Verrazano Narrows Storm Surge Barrier

ASCE Met Section Infrastructure Group Seminar 2009
Conference “Against the Deluge: Storm Surge Barriers to Protect New York City, March 31st 2009

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Contents

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The Netherlands

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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**

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Location Verrazano Narrows

North of Bridge
Not too far
Depth

Alignment half
a mile north of
Verrazano Bridge

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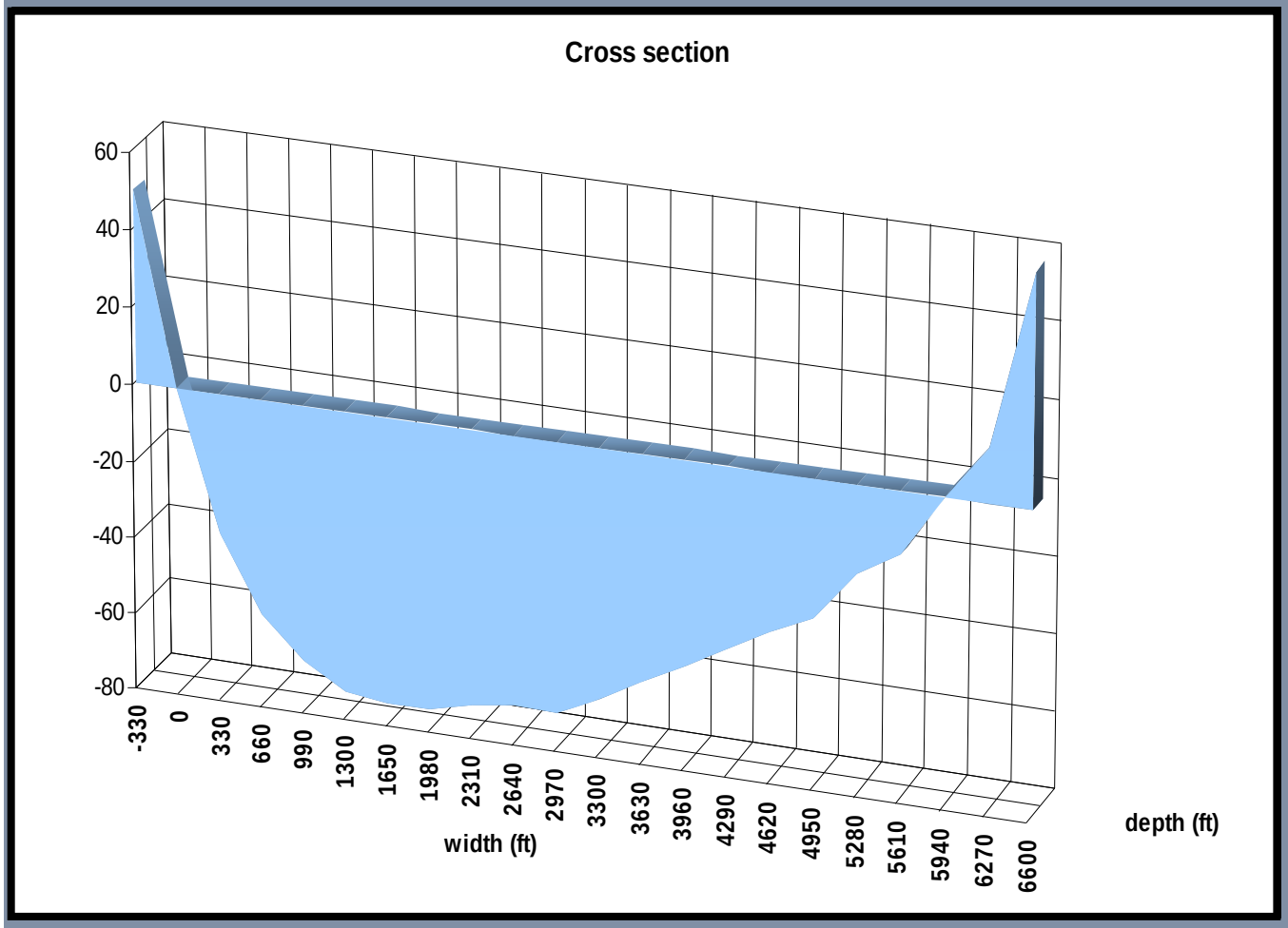
Present Cross section Verrazano Narrows



Cross section

Width: 6000 feet
Depth: 60 feet (max)

Wet cross section:
310.000 ft²

Embankement above 50 feet within 300-600 feet

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Impeding water only

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Passage of ships

Biggest ship afloat must be able to pass

Emma Maesk

Length: 1300 feet
Beam: 185 feet
Draft: 53 feet
Heigth: 251 feet

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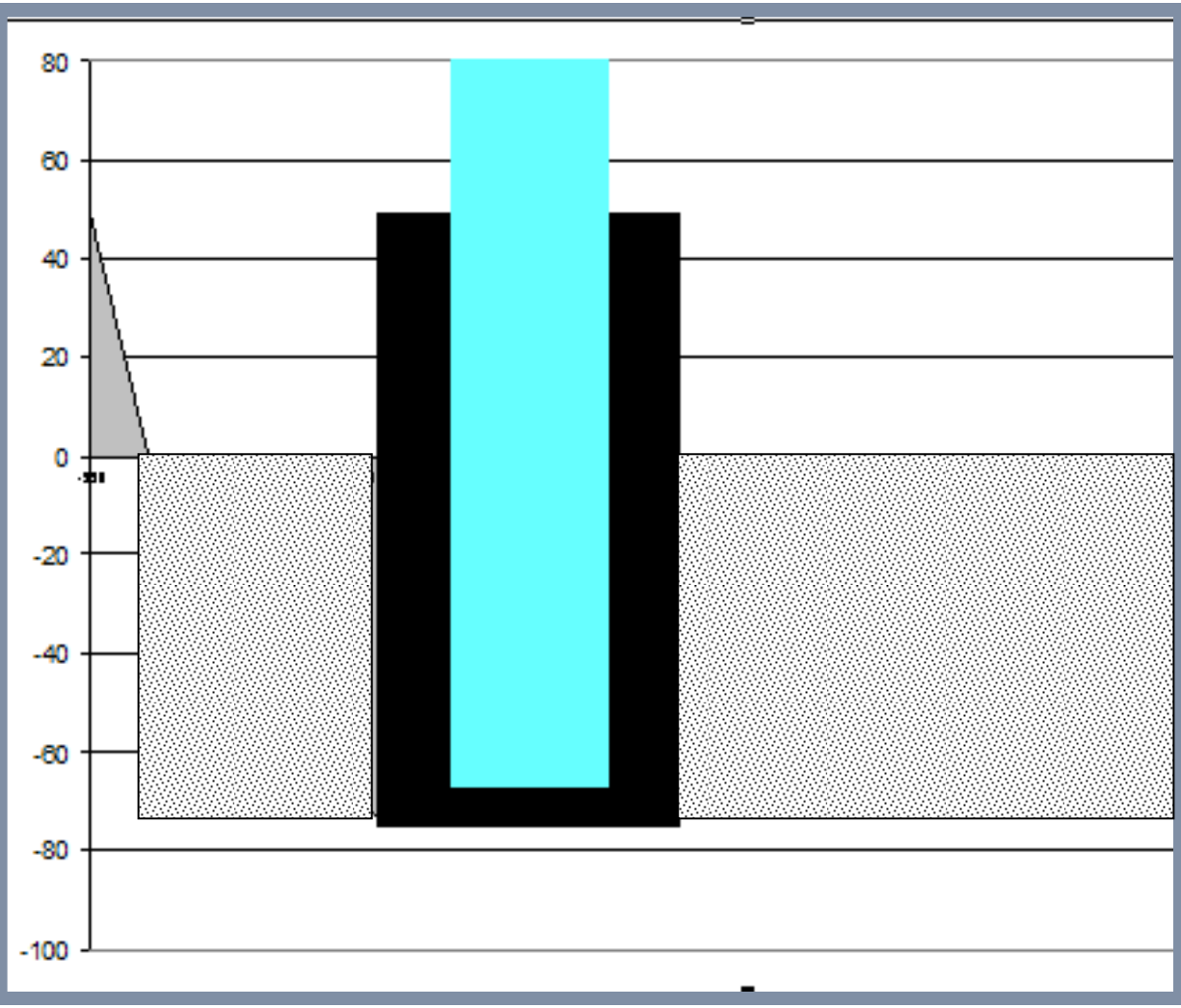
Cross section for biggest ships



