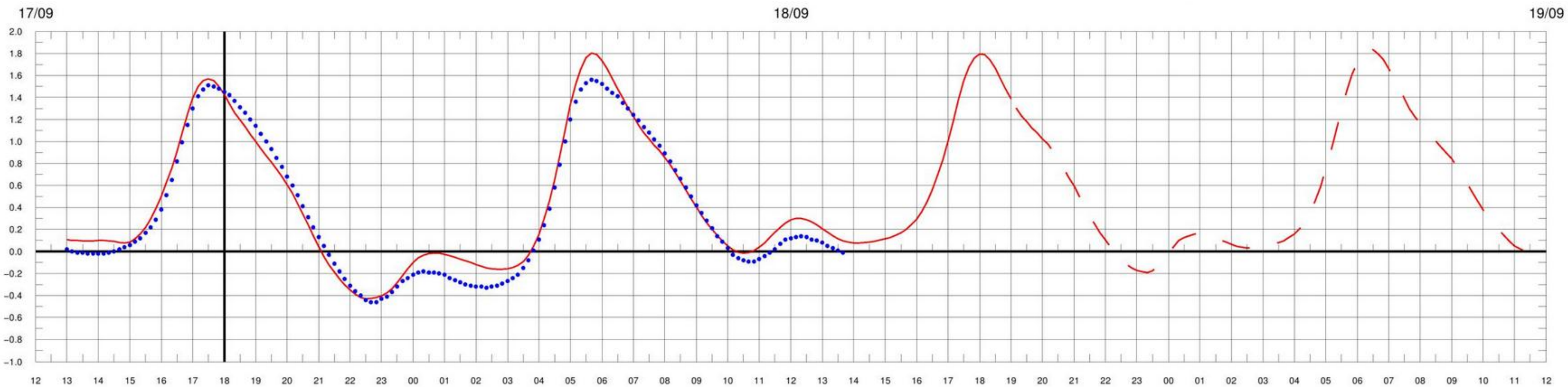



# Worst Case Scenario’s

# **Water** current forces

## *Data*

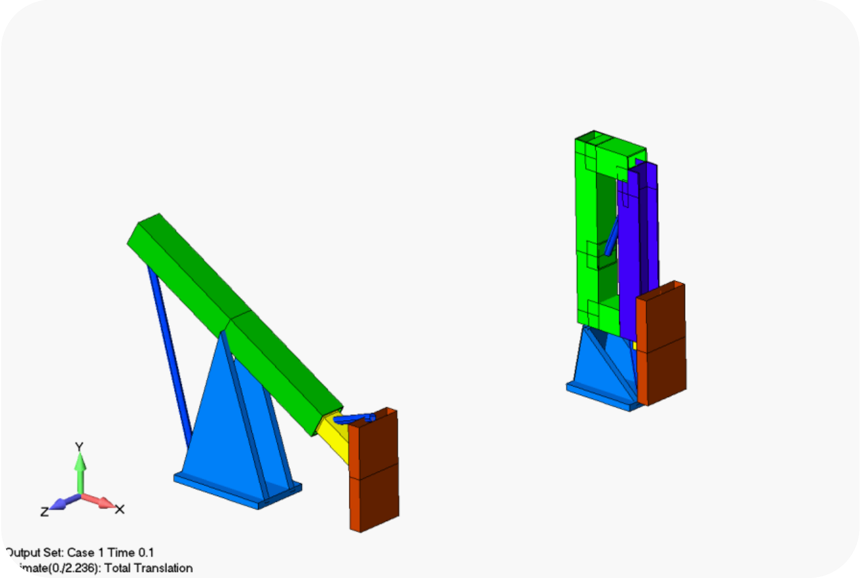
Operational Current Model Rotterdam Port Area

