PIANC Workshop
13-14th September 2011

Use of Synthetic Materials

By R. A. Daniel, Rijkswaterstaat
and J. Augustijn, Iv-Infra Group
NETHERLANDS

PIANC
Setting the course

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

PIANC
Setting the course

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

<u>Thermosets (usually reinforced)</u>

- Entire hydraulic gates
- Gate subassemblies like retaining walls, sluice valves, walkways
- Contact items like hinge bushings, saddle and buffer lining

<u>Thermoplastics (reinforced or not)</u>

- 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

Spiering Lock (Netherlands)

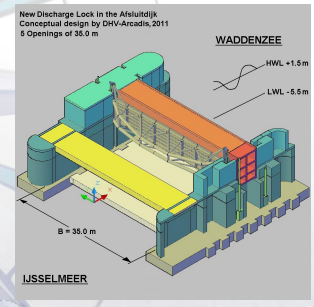
- Chamber width: 6.0 m
- Water depth: 3.3 m
- Max. water head: 2.5 m

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

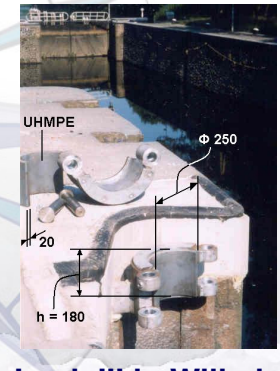
- Material: FGRP
- Width: ab. 1.5 m
- Dif. head: 2 ÷ 4 m

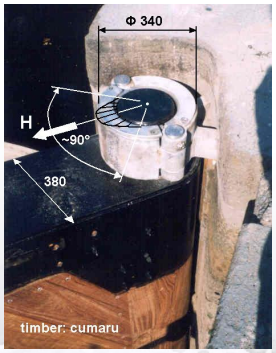
Grids, walkways

- Material: FGRP
- Width: ab. 1.5 m
- Load: 2.5 kN/m^2

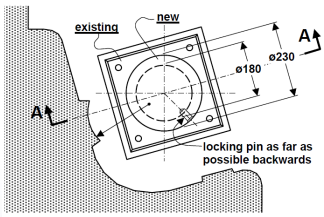
Synthetics in gate hinges (1)

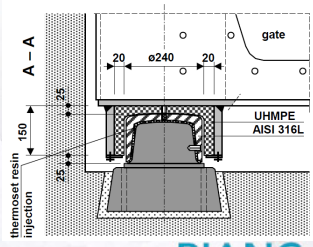
UHMPE in miter gate top hinge





… and bottom pintle





Lock III in Wilhelmina Canal, Tilburg
- **Deep but narrow – low hinge loads**
- **Large contact surfaces provided**

PIANC
Setting the course

Synthetics in gate hinges (2)

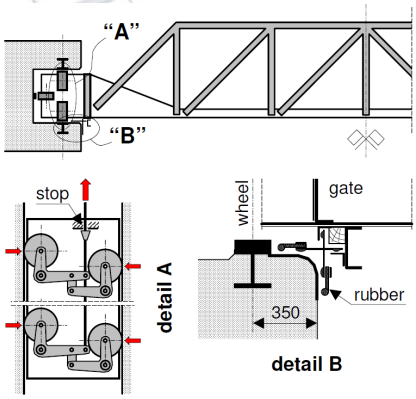
Thermoset resin composites in gate hinges

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

PIANC
Setting the course

Synthetics in gate guiding (1)

Conventional guiding



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

UHMPE guiding of vertical gates

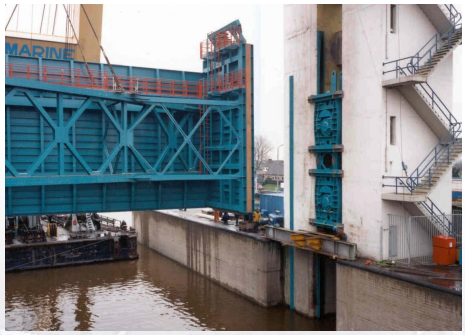
Hartel Canal Barrier, Rotterdam
- Span: 98.0 m, height: 10.0 m
- Differential head: up to 9.0 m

Synthetics in gate guiding (2)