Requirements for passage of ships

Width: 860 feet
Sill: - 66 feet
Clearance: unlimited
= blue area

Wet cross section:
19 %

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Additional cross section for smaller ships

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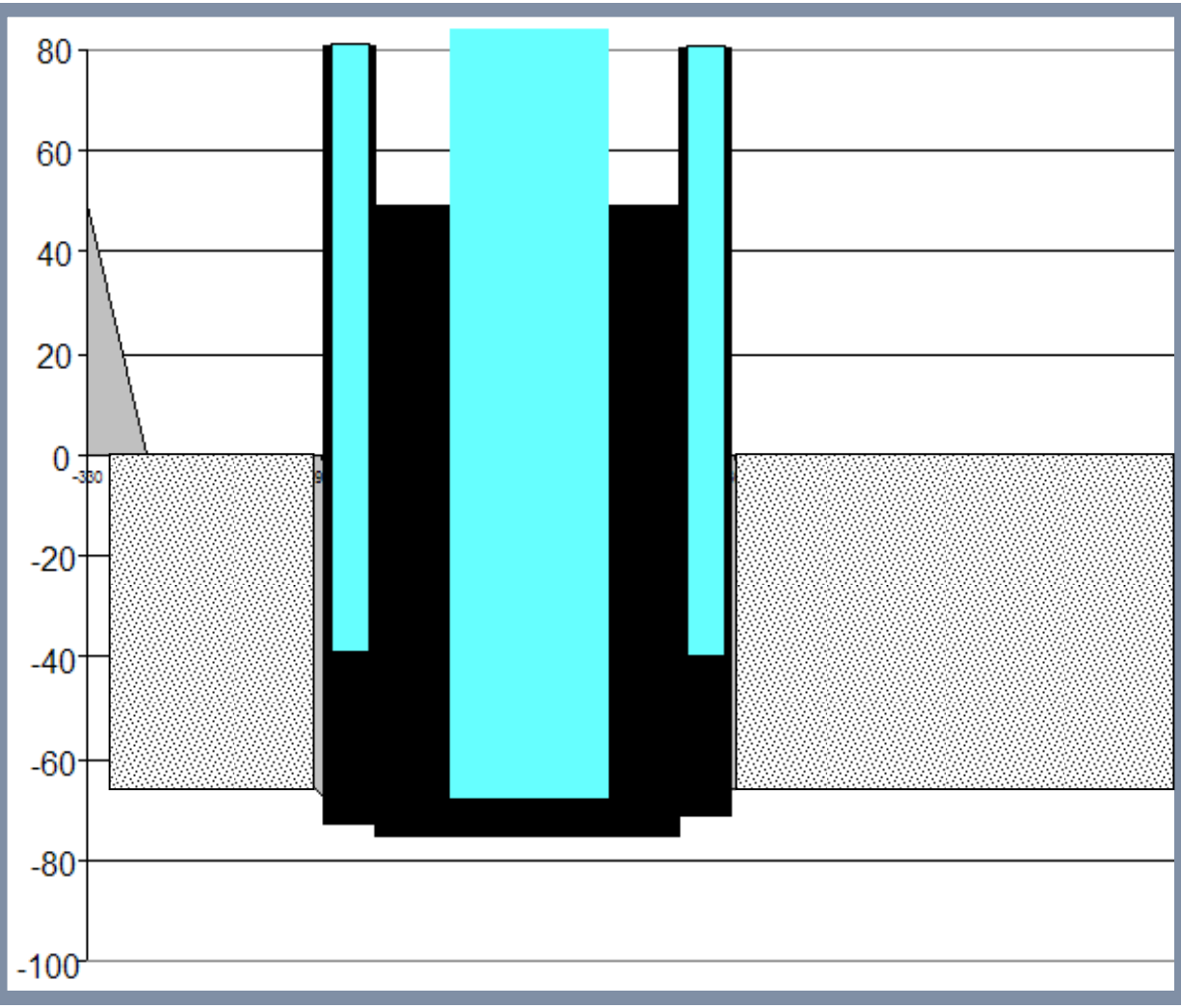
Additional cross section for smaller ships



2 gates

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

Total wet cross Section
23 %

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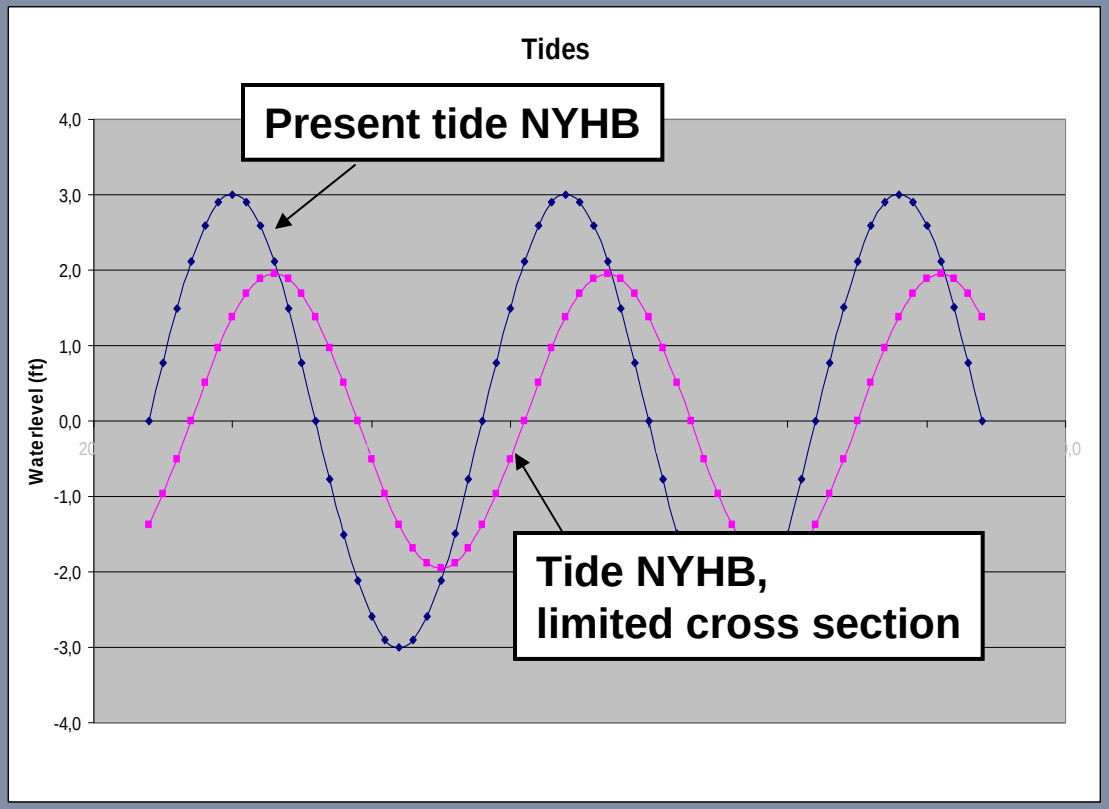
Reduction tide in New York Harbor Bay (1)



