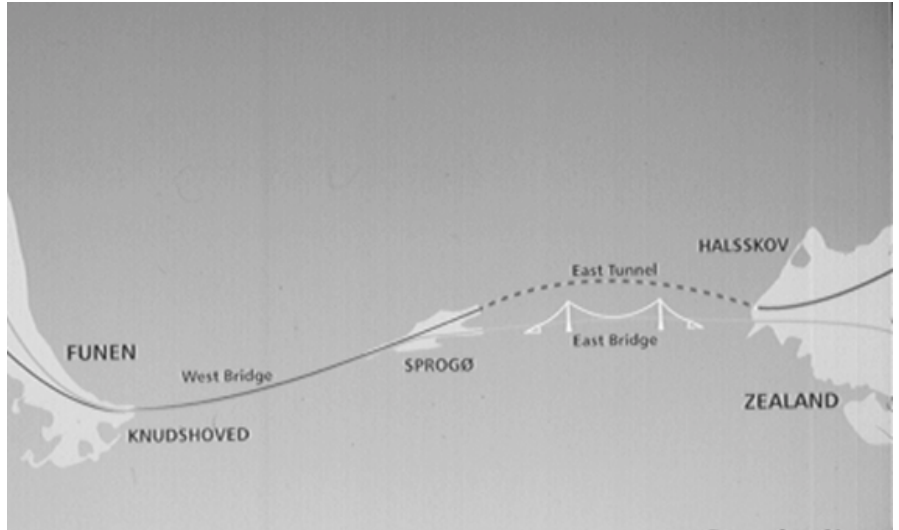
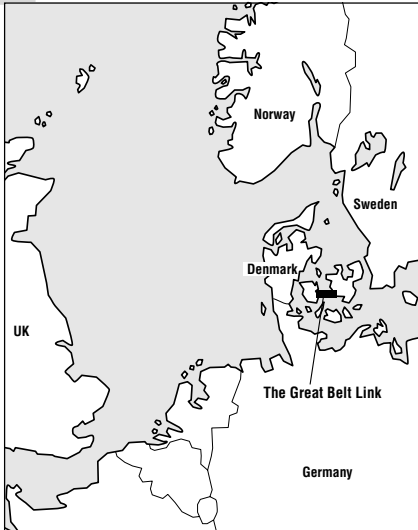


Bridging Scandinavia

Nils Francke

Part 1. The Great Belt Fixed Link



Great Belt Fixed Link joining western and eastern Denmark

(Great Belt A/S)

The construction of the Great Belt Fixed Link in Denmark is being financed by future users of the railway and motorway crossing. The project owner and client is the Danish company, Great Belt A/S in which the Danish State (The Ministry of Transport) is the sole shareholder. The company undertook the design, construction and operation of the Link. The railway link will be inaugurated this summer. The Link joins the western and eastern parts of Denmark across the Great Belt strait and is the largest and most expensive infrastructure project ever undertaken in Denmark. Today, a fleet of modern car and rail ferries carry passengers and freight across the Great Belt, but the opening of the Fixed Link will reduce journey times from 60 minutes to 7 minutes for rail users, and from approximately 90 minutes to 11 minutes for drivers.

Despite the modern ferry operations, the Great Belt represents a significant barrier for the 2.5 million people living on each side. At present, with only 5% to 10% of the products and services produced on each side crossing the Great Belt, the two parts of Denmark are effectively largely

isolated.

However, in future, many more products and services will cross the Great Belt, and although Great-Belt commuting is now unheard of, it will be commonplace when the Fixed Link opens.

The 18-km project consists of three major contracts:

- The East Bridge: A 6.8-km motorway bridge between Zeeland and Sprogø with a navigational clearance of 65 m. The substructure—two pylons, two anchor blocks and 19 bridge piers—is concrete, while the superstructure—bridge spans and cables—is steel. The East Bridge will be the world's second longest suspension bridge with a free span of 1624 m carried by two 254 m pylons. It will be completed in 1998.
- The West Bridge: A 6.6-km low bridge carrying the railway and motorway between Funen and Sprogø, with a navigational clearance of 18 m. The bridge is built from concrete elements and consists of fifty-one 110-m bridge spans, and twelve 82-m spans. Each span consists of a 24-m wide road girder and a 12-m wide railway girder. The West Bridge is Europe's longest

combined road and rail bridge and was completed in 1995.