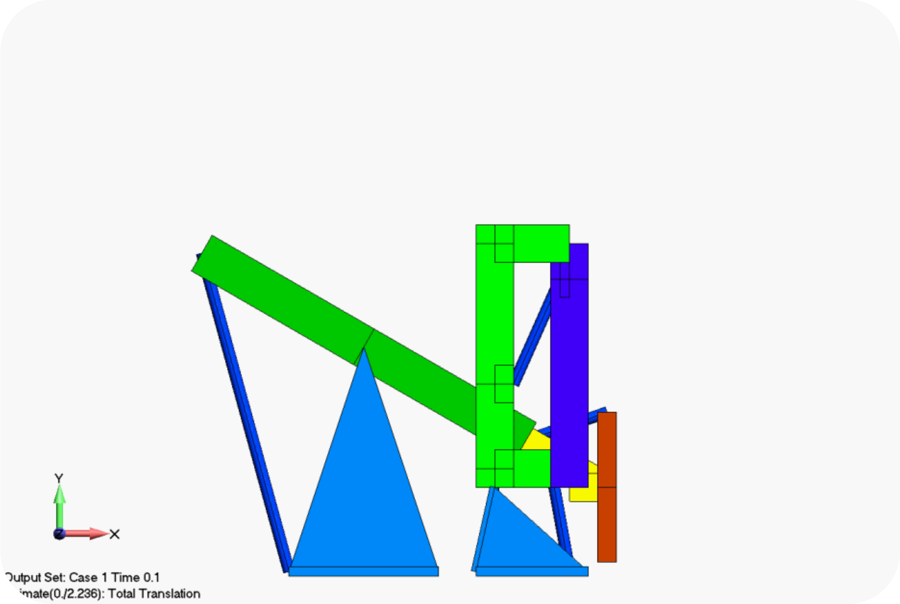



# Worst Case Scenario's

# 3D Modeling

*Concept development*




# Simulations & Design

# Final Concept


# Simulations & Design

# Simulations & Design

# Involved institutions & companies

## *Research organizations*

Business Modeling

Technical Development

Passing Vessel Motions

Wave Dynamics

# Industry Standards

# Involved institutions & companies

*Companies*

MARITIME LOGISTIC SERVICES

Bunker Operator

MAERSK

Container Liner

Boskalis

Dredging Expert

bp

Oil & Gas Sourcing, Production & Supply

Industry Standards

# Involved institutions & companies

## *Regulators & industry associations*

Port of Rotterdam

Lloyd's Register

OCIMF

Expertise- en InnovatieCentrum Binnenvaart
EICB

CBRB

Ministry of Infrastructure and the Environment
*Inspectorate for Transport, Public Works and Water Management*

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

# Industry Standards

# Industry Regulations

## *Standards*

Explosion Proof

Static Electricity

Electromagnetic Compatibility

# Industry Standards

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# PHYSICAL DESIGN

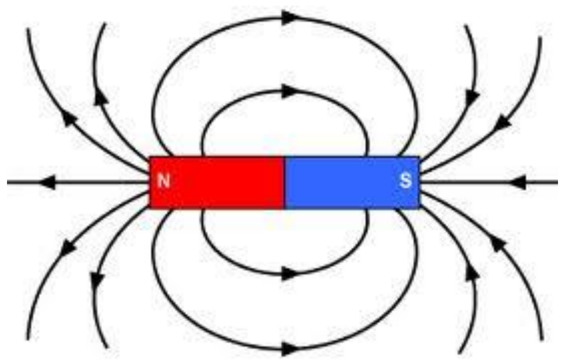
- **Magnetic Modules**
  - Technology magnetism
  - Force validation
- **Framework**
  - Special components
- **Software & Hydraulics**
  - System architecture