Limited wet cross section = limited tide

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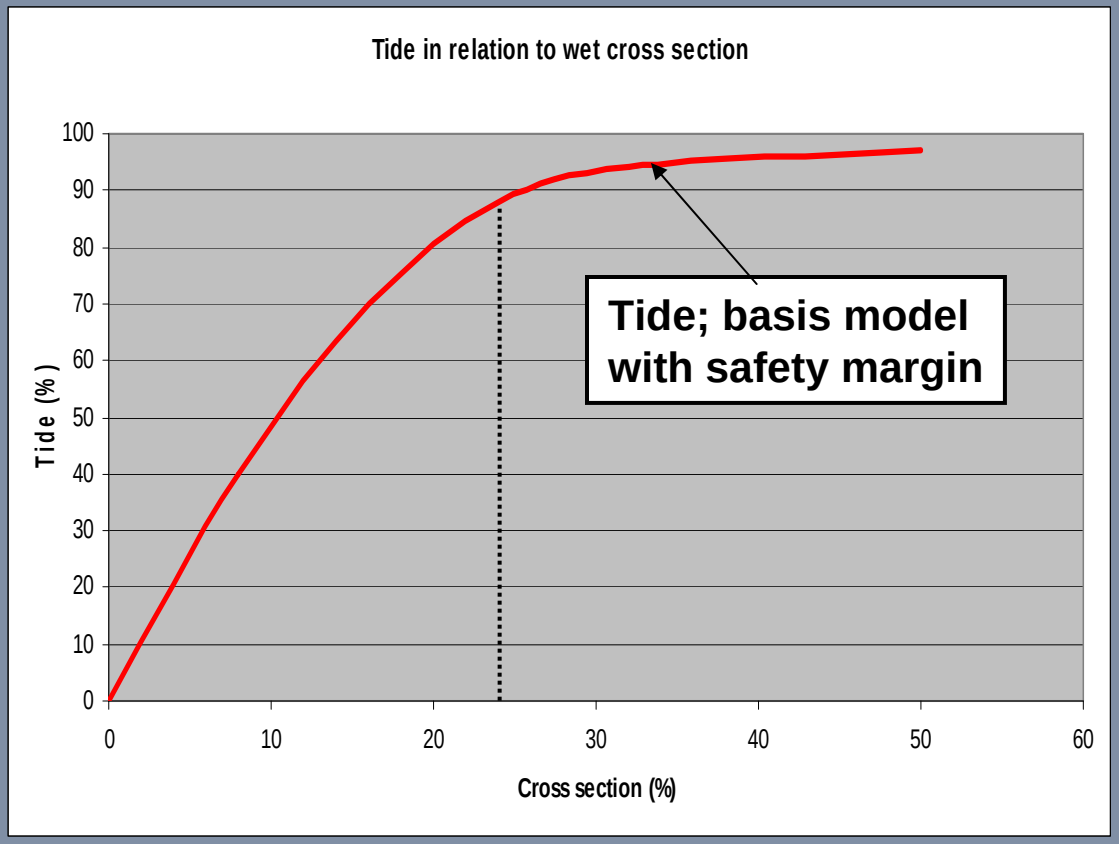
Reduction tide in New York Harbor Bay (2)



Limited wet cross section = limited tide

Reduction to 23% = tide reduction to 85-90 %

..

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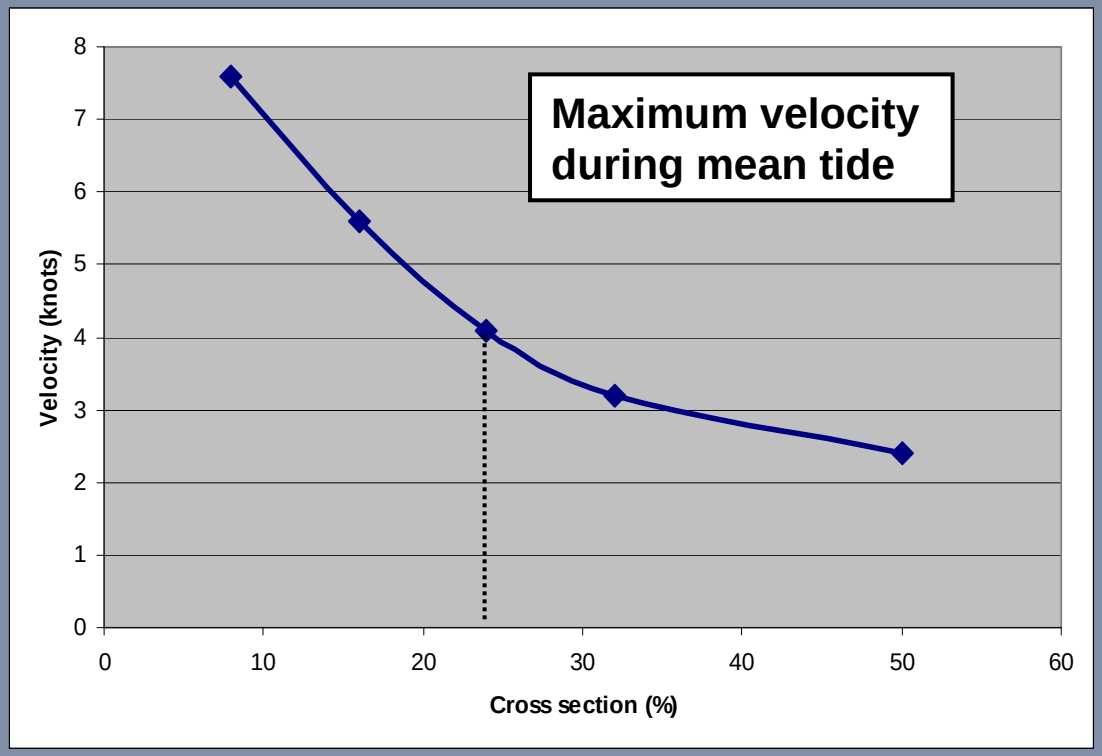
Reduction tide in New York Harbor Bay (3)



