Asset Management - Quay Walls
Don’t plan repairs. Predict them.
Presenter:
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Rotterdam, Netherlands
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Mr. Henk Voogt has started his career in the design and construction of quay walls and has since 2001 worked as an asset manager for marine structures at the Port of Rotterdam.

Since the very beginning, Henk has been involved in investigating and solving the problem of corrosion in Rotterdam as well as in the development of the KMS solution, a world-class asset management tool.
Quay walls @ PoR

• Quay walls are the pivot in our business model
• 65 km length (41 miles); up to 24 m deep (75 ft)
• Approx. 95% of the asset is submersed
• Asset replacement value: €1,45 billion
Why Asset Management on waterfront structures?

- The maritime assets of ports (mostly quay walls and jetties) add enormous value to the business of the port, but due to the function these structures serve, as well as their location in the marine environment, these assets are relatively costly to construct and maintain.
Today´s topic of Panel X

Enterprise Asset Management — A Strategic Imperative at Ports

Transportation infrastructure owners world-wide are improving their understanding of the life-cycle position of their broad portfolio of assets and developing risk-based approaches to the allocation of the organization’s scarce capital resources. The seminar’s wrap-up session will explore this emerging port management imperative, why it has become a critical management function, global best practices and how the port industry is approaching EAM with a focus on the experiences of ports, including lessons learned.
Asset Management: The imperative

- The increase of transshipment:
  - Technical deterioration is accelerated by more intensive use than originally built for.

- The question of the c-level:
  - What will happen if the proposed budget is not granted?
  - Can we avoid budget peaks?

- The problem of the asset manager:
  - What assets do I put the money on?
  - What risks do I have if I postpone maintenance works?
  - And in the long term, how does it influence the remaining lifetime of the assets?

- The questions of the commercial dep.:
  - Does the remaining useful life of the asset reach the end of contract with the tenant?
  - Can we prolong the contract without major investments?
Asset Management

ASSET MANAGEMENT MATURITY

INNOCENCE  |  AWARENESS  |  UNDERSTANDING  |  COMPETENCE  |  EXCELLENCE

Attitude shift from cost focus to value focus

COSTS GO DOWN  WHILE VALUE & PERFORMANCE INCREASE

MAINTENANCE COSTS

MAINTENANCE IS AN EXPENSE  MAINTENANCE IS AN INVESTMENT

Repairs are as good as before
Reactive – fix it when it breaks
Struggling with management systems
Systems are a valuable tool – information as an asset

Focus is on lifecycle & reliability
Optimized decision-making
Maintenance is part of the supply chain

Proactive predictive maintenance

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The Foundation

- **Master Data**
  - *How long, how wide, how many?*

- **Business Value**
  - *What’s the contribution to the goals of the organization?*

- **Risk Analysis**
  - *What endangers the functionality?*

- **Processes**
  - *Is the workflow adequate?*
But then?

- After putting the inventory in place, connecting that to asset management is quite another challenge.
  - How safe is the structure and what does it mean for the port’s tenants?
  - Will it reach the end of its potential lifespan?
  - When is the best moment to invest in maintenance work?
  - And with a finite budget, which areas of spending should be prioritized
Asset Management on Quay Walls

• A quay wall’s remaining lifetime and system integrity is mainly determined by the quality of the sub and superstructure.

• When the quay wall’s integrity is in danger, it’s often due to:
  • accelerated low water corrosion occurring at the substructure or
  • concrete deterioration in the superstructure
From Model to KMS

- Port of Rotterdam developed in partnership an asset management tool called KMS, which is the Dutch abbreviation of Quay wall Modeling System that:
  - Uses the results of *detioration models for concrete and steel* and compares it with the “end of contract” date
  - Identifies and ranks the *risks* that endanger the functionalities of the structure
  - Uses the *business value* of a quay wall to clarify its maintenance priority
Inspection module

- Inspection Request
  - Concrete
  - Steel
  - Coring
  - Visual Inspection
  - Cathodic Protection
  - Corrosion Measurements
  - Full Analysis
  - Chemical Analysis
Degradation Analysis per Zone and Element

Evaluate Degradation with STADIUM®

For each Zone/Element combination

Select the most critical Zone/Element combination

Post Treatment Analysis

Schedule Next Inspection

Close Monitoring Required

Repair

Critical Year (Trigger/Intervention)

Maintenance Proposal
# STADIUM® Expert System

**Graph for harbour “Hartelhaven” and section “H-L-N-MV-047-KAD-004-A” (150101/49)**

- Chemical degradation
- Chloride-induced corrosion
- Carbonation-induced corrosion

## Input Data
- Initial Portlandite Content: 39.7 g/kg
- Portlandite Content Dissolution Threshold (90% Initial Content): 36.7 g/kg

## Analysis Data
- **Portlandite Dissolution Depth**
  - Inspection Year: 35.2 mm
  - End of Contract Year: 54.1 mm

## Flags
- Yellow Flag Reached In: 2028
- Red Flag Reached In: 2038
STADIUM® Expert System

Evaluation Order "150085" on Section "H-L-N-MV-037-KAD-008-A"

| Current Analysis Year | 2011 | Inspection Date Year | 2011 | Corrosion Scale | 8.695 | Construction Year | 2001 |

Steel analysis
Source: SIMCO Technologies

Alert 0

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STADIUM® Expert System

Evaluation Order "150057" on Section "H-L-N-MV-037-KAD-002-B"

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Steel analysis
Source: SIMCO Technologies

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1st hole

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Critical Zone | 4 | 4 | 3 | 1
AMprover® Expert System

From Risk Analysis to Prioritization of the Maintenance Plan

Determine generic risk, effect, financial risk and probability (FMECA/RCM)

Combine asset & generic risk for a specific risk factor

One factor to express the economical added value of an asset

Prioritization of the maintenance plan based on the risk factor and business value
AMprover® Expert System
## Prioritization

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<th>SI Description</th>
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Annual Maintenance Cycle

Predicting  Simulating  Risk Analyzing  Prioritizing

Q1  Q2  Q3  Q4

Budget  Planning

Inspection Results  Inspection Tasks

Multi Criteria Prioritization  P.O. Planning

Budget Variant #1  Budget Variant #2  Budget Variant #3

Q4  Q3  Q2  Q1

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KMS Benefits

- **Short term:**
  - Transparency in annual budget for maintenance

- **Mid - Long Term:**
  - Insight on residual service life and maintenance costs per structure
  - Insight on total port concrete and steel costs

- “Just in time” inspections
- Proactive, prioritized and risk-based maintenance
- Save $$$
KMS - Awards

At the iMaintain Infrastructure Congress that took place in November 2012, by the Dutch Association for Effective Maintenance (NVDO), Port of Rotterdam’s KMS system is awarded “Project of the Year 2012”.

At the 2013 ACEC Engineering Excellence Awards, Port of Rotterdam’ Quaywall Modeling System (KMS) receives the 2013 ACEC New York Gold Award
KMS 2.0

- **Improving KMS:**
  - Develop deterioration models for rubber (fenders) and timber
  - Implement experiences
  - Validate the steel deterioration model in other conditions

- **And spread worldwide**
  - Applicable in every port
  - Available for every port