Gate UHMPE guiding

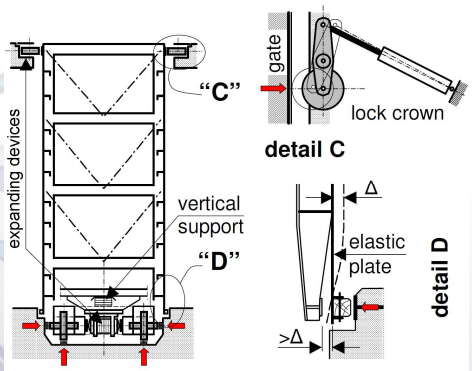
Hartel Canal Barrier:
Spans 49.0 m and 98.0 m,
height 10.0 m

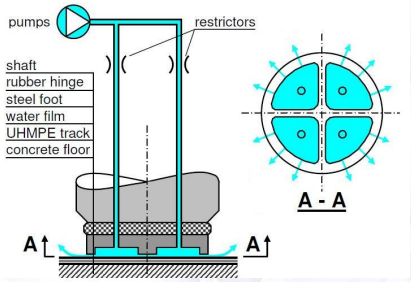
Gate conventional guiding



Hollandse IJssel Barrier:
Span 86.0 m, height 10.0 m

Synthetics in gate guiding (3)





Rolling gate on wagons

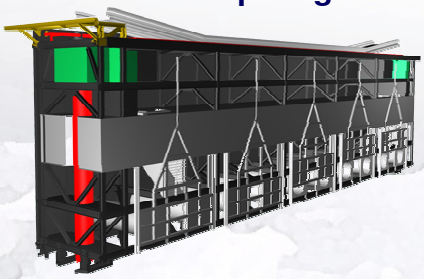
Sliding gate on "hydrofeet"

Three examples of applications

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

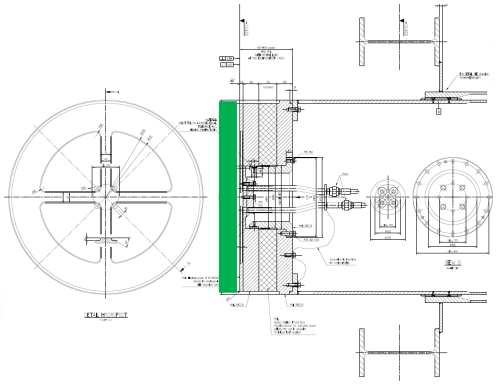
Malamocco lock gates - Venice

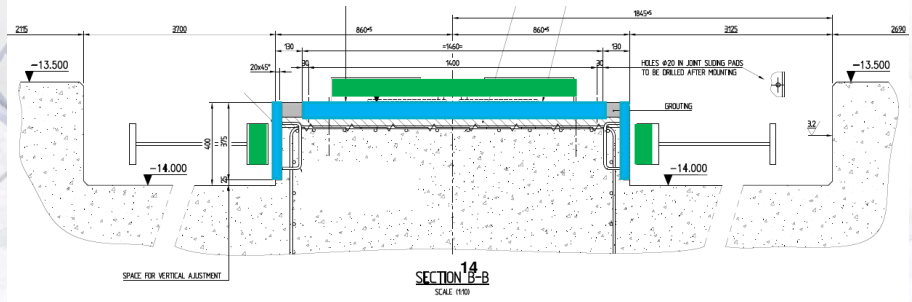
- "Sliding gate" vertical load taken by hydrofoot on UHMWPE slide track
- Horizontal loads taken by metal sliders on UHMWPE slide track
- Sealing by contact pressure between concrete surface and UHMWPE strip on gate



Malamocco lock

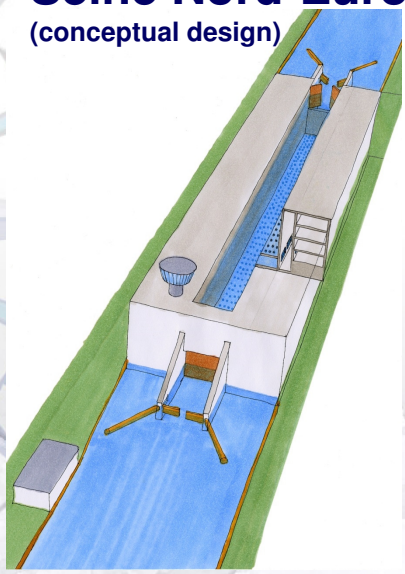
- Max. head: 3 m
- leakage no design criterium
- Desire of client to have little maintenance





Seine Nord-Europe

(conceptual design)