- The East Tunnel: An 8-km rail tunnel between Zeeland and Sprogø, parallel to the East Bridge. 7.4 km of the 8-km tunnel is bored and the rest is cut-and-cover. The tunnel consists of two parallel tubes with an internal diameter of 7.7 m and a centre-line distance of 25 m. The tubes are connected by 31 cross passages each with a diameter of 4.5 m. The greatest track depth below sea level is 75 m. The tunnel is Europe's second longest submarine tunnel, and since its completion in autumn 1996, Great Belt A/S, and Danish State Railways (DSB) have been carrying out test programmes.

Work on the Great Belt Fixed Link began in 1988, and the rail link (the East Tunnel and the West Bridge) will be officially inaugurated for passenger trains on 1 June 1997. However, freight trains will begin crossing the Link on 6 April 1997. The East Bridge road link will open to traffic in the summer of 1998.

Financing and Repayment

In principle, the Fixed Link must be paid for by users. From the outset, it was important that the cost should not fall on taxpayers in general, but only on those using the Link.

Railway users will pay the costs through ticket purchase, as is the case with the present crossing by ferry. However, for Danish motorists, the concept of a road toll is something of a novelty because tolls have never been levied previously on any stretch of motorway or road in Denmark.

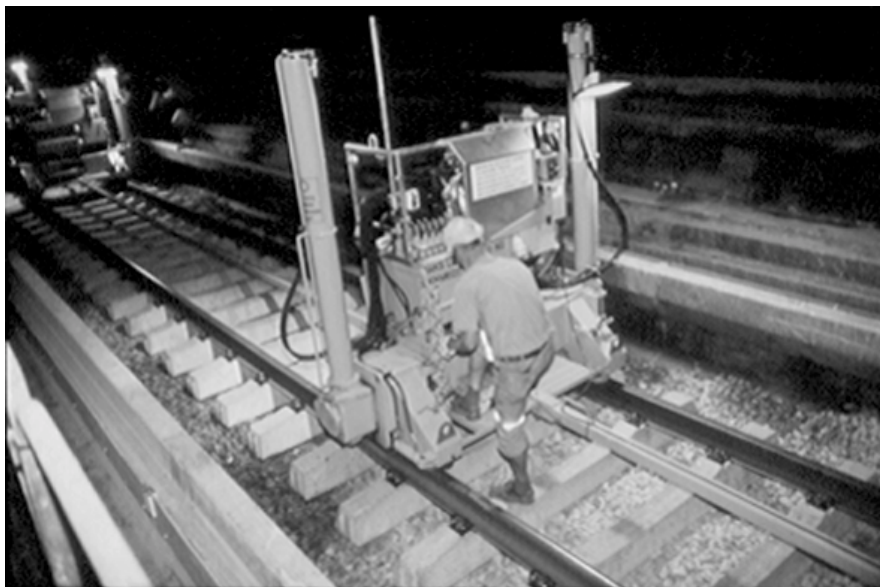
To finance the project, Great Belt A/S raised loans in Denmark and on international markets. The project budget is Dkr21.6 billion (\$3.7 billion) at January 1988 prices. Repayment will commence on completion of the Link when the company starts receiving revenue from tolls. When the rail and road links open in 1997 and 1998, respectively, the cost to both DSB and motorists for using the Fixed Link will be 20% less than expected when the project began. This became clear when the political parties behind the project amended the structure of DSB, as well as the original Public Works Act. This new agreement vests ownership of the railway link in Great Belt A/S, with DSB leasing the link from Great Belt A/S. The new Danish Railway Board will be responsible for operation and maintenance of the rail link. The Board will lease the right to use the rail link to DSB and other operators on behalf of Great Belt A/S.

DSB will rent the railway link at an annual charge of Dkr525 million, except in 1997 and 1998, when the charges will be Dkr84 and 129 million, respectively. The amount will depend on traffic volumes and is subject to review no later than the end of 2000.

Payment is divided into fixed and variable amounts for both passenger and goods transport. The variable payment is intended to ensure that Great Belt A/S



The East Bridge will be the world's second longest suspension bridge on its completion in 1998. (Great Belt A/S)



Laying rail tracks in East Tunnel

(Great Belt A/S)

receives a higher payment if train traffic volumes increase more than forecast. Conversely, Great Belt A/S will receive lower payment if the Link is used less than anticipated.

The annual charge of Dkr525 million paid by DSB is 60% less than envisaged in the original Public Works Act, which assigned ownership of the railway link to DSB.

Motorists using the road link will pay 20% less than stipulated in the original Act. The one-way toll will be Dkr200 for private cars and small vans, Dkr300 for campers and trailers, Dkr400 for trucks under 10 m and Dkr640 for trucks over 10 m.

