Verrazano Narrows Storm Surge Barrier

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The Netherlands
Comparison of New York / New Jersey and the Netherlands

- Complex sea, tidal and river water systems
- Urban area with high property values & densities
- Large urban areas below or just above sea level vulnerable to floods
- Environmental impact as a major issue
- Large ports with intense shipping
Location Verrazano Narrows

North of Bridge
Not too far
Depth

Alignment half
a mile north of
Verrazano Bridge

New York Harbor Bay
The Narrows
Staten Island
Long Island
Verrazano bridge
Present Cross section Verrazano Narrows

Cross section

Width: 6000 feet
Depth: 60 feet (max)

Wet cross section: 310,000 ft²

Embankement above:
50 feet within 300-600 feet
Impeding water only

No realistic option

Passing ships

Tidal flow
Passage of ships

 Biggest ship afloat must be able to pass

 Emma Maeske

 Length: 1300 feet
 Beam: 185 feet
 Draft: 53 feet
 Height: 251 feet
Cross section for biggest ships

Requirements for passage of ships

Width: 860 feet
Sill: - 66 feet
Clearance: unlimited

= blue area

Wet cross section: 19%
Additional cross section for smaller ships
Additional cross section for smaller ships

2 gates

Width: 165 feet
Sill: -40 feet
Clearance: 80 feet

Total wet cross section 23%
Reduction tide in New York Harbor Bay (1)

Limited wet cross section = limited tide
Reduction tide in New York Harbor Bay (2)

Limited wet cross section = limited tide
Reduction to 23% = tide reduction to 85-90 %
Reduction tide in New York Harbor Bay (3)

Limited wet cross section
= limited tide

Reduction to 70.000 sq ft2
= tide reduction to 85-90 %

.. and higher peak velocities up to 6-8 knots

Additional wet cross section for
• higher tidal range
• lower velocities
Additional cross section tidal flow

16 gates

Width: 130 feet
Sill: - 40 feet
Clearance: 5 feet

Total wet cross section 155,000 ft²
= 50 % of present wet cross section
Combination of three existing Dutch barriers ...(1)

Maeslant storm surge barrier 1997
Combination of three existing Dutch barriers …(2)

Hartel Canal storm surge barrier 1997
Combination of three existing Dutch barriers ...(1)

Easter Scheldt storm surge barrier 1986
Sector gate for large opening: Maeslant

... used in the right places (1)
… used in the right places (2)

Sector gate for large opening: Maeslant
Lifting gates, high clearance for smaller openings: Hartelkering
… used in the right places (3)

Sector gate for large opening: Maeslant
Lifting gates, high clearance for smaller openings: Hartelkering
Lifting gates, fixed beam for extra wet cross section: Easter Scheldt
Technical overview

Closed

Open
Artist impression
Requirements impeding water

- Structural reliability
- Reliability closure
- Limit overtopping and leakage

Design storm
Category 3 hurricane
Surge of 22 feet
Height: allowing overtopping and some leakage

- Allowing overtopping is reducing height and reducing costs
Allowing overtopping and some leakage

- Allowing overtopping is reducing height and reducing costs
- Inside water level will rise - allowable below safe water level

![Diagram showing water level changes with overtopping and river discharge](Image)

**Legend**

- **Open**
- **Closed**
- **Safe level**

**Graph**

- **With overtopping**
- **With river discharge**
- **No river, no overtopping**
Details sector gate

- Enormous gates
- 640 feet long
- Sliding over sill
- Height -66 to +30 feet
Detail sector gate

Large Foundation

Locomobiel
Details 130-feet lifting gate

Fixed beam between + 5 and + 36 feet
Sill at -40 feet
Gate between -40 and + 5 feet
Gate hanging on cylinders
Maintenance road
Details 130-feet lifting gate

Some leakage between gate and fixed beam
Operating mechanism 130-feet lifting gates

Cylinders able to lift heavy gates
Fail-safe solution:
  If operating system fails automatic closure of gates by local system, battery controlled, using gravity
Applicable up to lifts of 80 feet
Reliable if used / tested monthly
Details 165-feet lifting gate

No fixed beam
Sill at -40 feet
Clearance of 80 feet
No cylinders but winches in towers
Height up to +28 feet

Large lifting gate 1,000 kips
(= 1 meps?)
Reliability

Reliability is a key issue; measures taken include:

- Use proven concepts
- Operating mechanism above water
- Fail save design
- Simple movement (horizontal or vertical only)
- Easy accessible for maintenance

Operations is vital

- Early warning system
- Decision making (who, en when)
- Stopping of ships
Maintaining reliability is essential

How to keep a structure reliable when you use it only one every 10 years

- Maintenance driven design
- Thoughtful construction
- Risk based management
- Learning and cooperating with other storm surge barrier managers
- Strong organization with sufficient budget
## Costs

<table>
<thead>
<tr>
<th>Rough estimate</th>
<th>Cost (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector gate</td>
<td>2.5 bln</td>
</tr>
<tr>
<td>16 + 2 lifting gates</td>
<td>3.5 bln</td>
</tr>
<tr>
<td>Tie-in structures</td>
<td>0.5 bln</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6.5 bln</strong></td>
</tr>
</tbody>
</table>

O&M Budget estimated US$ 75mln annually

Much lower costs with less lifting gates

Many additional studies required
Concluding remarks

Storm surge barrier possible

Reliability is key issue

Barrier includes all state of the art knowledge of barrier design and operation

Requirements and dimensions will determine costs => additional studies

An extra landmark for New York …
Conclusion

bringing safety when required
Questions
Questions