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**

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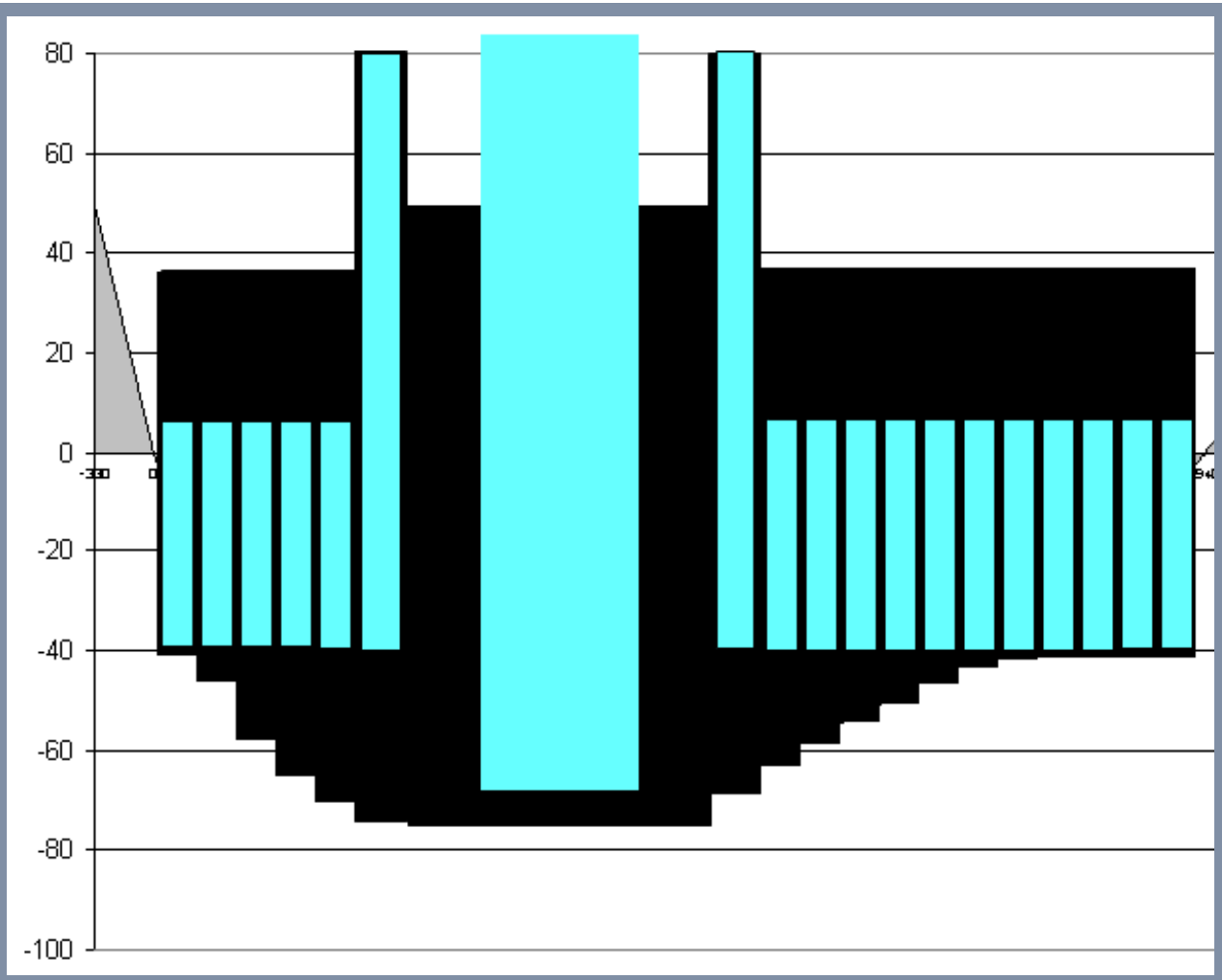
Additional cross section tidal flow



16 gates

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

Total wet cross section 155.000 ft2

= 50 % of present wet cross section

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Combination of three existing Dutch barriers …(1)

Maeslant storm surge barrier 1997

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Combination of three existing Dutch barriers …(2)

Hartel Canal
storm surge barrier
1997

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Combination of three existing Dutch barriers …(1)

Easter Scheldt storm surge barrier 1986

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… used in the right places (1)

Sector gate for large opening: **Maeslant**

… used in the right places (2)

Sector gate for large opening: **Maeslant**
Lifting gates, high clearance for smaller openings: **Hartelkering**

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… 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**

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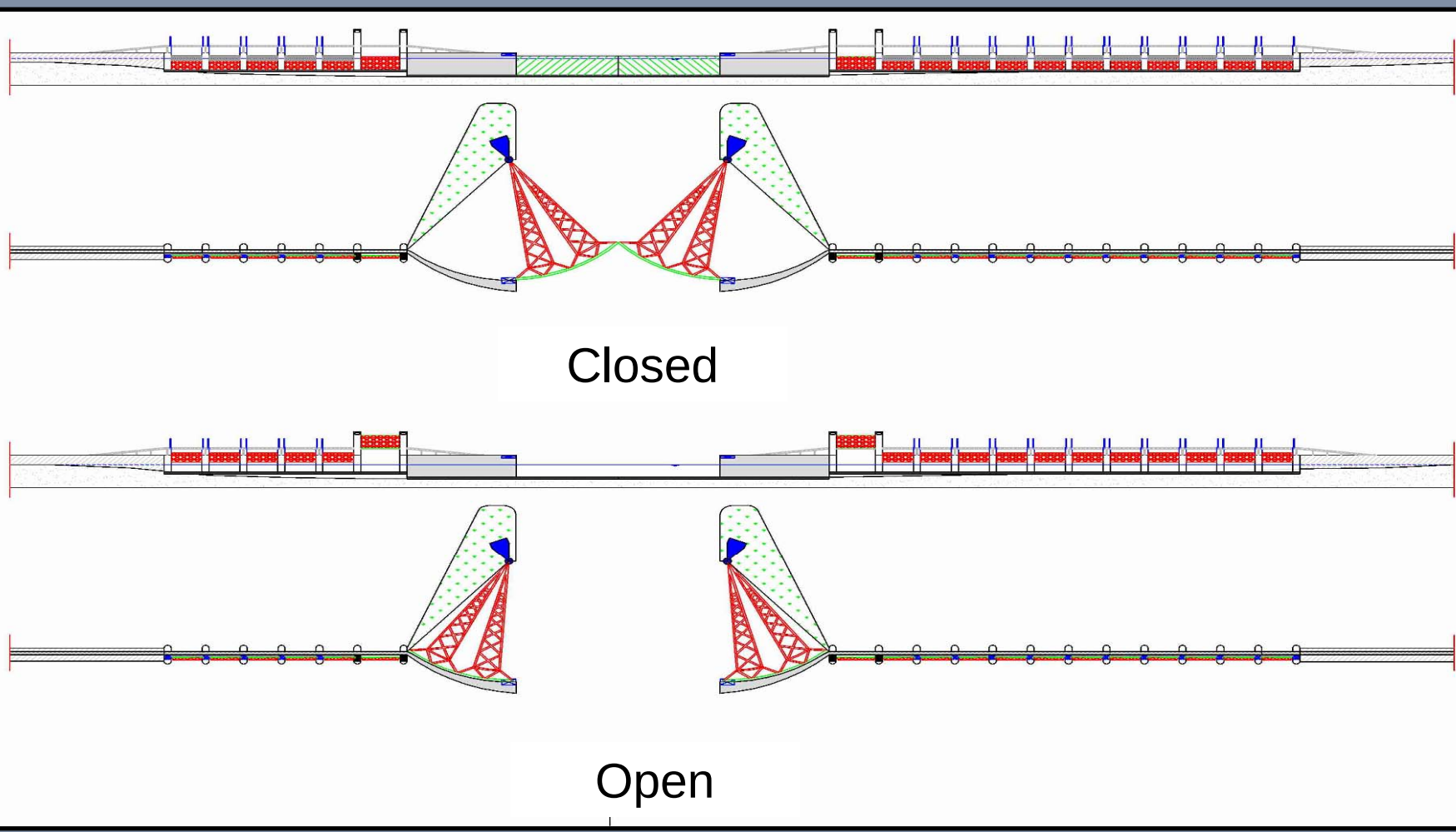
Technical overview



