Femern Baelt Fixed Link

Concrete Strategy

Macro Perspective
Steen Lykke, M.Sc., Project Director, Tunnel

- 2008 – date, Project Director, Tunnel
  Femern Bælt A/S

- 2001 – 2008 Project Manager, Bosphorus,
  Istanbul, The Marmaray Project

- 1993 – 2001, Contracts Director,
  Oeresundskonsortiet, DK

- 1979 – 1993, Steensen & Varming
  Director, Civil & Structural Works
  Denmark
The Danish Tradition
Great Bælt Link
Øresund Link
A new growth region?
Facts and Figures

- Strait Width: 19 – 20 kilometers
- Max Water Depth: approximately 30 meters
- Total Budget including Hinterland: 6.5 – 7 billion €
- No tax-money involved, Users will pay (Coast to Coast)
- Prognoses: Pay-back period 27 years
- Ship traffic east – west: App. 46,000 / year
- Ship traffic north - south: App. 20,000 / year
- Is a combination Bridge / Tunnel an option: NO
- A cable stayed bridge is the preferred solution
- An immersed tunnel is the preferred alternative
Danish Hinterland

- Railway Ringsted-Rødby, Upgrading, electrification
- Railway Vordingborg-Rødby from one to two tracks except Storstrømsbridge
- Minor upgrading of Sakskøbing-Rødby motorway
German Hinterland

- Ensure sufficient capacity of Railway Bad Schwartau - Puttgarden

- Railway Lübeck-Puttgarden electrified

- Railway upgraded to two tracks 7 years after opening

- Road Heiligenhafen-Puttgarden upgraded to 4 lanes
Finance Model

100% Danish owned Company
Danish State Guarantee

Danish Hinterland
Appr. 1.0 billion €
May be financed by income from the fixed link fees

Coast to Coast
Fixed Link
Appr. 4.5 – 5.0 billion €

Financed by income from fixed link fees

100% German Company

German Hinterland
Appr. 1.0 billion €
<table>
<thead>
<tr>
<th>Jahr</th>
<th>Ereignis</th>
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<tbody>
<tr>
<td>2008</td>
<td>Unterzeichnung des Staatsvertrags über die feste Fehmarnbeltquerung</td>
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<tr>
<td>2009</td>
<td>Ratifizierungsverfahren des Staatsvertrags in Deutschland und Dänemark</td>
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<tr>
<td>2011</td>
<td>Planungsphase einschl. Umweltverträglichkeitsuntersuchungen</td>
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<tr>
<td>2012</td>
<td>Entscheidung zur endgültigen Linienführung und baulichen Lösung. Genehmigungsverfahren in Deutschland und Dänemark</td>
</tr>
<tr>
<td>2018</td>
<td>Bau der Querung</td>
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</tbody>
</table>
Average daily traffic
Scandinavia - Continent

Rødby-Puttgarden
Gedser-Rostock
Trelleborg
Bridge or tunnel?
Technical Solutions not yet fixed

From here,

POTENTIAL SOLUTIONS
The Preferred Solution

A cable stayed Bridge
Cable Stayed bridge
– The preferred Option
Oresund Bridge
Great Belt, the Eastbridge
Bridge, facts and figures so far

- **Top of pylon:**
  - Femern 281 m
  - Great Belt 254 m
  - Øresund 204 m

- **Clearance:**
  - Femern 65 m
  - Great Belt 65 m
  - Øresund 55 m
Section of typical Girder

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Width</th>
<th>Height</th>
<th>Weight per Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>Femern</td>
<td>Ca. 28,7 m</td>
<td>Ca. 15,0 m</td>
<td>Ca. 14,000 T</td>
</tr>
<tr>
<td>Øresund</td>
<td>23,5 m</td>
<td>10,9 m</td>
<td>Ca. 7,000 T</td>
</tr>
<tr>
<td>Great Belt</td>
<td>31,0 m</td>
<td>10,4 m</td>
<td>-</td>
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</table>
A cable stayed Bridge

Respect the Challenge !
We can do it !
The Preferred Alternative

An Immersed Tunnel
The Øresund Immersed Tunnel
The Øresund Immersed Tunnel
The Bosphorus Immersed Tunnel
Elements, Bosphorus
Primary Areas of Focus Points

- Optimising Immersed Tunnel Cross Section and Alignment
- Optimising Ventilation and Safety Installations
- Optimising the "experience" of passing through the Tunnel and the Aesthetics
- Optimising construction methods
- Minimising Risks during Construction and under Operation
- Minimising adverse effects on the environment
Physical Conditions, Bosphorus

Bosphorus, Construction Site, Safety
Aesthetics, Landscape and Architecture
Some facts, Øresund versus Femern IMT

Øresund
- (3.5) 4.0 km long
- No of elements 20
- Deepest Point ~ 23 m
- Weight per element ~ 55.000 tons
- Amount of concrete ~ 700.000 m³
- Dredged material, trench ~ 2.200.000 m³

Femern
- (19.0) 19.5 km long
- No of elements ~ 105 *
- Deepest point ~ 43 m
- Weight per element ~ 63.000 tons *
- Amount of concrete ~ 4.000.000 m³
- Dredged material, trench ~ 20.000.000 m³
The Preferred Alternative
Respect the Challenge!
We can also do it!
It is nice to go underground!
EIA Study – Services

1. Hydrographic services
2. Marine biology services
3. Bird study services
4. Fish & fishery services
5. Marine mammals services
6. Danish ramp area EIA
7. German ramp area EIA

Scoping report & EIA Study report
Geotechnical Investigations
Navigational Studies, Marine Safety
Special Focus:
Concrete
Documented Success no 1 for the Concept
Documented Success no 2 for the Concept
Femern Concrete Group

- Contract Strategy Design & Build
  - Functional Requirements (physical properties, sustainability and durability)
  - Minimum Requirements (stay within known technology)
  - Exclusions (clarity)
- Common requirements for Bridge and Tunnel
- Headed by Femern
  - Ulf Joensson and Christian Munch-Petersen
  - Experts from the Design Groups
  - External experts
- Works started in April 2009
- Draft requirements ready May 2010
Concrete Strategy

- Service life of 120 years using well-known technology
  - Well-tried with positive results in similar conditions
  - No initiation of corrosion or major repair works
- No competition on quality!
- As much flexibility to Contractors as possible
- Use experience from Øresund Link and Bosphorus Tunnels
Basis for the Requirements

- EN 206-1 and EN 13 670-1 + Femern “NAD”
- Stand alone document
- Comprehensive pre-testing and FS trial castings
- QC program supported by Conformity Procedures
- Systems for certification/accreditation where possible
State-of-the-Art Reports

- Technical notes from Øresund Link + New areas (e.g. SCC, FRC)
- 11 background reports
- Scientific basis and documentation for the requirements
- Serves as support for management of the construction phase
Femern Exposure Site – Special Activity

- Installation is planned in Rødbyhavn
- Start installation end of 2009
- Collect early data for check of the requirements
- Long term data collection for knowledge build-up
- Follow up of Contractors mix designs during construction
- Platform for research activities
Exposure Sites, Examples
Collaboration Research Activities

- Femern A/S takes an active part in research activities
- Present engagements:
  - Senso-Byg, D2 – Store konstruktioner
  - Nanotech DTU: Resistance to reinforcement Corrosion in Concrete Structures
- More may come
Thank you for listening –
Questions & Answers