As a result of the lowered prices and increased traffic volumes, the total debt will be repaid in 35 years.

Future of Great Belt

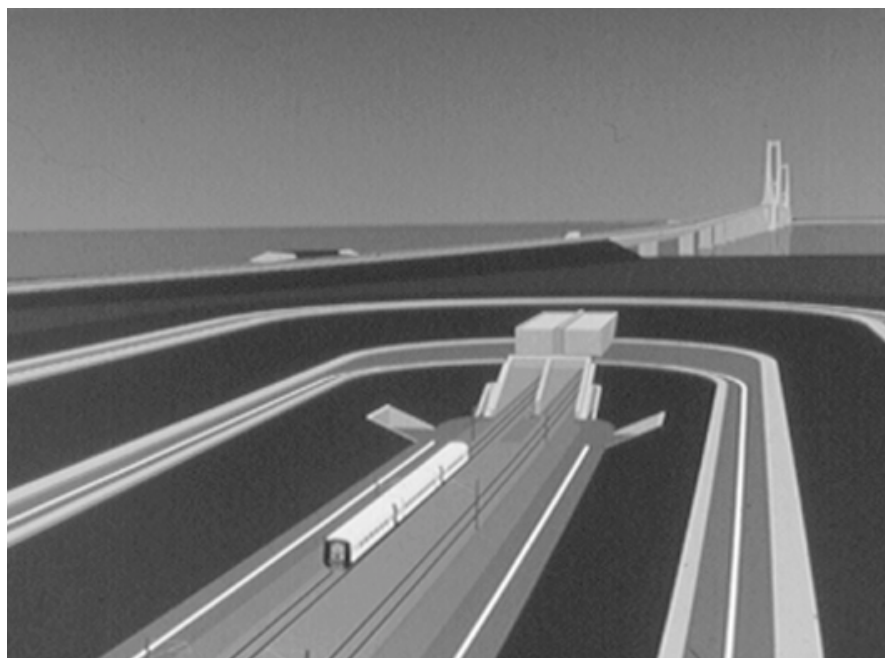
One of the most noticeable results of the Fixed Link will be a significant reduction in travel times. Crossing by railway will be cut from 60 minutes to 7 minutes, while travel by car will be cut from about 90 minutes to 11 minutes. Thanks to the time reductions, the number of trains and cars crossing the Great Belt is expected to be twice today's volume. In 1997, a daily average of 26,000 train passengers are expected to cross the Link. When the road link opens in 1998, a daily average of 16,000 cars is expected.

Great Belt A/S is currently preparing its future operational structure, which will be divided into four functions: a technical department responsible for maintaining and servicing the road link; an economics department in charge of data processing, personnel and revenue administration; a finance department responsible for debt repayment; a management secretariat handling administrative and marketing functions.



The West Bridge is a low motorway and railway concrete bridge.

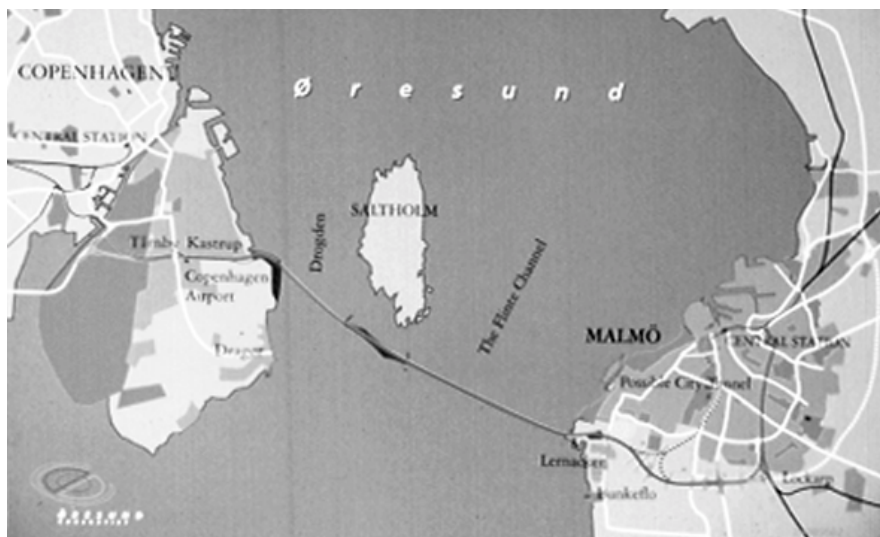
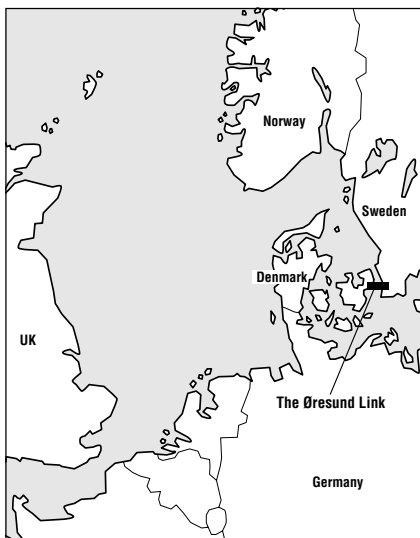
(Great Belt A/S)