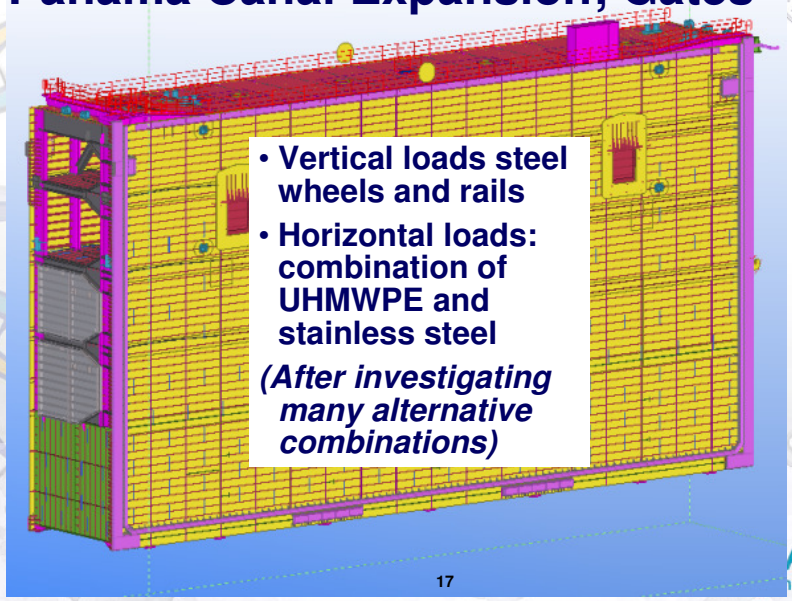
PIANC
Setting the course

Seine Nord-Europe

- 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

PIANC
Setting the course

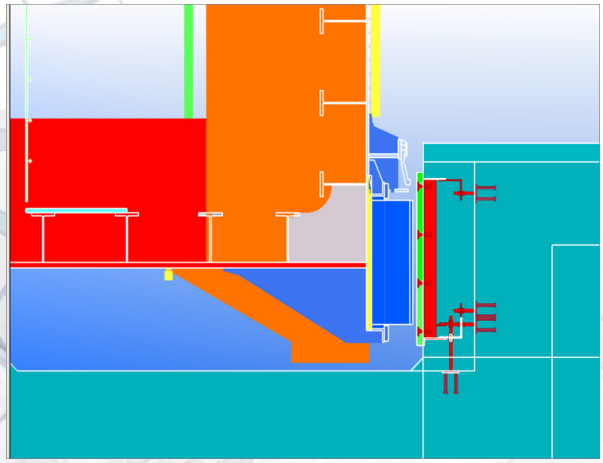
Panama Canal Expansion; Gates



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

(After investigating many alternative combinations)

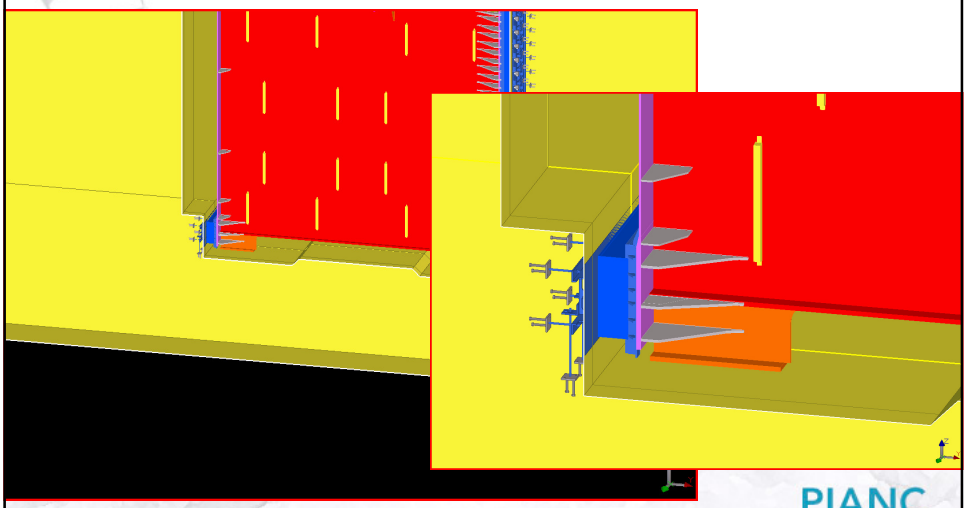
Panama Canal Expansion Gates



Evolution due to:

- Stringent leakage criteria
- Substantial (21 m) differential head
- Required accuracy of construction

Panama Canal Expansion Gates



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