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Artist impression

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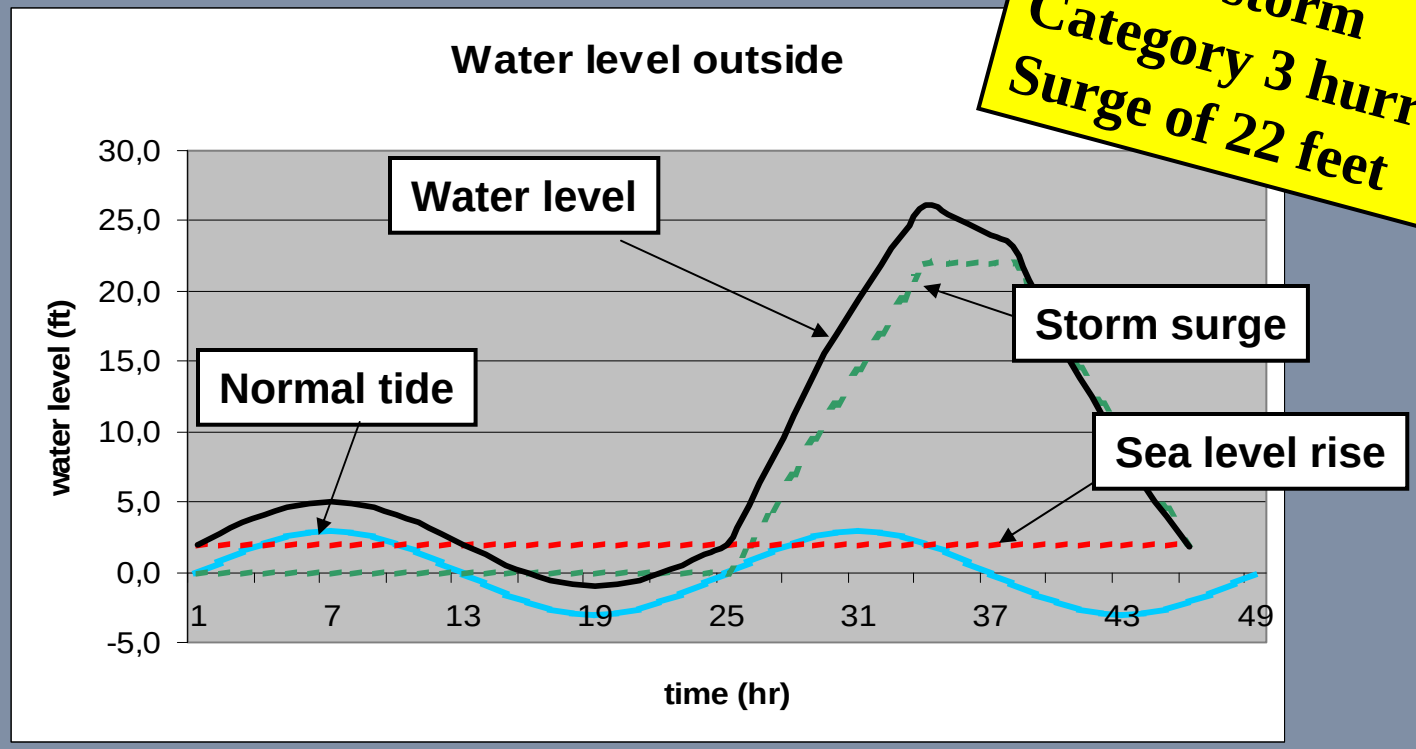
Requirements impeding water

- Structural reliability
- Reliability closure
- Limit overtopping and leakage



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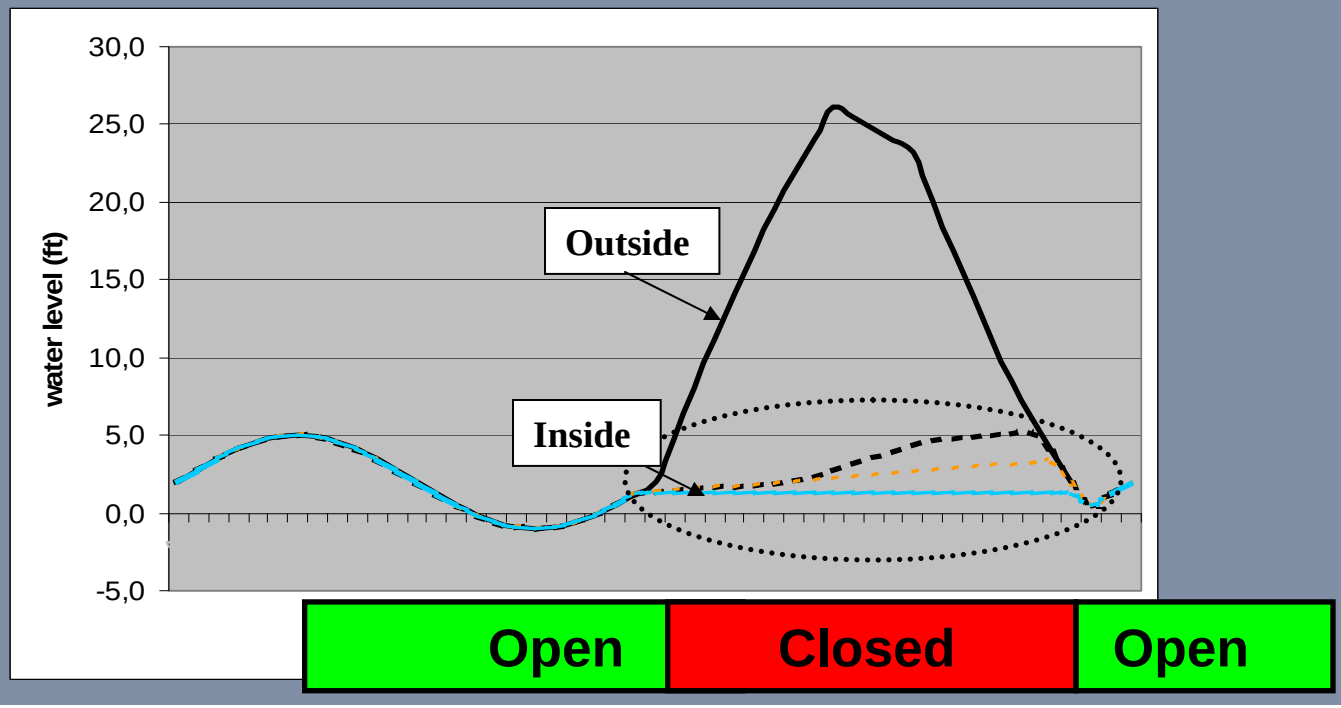
Height: allowing overtopping and some leakage

