New Materials and Systems in Miter Gates

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New Materials and Systems in the Design of Miter Gates

• Miter gates – proven but improvable
• New materials
  - for entire structure
  - for gate components
• System functionality extensions
  - carrying reversible hydraulic loads
  - operating in wide chambers
• System improvements
  - retaining plate position
  - suspension gate
• Conclusions
Miter gates – proven but improvable

- Some history...
- Well-proven system, appreciated by navigation
- Harmony with environment: Water itself holds it closed
- 2 feasibility limits: unidirectional operation unfit for wide chambers
- Gate material: Timber → steel → ???
- Component improvements within the proven system

Gate material improvements

<table>
<thead>
<tr>
<th>Aluminized steel</th>
<th>Cold-formed steel</th>
<th>FSC certified timber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material: AlMn5</td>
<td>Material: S355J2</td>
<td>Material: Cumaru</td>
</tr>
<tr>
<td>Project: Naviduct</td>
<td>Project: Uelzen</td>
<td>Project: Lock III,</td>
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<tr>
<td>Enkhuizen (Ned.)</td>
<td>Lock (Ger.)</td>
<td>Wilhelmina Canal</td>
</tr>
</tbody>
</table>

Scotland, 21st cent.
Netherlands, 16th cent.
### New structural materials (1)

**HS Concrete**
- **Material:** HSC
- **Project:** IJburg Lock, Amsterdam

**Stainless steel**
- **Material:** 1.4462
- **Project:** Study for Nieuwegein Lock

**Composites (FRP)**
- **Material:** FGRP
- **Project:** Spiering Lock, Werkendam

### New structural materials (2)

**Spiering Lock (Netherlands)**
- **Chamber width:** 6.0 m
- **Water depth:** 3.3 m
- **Max. water head:** 2.5 m

**Goleby Lock (France)**
- **Chamber width:** 5.1 m
- **Water depth:** 2.2 m
- **Max. water head:** 6.0 m
New contact materials (1)

- Gate hinge contacts
- Metallic
  - Steel alloys
    - Manganese steel
    - Refined steel
    - Case hardening steel
    - Stainless steel
  - Non-iron alloys
    - Bronze
    - Aluminum-copper
    - Aluminum-bronze
    - Hard chrome plating
- Non-metallic
  - Homogeneous
    - Polyethylene
    - Polymide + PTFE + fiberglass
    - Polymer alloys (Thordon)
  - Composites
    - Phenolic resins + polyamide fibers (Temah)
    - Phenolic resins + aramid (Raikko)

New contact materials (2)

V = G
H = G \frac{a}{h}

system component segment asperity

PIANC Setting the course
New contact materials (2)

\[ V = G \pm (0.1 \div 0.3) \cdot H_1 \]
\[ H_1 = G \frac{a}{h} \]
\[ H_2 = \mu V \]
\[ H = H_1 + H_2 \approx G \frac{a}{h} + \mu V \]

**Conclusion:**

- The actual contact loads in gate hinges are substantially higher than from static equilibrium conditions.

New contact materials (3)

- G-X120Mn12
- AISI 316L
- Aluminum Bronze
- Tenmat T814
- UHMPE
- Polyamide
- Thordon SXL
- Railko RG2
- Polyamide
- SKF

Carrying reversible water heads (1)

Other realized systems:
• Locking the front posts,
• Locking braces aside the drive rods, ...
• Locking by drive cylinders.

Carrying reversible water heads (2)

General conditions:
• Only for small reverse loads applicable
• Highly reliable drives
• Gate prestression on every closure - fatigue
• Additional measures against leakage
Operating in wide chambers

- Problems: high hinge loads, long closing times, ...
- Wide lock chambers are a domain of rolling gates
- What if rolling gates are not an option?

System improvements (1)

Retaining plate position:
- Phenomenon of gate “climbing”
- Relation with retaining plate position
System improvements (2)

Suspension gate concept:
• No vertical loads in hinges – low wear, low maintenance
• Less fatigue in heel posts
• Longer service life of hinges, heel posts a.o.
• Aesthetical values

Conclusions

• Miter gate as a system remains favorable. Modern technology offers improvements but no basic changes of this system.
• Improvements can be found in three directions:
  - application of new materials,
  - extension of system functionality,
  - modification of system components.
• From new material applications, polymers and FRP’s are particularly interesting. This applies to both gate structure and its components.
• Extensions of system functionality include e.g. carrying small reverse water heads and closing wide lock chambers.
• Diverse system component modifications are possible. Examples are: downstream position of retaining plate, gates of trough sections, gate support at its top bearings, gate suspension.

Thank you