INNOVATION IN NAVIGATION LOCK DESIGN

INCOM – WG29 (2006-2009)

Networking & Navigation Infrastructure

PIANC USA

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WG29: Lock Innovations

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Corresponding members:
China, France, Panama, UK
LOCK INNOVATIONS

The PIANC report n°106 (2009):

• Complement to PIANC 1986 report.

• Documenting Innovations and changes since 1986
NEW LOCK INNOVATIONS

• Hydraulics (filling and emptying),
• Operations and Maintenance,
• Environmental,
• Design (concrete, foundation, gate,…),
• Construction Methods,
• ……
Major changes in design since 1986 include:

- Maintenance and Operation,
- Focus on Reliability
- Increased Attention to Life Cycle Cost
- Attention to Renovation and rehabilitation
InCom WG 29 CONCLUSIONS

Trade off problems in Lock Design

⇒ “HIGHLY RELIABLE” equated to “PROVEN TECHNOLOGY”
If true ⇒ Is there a place for innovation in lock design?
WG29 ⇒ Yes. Innovation is required to increase reliability, reduce construction cost, fulfil new requirements,…
Do not be afraid of innovation. ⇒ Promote innovation.

⇒ “RELIABILITY” versus “COST” (in lock design)
The trade-off is highly dependent on design requirements.
Ex: “Panama Canal” versus the “Renovation of a small pleasure lock in Finland”
INNOVATIONS IN LOCK DESIGN

→ EXAMPLES
Innovative features or unusual aspects.
review various types of innovation and state of technology.
Illustrate the subjects covered in the report.
No actual lock (a ship lift), but characteristic for its principle, its aesthetic design and its multiple purpose, which includes tourism.
An innovative use of existing techniques can be seen at the Drop Lock. Vessels are temporarily lowered, just to cross the road underneath.
Where locks are built in rock, concrete walls do not always need to be used. In those cases it is possible to use only a floating pontoon to moor the ships during lockage.
China – Three Gorges

With a total lift of 113 m and a max. water head of 45.2 m, the Three Gorges locks are in height the largest locks in the world.

Apart from its dimensions, also the Filling and Emptying system and the prevention of Cavitation are major innovative aspects.
Panama - Canal Expansion

Third Lock Project in Panama

- Three-step locks,
- Each with 3 water saving basins
- Side F/E system
- fresh and salt water on lock limits
- 365 / 24 / 7 uninterrupted use

Lock dimensions

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
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<tbody>
<tr>
<td>Length</td>
<td>1281 m</td>
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<tr>
<td>Lift</td>
<td>27 m</td>
</tr>
<tr>
<td>Width</td>
<td>55 m</td>
</tr>
<tr>
<td>Depth</td>
<td>18.3 m</td>
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Areas of Innovation

- Hydraulic
- O & M
- Environ
- Design / Construct
- Misc

Así funcionan las tinas

PIANC USA – Atlanta, June, 2011
An important example of structural innovations is the development of monolithic locks. At the Hohenwarthe lock this solution is used for the 250 m long bottom plate.
Monolith LOCK

Standard Concept
With dilatation joints

No internal longitudinal stresses

Monolith Concept
Without dilatation joints

Internal longitudinal stresses
Netherlands - Naviduct

Areas of Innovation

<table>
<thead>
<tr>
<th>Hydraulic</th>
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</table>

Lock Dimensions

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<tr>
<th></th>
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<tbody>
<tr>
<td>Length</td>
<td>160 m</td>
<td>Lift:</td>
</tr>
<tr>
<td>Width</td>
<td>42 m</td>
<td>Depth</td>
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Enkhuizen, the Netherlands.

A unique combination of a double navigation lock and an underpass for road traffic.
USA – Greenup Lock

Areas of Innovation

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Lock Dimensions

<table>
<thead>
<tr>
<th>Length</th>
<th>366 m</th>
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<tbody>
<tr>
<td>Width</td>
<td>33.5 m</td>
</tr>
<tr>
<td>Lift</td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td></td>
</tr>
</tbody>
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Construction Methods in the wet

In the USA many different In the Wet construction methods are in use. Among these are the Float-In and Lift-in techniques of precast elements.
FILL AND EMPTY SYSTEMS

Are of two types:

- Through the sill
- Through longitudinal culverts

Typical layouts of Longitudinal culverts:

- Wall culvert side port system
- Wall culvert bottom lateral system
- In-Chamber long. culvert system (ILCS)
- Longitudinal culverts under the lock floor
- Dynamically balanced lock filling system
- Pressure chamber
Water Saving Basins (WSBs)

Various types of Water Saving Basins.
Integrated WSBs

The integrated system which integrates the WSBs in the two side walls, and makes the lock structure more stiff, compact and less land consuming.

Lock sidewalls with integrated WSBs
Lock Gate
2. - MECHANICAL PARTS: SEALS, BEARINGS, HYDRAULIC CYLINDERS, OPERATING EQUIPMENT

Electromechanical actuators, using a capsulated threaded pin (Germany)

Mitre gate at Uelzen II
3- NEW INNOVATIVE GATE CONCEPTS

a- Folded Plate for gates (Germany) – see previous page

b- Reversed Mitre Gate (NL, UK, …)

Reverse Mitre Gate (IJmuiden-NL)
NEW INNOVATIVE GATE CONCEPTS

c- Suspended Mitre Gates (NL)

Mitre gates supported only at their top hinges
NEW INNOVATIVE GATE CONCEPTS

d- Rotary Segment Lock Gate (horizontal axis) - Germany

Lisdorf Lock – Flood discharge through the lock
NEW INNOVATIVE GATE CONCEPTS

e- Vertical-axis Sector Gates
(Germany, Finland, Japan, …)
NEW INNOVATIVE GATE CONCEPTS

f) COMPOSITE LOCK GATES

CETMEF (France)

→ Arch gate

RWS - the “Spieringsluis”

→ high strength composite

Main advantages of composite arch gates are:

• No corrosion;
• Good resistance to aging in damp environment;
• Paint not required → reducing maintenance;
• Light - easing transportation and installation;
• Light - reducing size of machinery;
LOCK GATES – INNOVATIVE CONCEPTS

4. – GATE TIGHTNESS, LININGS and SEALS

→ The “come back” of sliding gates/valves

In the Netherland, Germany, Panama, USA etc.

UHMPE (ultra-high molecular weight polyethylene)
Is a reliable and very durable material to be used for sliding gate and lock filling and emptying valves.
7. – GATE EQUIPMENT

Magnetic automatic innovative mooring systems

Magnetic Mooring System at KaiserLock (Cavotec Ltd)