Memo

The selection of the immersed tunnel as the preferred solution

**Introduction**

An immersed tunnel is the best technical solution for a Fixed Link across the Fehmarnbelt. This conclusion is reached on technical, safety, environmental and financial grounds.

From a plan approval perspective, each of the technical solutions investigated – an immersed tunnel, a bored tunnel and a bridge – can be approved in both Germany and Denmark. Femern A/S’ extensive environmental investigations have shown that while all technical solutions would have impacts on the environment – some temporary, others longer lasting – none of them has such strong environmental consequences that they would prevent the respective solutions from being approved.

During the technical investigations, Femern A/S compared the immersed tunnel with the cable-stayed bridge, as well as the immersed tunnel with the bored tunnel. The conclusions are set out below.

**Immersed tunnel vs. cable-stayed bridge**

* The technical challenges of the cable-stayed bridge are greater than those of the immersed tunnel. The cable-stayed bridge would be the world’s longest of its kind with two record spans of 724 m each. While the immersed tunnel will also be the longest of its kind, the technical challenge is much less significant. Therefore, the construction risks to the cable-stayed bridge are higher.
* The cable-stayed bridge would constitute a permanent risk for shipping safety. While this risk could be minimised through the introduction of a permanent VTS-system, an element of risk would always remain and a ship collision with the potential spill of hazardous substances could have severe consequences for the environment.
* The cable-stayed bridge would expose traffic to wind and weather conditions, which could restrict the traffic flow – just as is sometimes the case on the Fehmarnsund bridge.
* The cable-stayed bridge would have a permanent impact on the marine environment since its pillars could affect the water exchange in the Fehmarnbelt.
* The cable-stayed bridge would risk causing permanent impairment to bird migration in the region.
* In terms of construction period, construction costs and maintenance costs, the immersed tunnel and the cable-stayed bridge are comparable. It would take 6 years to build the cable-stayed bridge and 6 ½ years to build the immersed tunnel. The cable-stayed bridge would be slightly more expensive during the construction phase, but a little less so during the operation and maintenance phase.

**Immersed tunnel vs. bored tunnel**

* The construction risk of the bored tunnel is substantially higher than for an immersed tunnel. The geological conditions in the Fehmarnbelt make it difficult to drill and to stabilise a tunnel underneath the seabed, which would need to run much deeper than the immersed tunnel.
* Moreover, to give the tunnel tubes the same functionality as the immersed tunnel, it would be necessary to build three separate tubes using six of the world’s largest tunnel boring machines – two for each tube. Four of the boring machines would need to have a diameter exceeding 15 m and two of them exceeding 16 m. Each machine would have to drill approximately 10 km through difficult and mixed ground without a major breakdown as they could not be replaced once drilling had begun.
* The bored tunnel would require a larger construction site on Fehmarn than the immersed tunnel.
* In terms of construction period (8 years), construction costs (EUR 6.8 billion) and maintenance costs, the bored tunnel is significantly more expensive – approximately EUR 1.3 billion or 25% more during construction, and 20% more during operation and maintenance. It would also take 18 months longer to build. This would lead to a considerably longer repayment period and higher interest burden, which would effectively render the project uneconomical.

**Conclusion – the reasons in favour of the immersed tunnel**

The overall comparison of the immersed tunnel with the other technical alternatives highlights the advantages of the immersed tunnel. The immersed tunnel is the best solution because:

* The existing technical knowledge and robustness of the construction methods is the highest among the solutions.
* There is no potential collision risk for shipping during its operation, because it runs underneath the seabed. Furthermore, it will not affect the water exchange across the Baltic Sea.
* It constitutes a safe and comfortable solution for traffic, offering escape routes every 100 metres along all four tunnel tubes. Use of the tunnel will constitute a higher safety level for road as well as for rail compared to the safety level in the open land
* Its main environmental effects are confined to the construction period, which means that it has little long-lasting or permanent effect on the environment and that no severe environmental detrimental effects can be expected