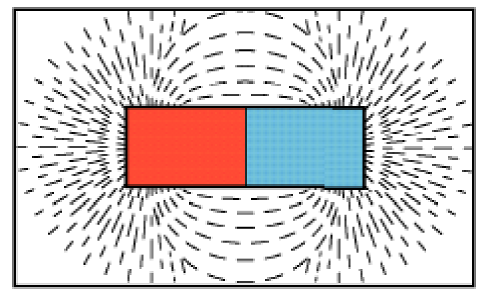


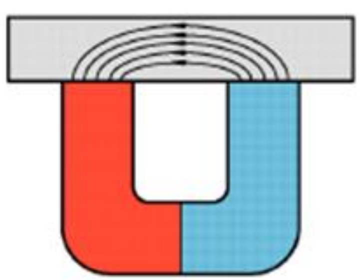
# Magnetic Modules

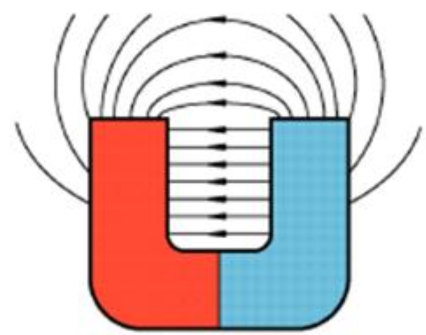
## **Technology magnetism**

*Magnetic flux*





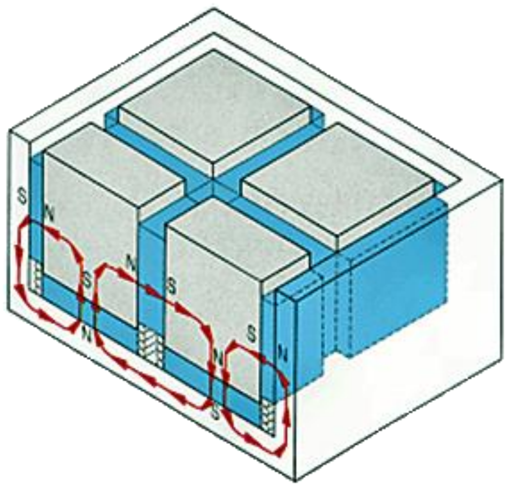


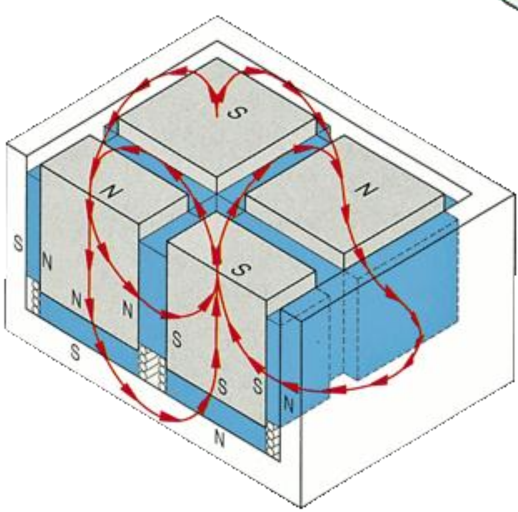
# Magnetic Modules

## Technology magnetism

***Semi-permanent quad pole***

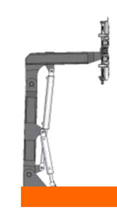