- **Allowing overtopping is reducing height and reducing costs**



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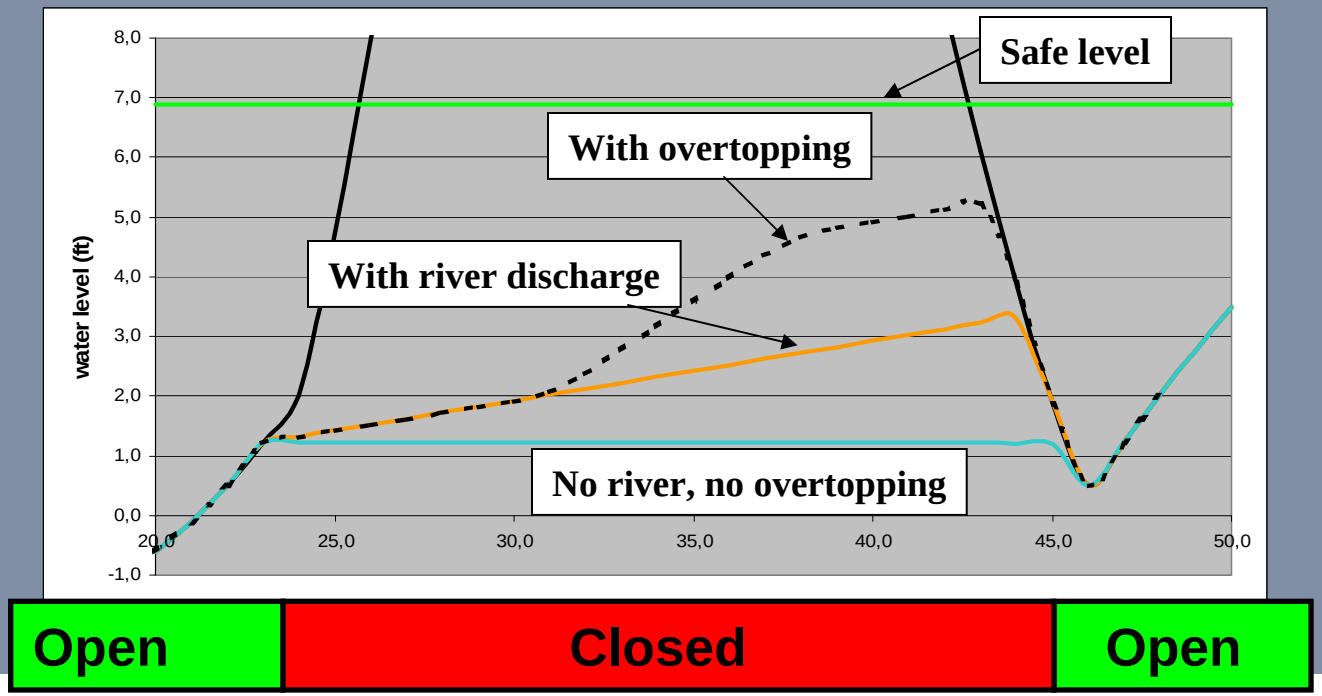
Allowing overtopping and some leakage

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



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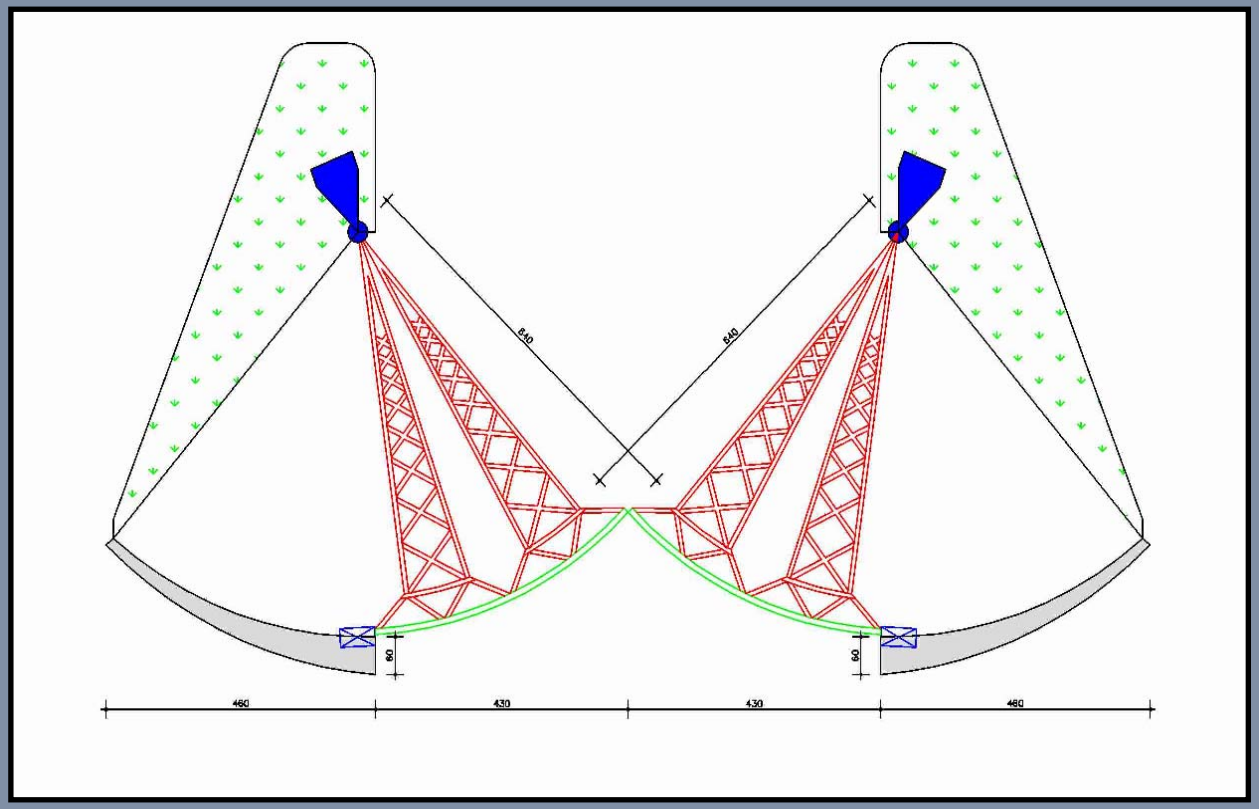
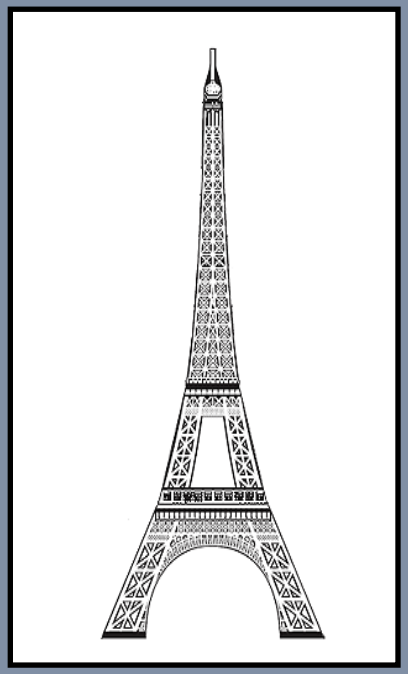
Details sector gate





