Use of Synthetic Materials and the Comeback of Sliding Gates versus Rolling Gates

- Synthetics - benefits and application areas
- Entire gates of synthetic materials
- Synthetics in gate hinges
- Synthetics in gate guiding
- Synthetics in sliding gates and their tracks
- Other application areas
- Conclusions
Benefits of using synthetics

• Engineered materials – potency of fitting every purpose
• Very good mechanical properties (e.g. strength, friction coefficient)
• Chemical stability, no corrosion – potentially long service life
• Very well controlled processing – low dispersion of properties
• Generally very low maintenance requirements
• Environmental benefits: low energy consumption and pollution rates
• Integration of functions possible

Application areas of synthetics

Thermosets (usually reinforced)
• Entire hydraulic gates
• Gate subassemblies like retaining walls, sluice valves, walkways
• Contact items like hinge bushings, saddle and buffer lining

Thermoplastics (reinforced or not)
• Guiding for vertical lift, rolling and other gates, gate sluices etc.
• Tracks for sliding and sector gates
• Slide layers in some hinges
Gates of synthetic materials

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

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

Gate subassemblies

**Retaining wall in discharge lock gate**
- Material: CFRP
- Width: 40.0 m
- Dif. head: 6.0 m

**Sluice valves in gates and culverts**
- Material: FGRP
- Width: ab. 1.5 m
- Dif. head: 2 ÷ 4 m

**Grids, walkways**
- Material: FGRP
- Width: ab. 1.5 m
- Load: 2.5 kN/m²
**Synthetics in gate hinges (1)**

UHMPE in miter gate top hinge

- Deep but narrow – low hinge loads
- Large contact surfaces provided

... and bottom pintle

Lock III in Wilhelmina Canal, Tilburg

- Deep but narrow – low hinge loads
- Large contact surfaces provided

![UHMPE in miter gate top hinge](image1)

![Lock III in Wilhelmina Canal, Tilburg](image2)

**Synthetics in gate hinges (2)**

Thermoset resin composites in gate hinges

“Naviduct” Krabbersgat in Enkhuizen

- Top hinge: Feroform T814 composite in a ball bearing (Feroball)
- Bottom pintle: Feroform T814 bushing and stainless steel A316L shaft

![“Naviduct” Krabbersgat in Enkhuizen](image3)
**Synthetics in gate guiding (1)**

**Conventional guiding**

- "A"
- "B"

**UHMPE guiding of vertical gates**

Diverse gates, e.g.:
- Meuse St. Andries Lock

Hartel Canal Barrier, Rotterdam
- Span: 98.0 m, height: 10.0 m
- Differential head: up to 9.0 m

**Synthetics in gate guiding (2)**

Gate **UHMPE guiding**

Hartel Canal Barrier: Spans 49.0 m and 98.0 m, height 10.0 m

Gate **conventional guiding**

Hollandse IJssel Barrier: Span 86.0 m, height 10.0 m
Synthetics in gate guiding (3)

Rolling gate on wagons
Sliding gate on “hydrofeet”

Three examples of applications

- Malamocco lock gates – Venice
- Seine-Nord Europe
- Panama Canal expansion project
Malamocco lock gates - Venice

- “Sliding gate” vertical load taken by hydrofoot on UHMWPE slide track
- Horizontal loads taken by metal sliders on UHMWPE slide track
- Sealing by contact pressure between concrete surface and UHMWPE strip on gate

Malamocco lock

- Max. head: 3 m
- Leakage no design criterium
- Desire of client to have little maintenance
Seine Nord-Europe
(conceptual design)

- Seven locks; 15 m to 32 m head
- Three types of gates:
  - Upper gates: Miter gates
  - Lower gates: Lift gates
  - Valves: Lift gates
- Bearing / sealing miter gates; UHMWPE replacing tropical hard wood
- Bearing / sealing lift gates; UHMWPE slide tracks, stainless steel sliders (low friction due to choice of gate)
- Valves: Lengthy discussions about types and capacity to seal with UHMWPE slide tracks on concrete
Panama Canal Expansion; Gates

- Vertical loads: steel wheels and rails
- Horizontal loads: combination of UHMWPE and stainless steel

(After investigating many alternative combinations)

Panama Canal Expansion Gates

Evolution due to:
- Stringent leakage criteria
- Substantial (21 m) differential head
- Required accuracy of construction
Conclusions

- Modern synthetic materials offer a number of advantages when applied in hydraulic gates.
- The applications of synthetics can be classified in three groups:
  - entire hydraulic gate structures,
  - subassemblies of hydraulic gates (e.g., retaining walls),
  - system components (bearings, guides, slide tracks).
- Application of synthetics allows for replacement of wheels and rollers by sliding supports in both vertical lift and rolling gates. This reduces the maintenance costs and spares the environment.
- The application of synthetics in sliding surfaces is influenced by “culture” or “what one is used to”.
- If the design parameters allow you to, using synthetic slide tracks and metal sliders is likely to be the most economic solution.
- Optimization of the design on life cycle costs is not (yet) the obvious choice.

Thank you