**OFF**





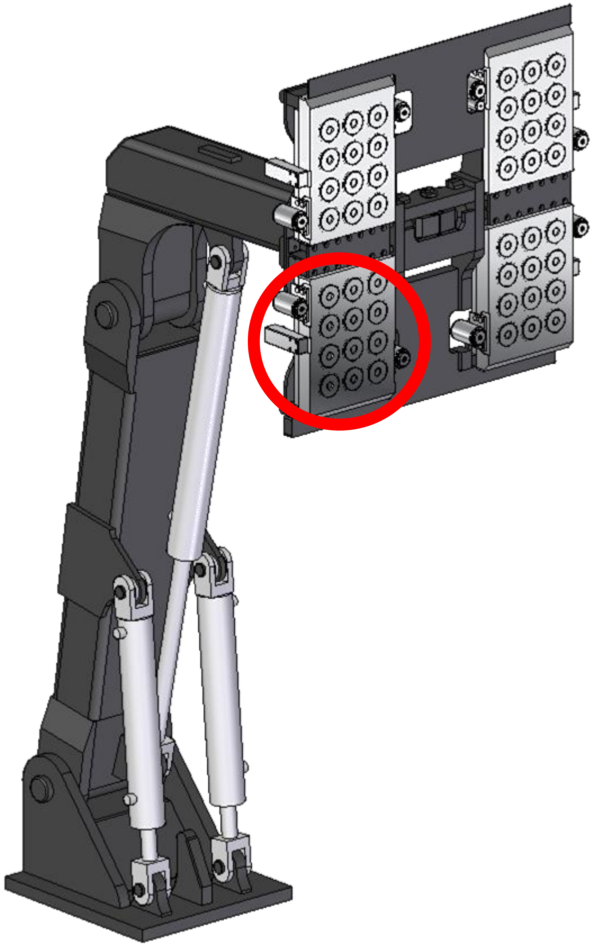
**ON**

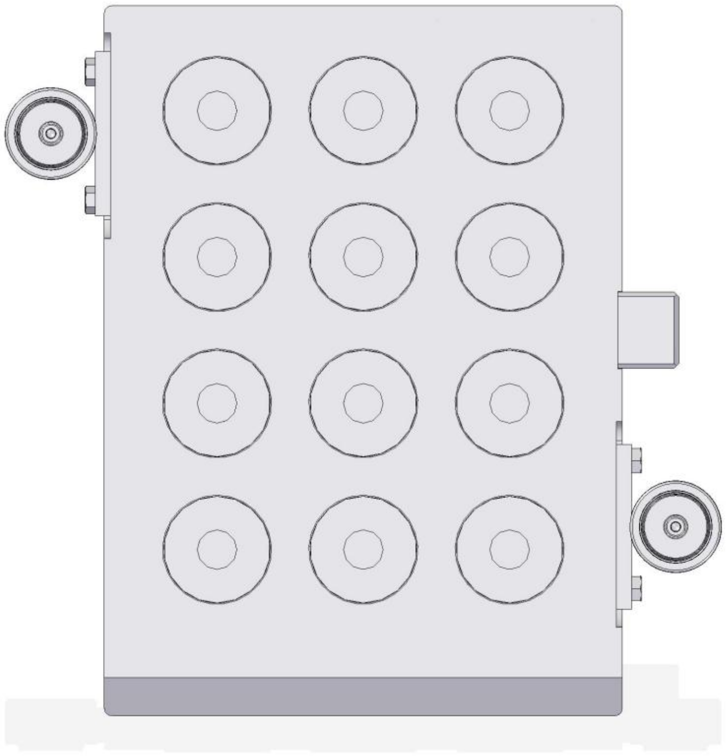
- Perfect balance between North- en Southpole
- All poles are active poles
- High, controled flux
- No radiation flux
- No remaining magnetism in the hull
- Max magnet force (approx 14 kg/ cm²)
- No loss of magnetic force without electric power