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

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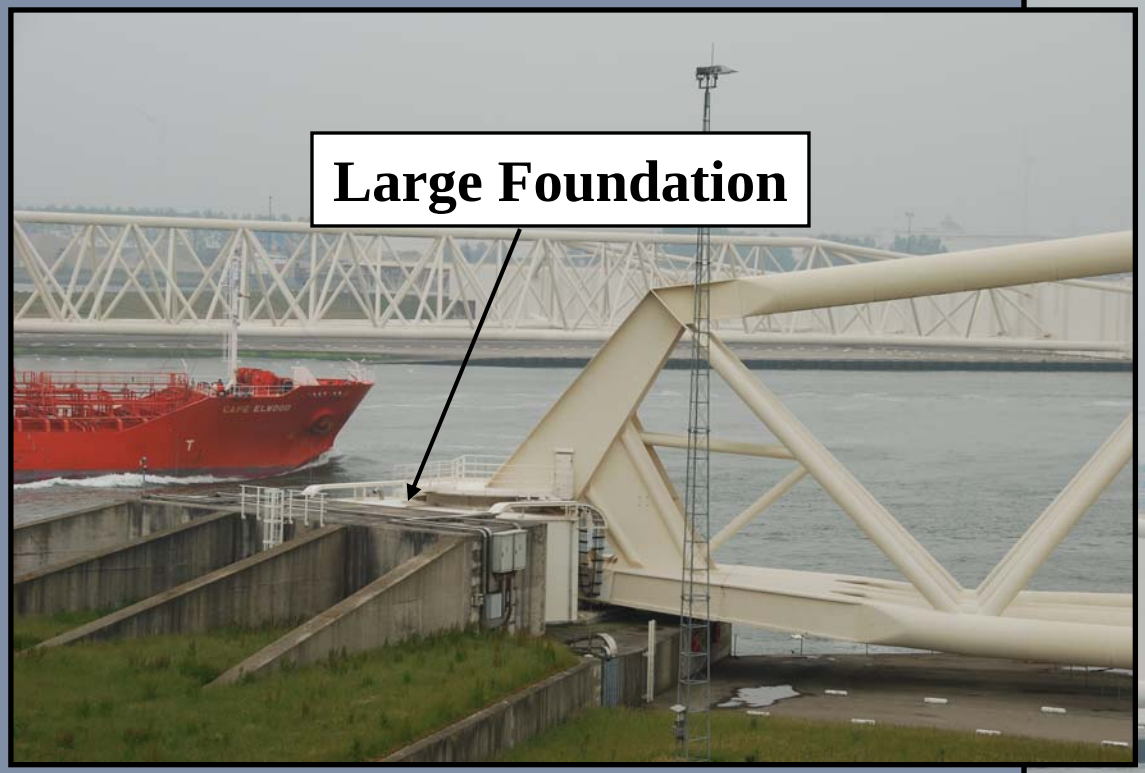
Detail sector gate



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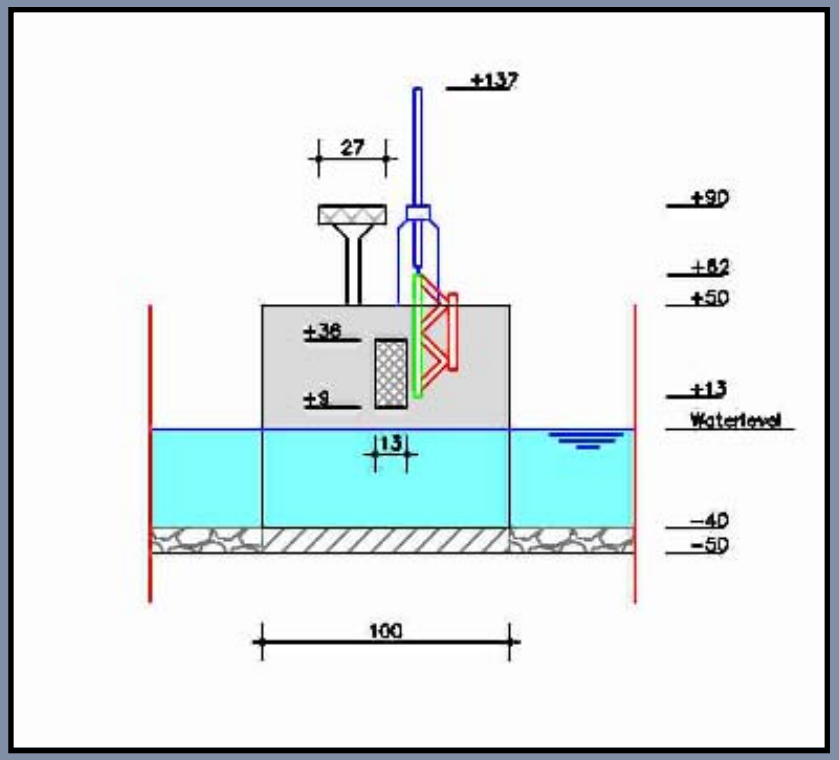
Details 130-feet lifting gate