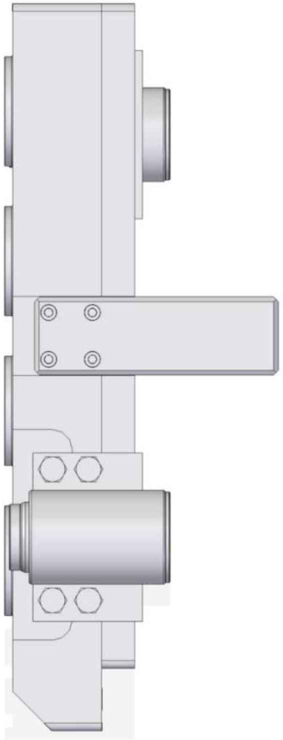


# Magnetic Modules

## Force validation
*Fender control / Local pull-test*





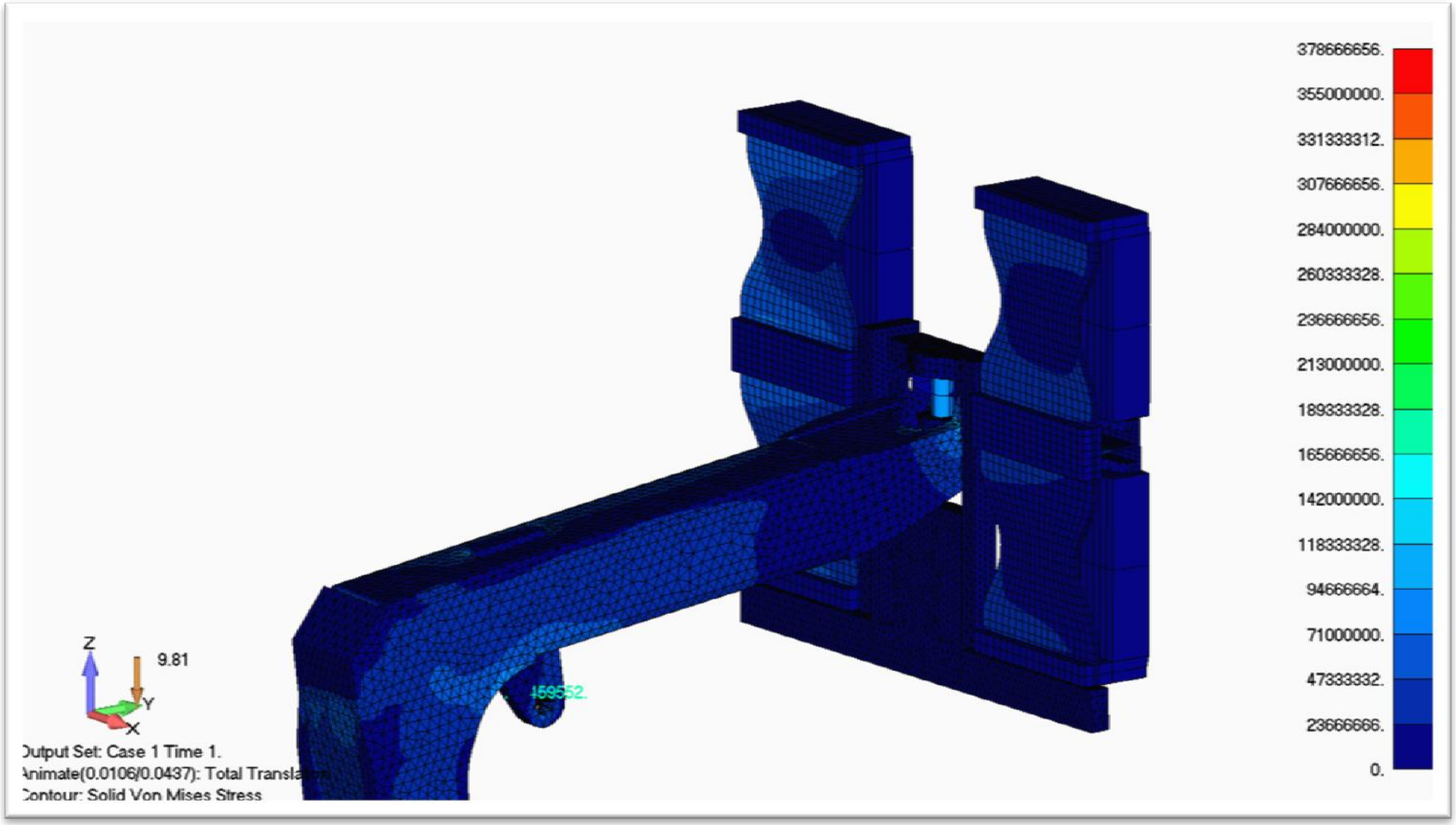


# Construction Framework

## Special components

### *Suspension frame*

Mechanical synergy

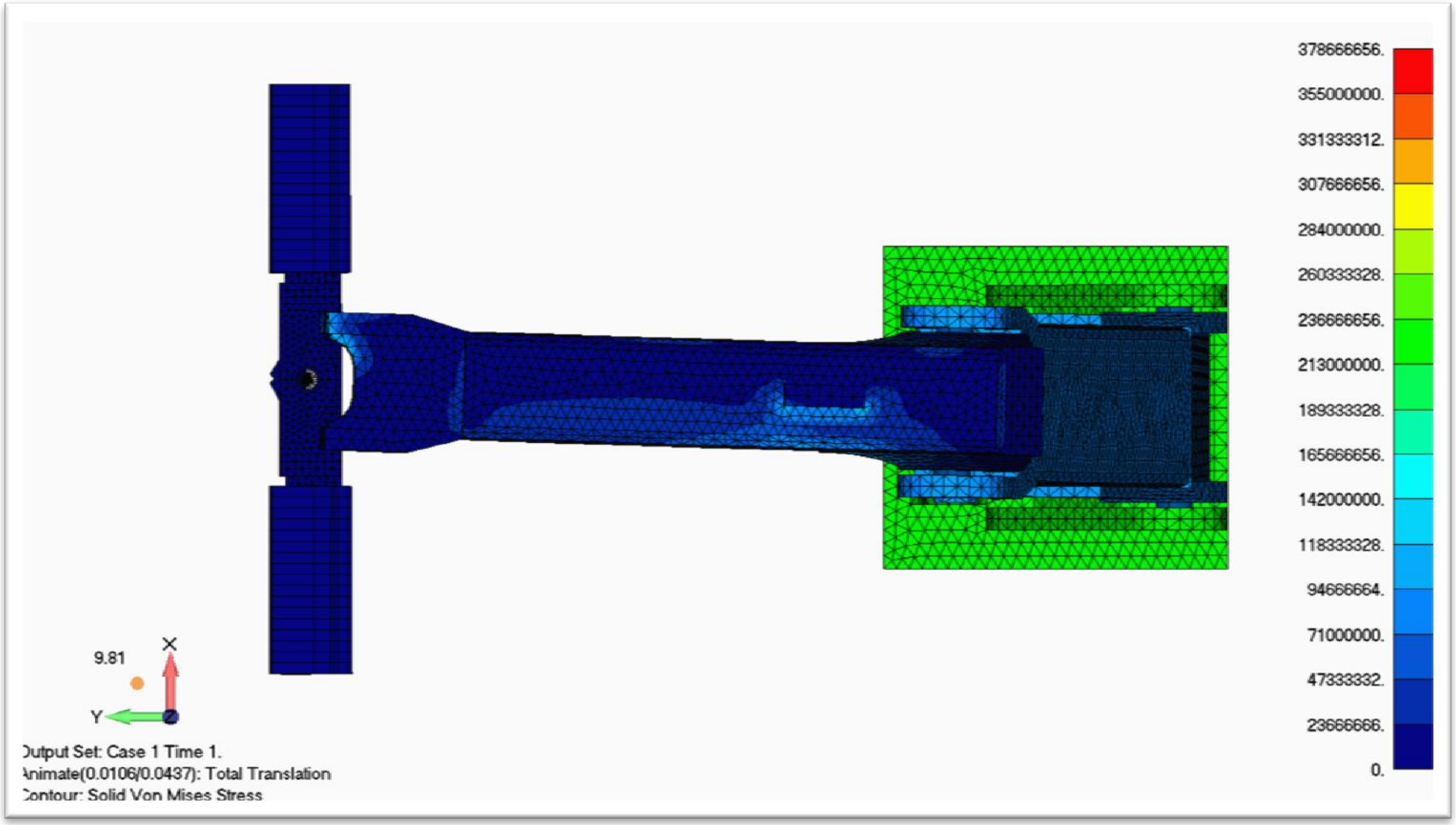



# Construction Framework

## Special components

### *Suspension frame*

Mechanical synergy

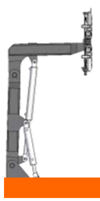



# Software & Hydraulics

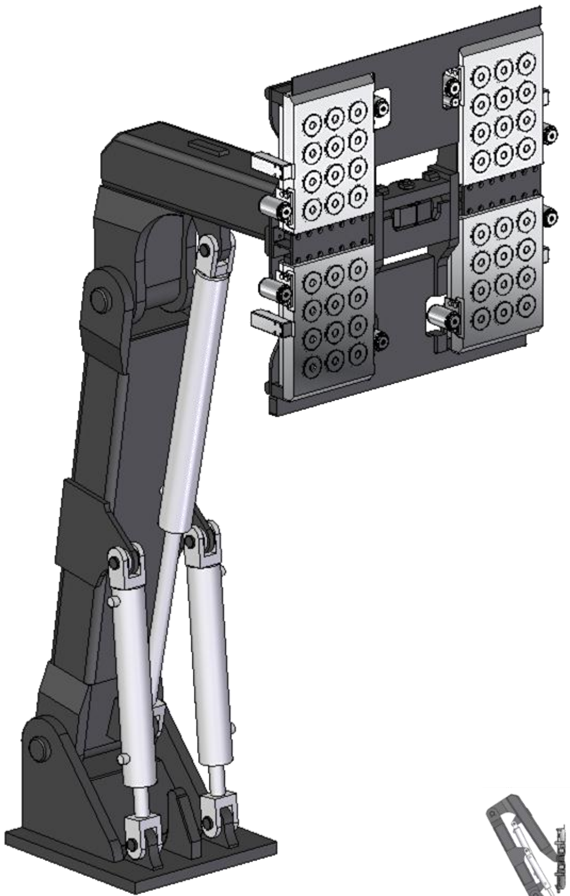
## System architecture

### *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



# DOCKLOCK©



## Installation on ships and quayside

### Automatic Magnetic Mooring

- Safety
- Efficiency
- Sustainability

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# 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 ?