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

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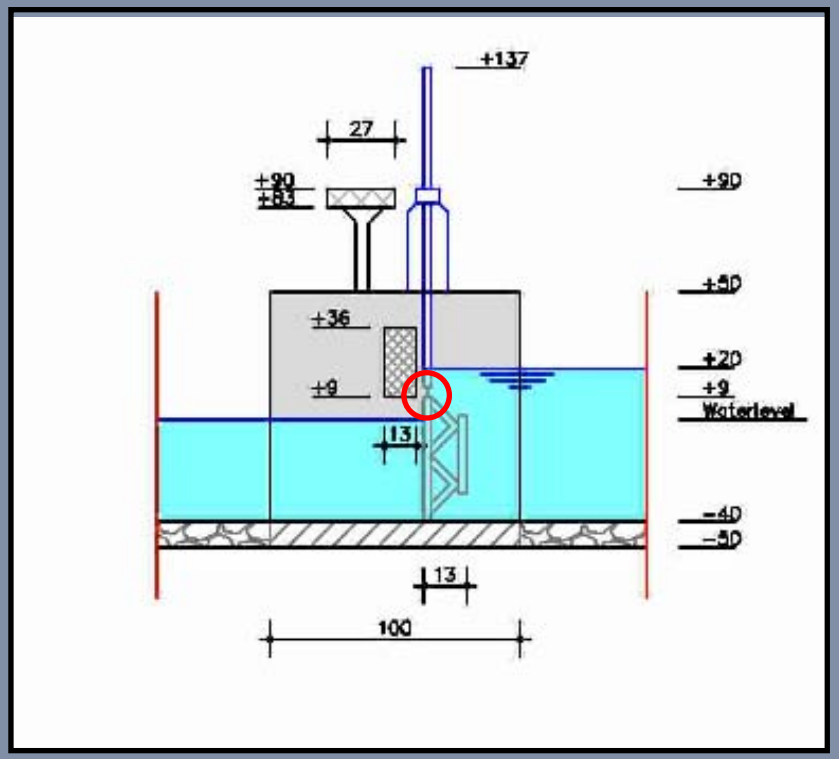
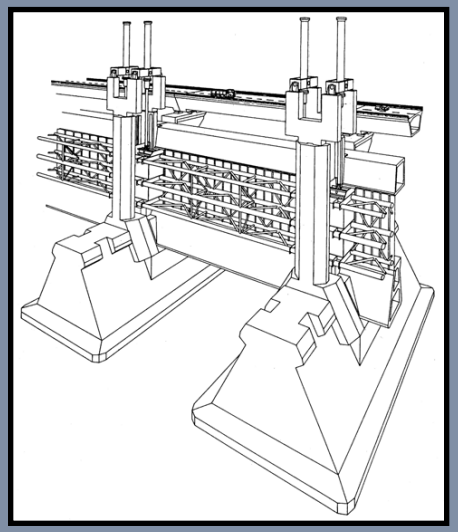
Details 130-feet lifting gate



Some leakage between gate and fixed beam



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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

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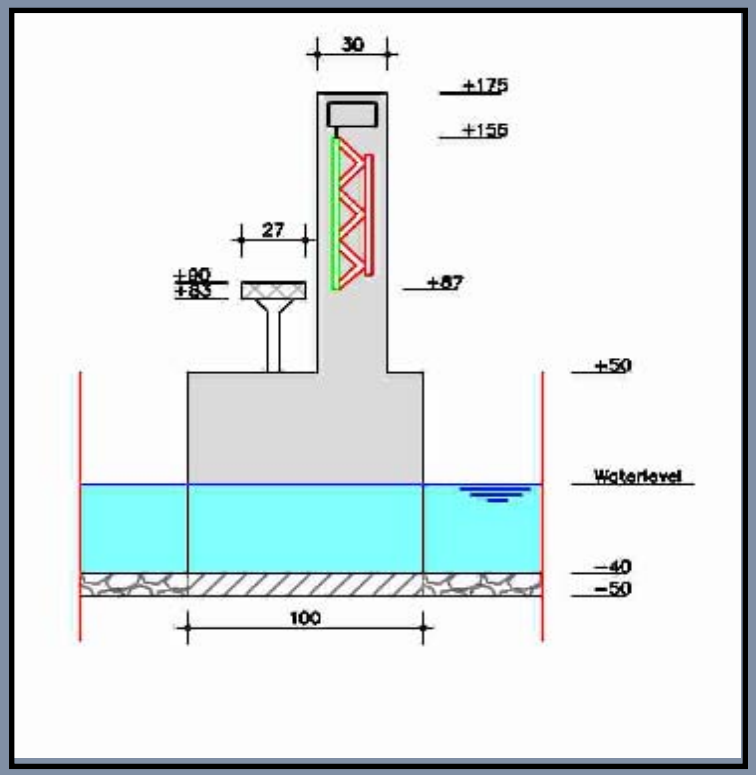
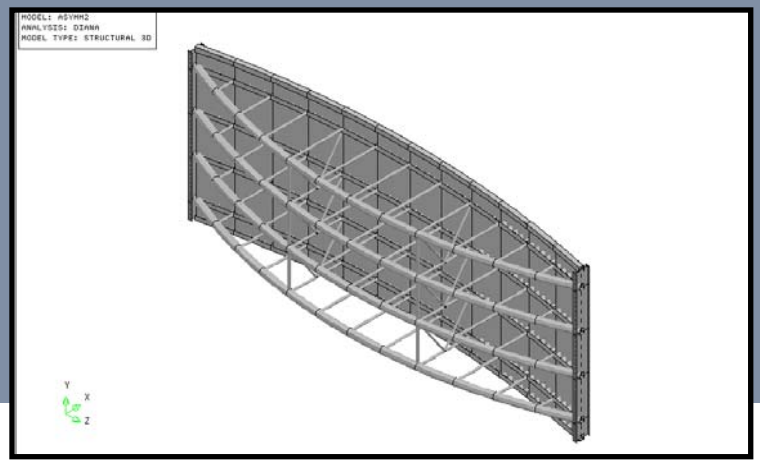
Details 165-feet lifting gate



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?)



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Reliability

Reliability is a key issue; meassures 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**
- **Dicision making (who en when)**
- **Stopping of ships**

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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**

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Costs

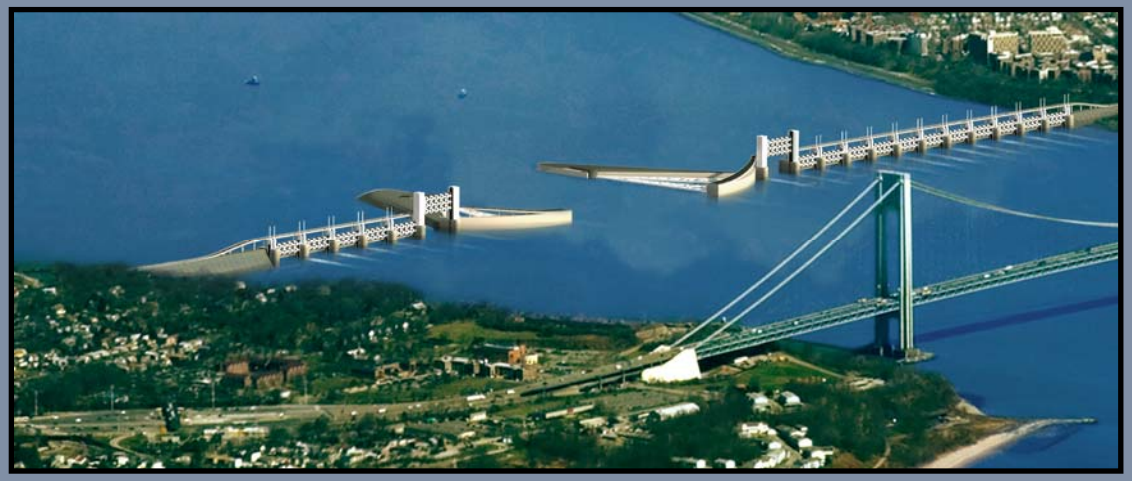
Rough estimate

Sector gate	US$ 2.5 bln
16 + 2 lifting gates	US$ 3.5 bln
Tie-in structures	US$ 0.5 bln
Total	US$ 6.5 bln

O&M Budget estimated US$ 75mln annually

Much lower costs with less lifting gates

Many additional studies required



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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 …

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Conclusion

bringing safety when required

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Questions

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Questions