Tunnel portal on island of Sprogø, linking West Bridge with East Tunnel and East Bridge

(Great Belt A/S)

Part 2. The Øresund Fixed Link



Øresund Fixed Link joining Denmark and Sweden

(Øresundskonsortiet)

The railway and motorway fixed link across the Øresund Strait is a joint Danish-Swedish project to create easy access between the two nations. The giant project will be financed by users. Construction of the Fixed Link across the Øresund Strait between Denmark and Sweden is well under way with the aim of improving transport connections between the two countries, strengthening cultural and economic cooperation. It is expected to stimulate integration of the Øresund region, paving the way for successful competition with Europe's other major regional centres.

The Fixed Link is one of Scandinavia's largest infrastructure investments—the budget for the coast-to-coast link is DKr13.9 billion at 1990 prices. The Link between Copenhagen and Malmö will be financed by international loans, guaranteed by the two governments and is to be repaid by the users—motorists, freight operators and railways—crossing the Link after it opens in 2000.

The client for the coast-to-coast link is the Danish-Swedish company, Øresundskonsortiet, a joint venture between the Danish state-owned company, A/S Øresund, and the Swedish state-

owned company, SVEDAB. A/S Øresund is also the client for the land works in Denmark, while SVEDAB is the client for the Swedish land works.

The 16-km Link consists of a double-track railway and a four-lane motorway, carried by bridge and tunnel. The financing has been structured so road users will shoulder the major burden of the railway link construction costs. This solution will allow the railway to take a significant share of the expected increase in freight and passenger traffic, thereby reducing negative effects of the car on the environment.



All passenger trains crossing the Øresund Fixed Link will stop at a new station in Copenhagen International Airport (Great Belt A/S)



Tunnel portal on Danish coast

(Great Belt A/S)



Computer image of Øresund double-deck bridge

(Øresundskonsortiet)



Tunnel element factory under construction with large floating basin in foreground
(Øresundskonsortiet)

Regional Economies

Imports and exports between Denmark and Sweden account for more than 10% of each country's foreign trade and there has traditionally been extensive economic cooperation between the two countries. In addition, a significant part of Denmark's trade with other Nordic countries occurs via Sweden, and Denmark itself is an important transit route for Scandinavian trade with Europe.

The Øresund region has an annual GNP of DKr500 billion and is poised to become an economic hub within Europe. For comparison, the combined Swedish and Danish GNP totals DKr2400 billion. Measured in GNP terms, the Øresund region is the eighth largest in Europe, ranking fifth in terms of educational and research institutions. As an air traffic hub, it is sixth in Europe.

The total urban population of the area is 2.3 million, expanding to 3.2 million if the population in the surrounding areas is included. The overall work force is 1.5 million.

Combined Road and Rail Link

The road and railway link between the Danish and Swedish coasts will extend for approx. 16 km. An artificial peninsula has been built off the Danish coast at Kastrup, along with an artificial island south of Salholm, in the middle of the

Øresund Strait.

A 3.51-km immersed tunnel for trains and vehicles will be built between the peninsula and the island because a bridge is not acceptable due to the proximity of Copenhagen International Airport. Traffic will emerge from the tunnel onto the 4.05-km island and continue on a 7.8-km double-deck bridge with cars on the upper deck and trains on the lower deck. At present, Øresundskonsortiet has concluded contracts for 85% of the coast-to-coast works. The contracts for the railway and other joint coast-to-coast installations will be signed in 1997.

Major environmental impact studies were carried out to achieve a design providing the greatest consideration and respect for the environment—both during construction and after the Link's completion.

In particular two objectives have been observed:

- The Fixed Link may not affect the flow of water in and out of the Baltic Sea (Zero Solution).
- The link may only create conditions detrimental to the environment near the construction area for a short period.

The project has been modified continually to achieve these two objectives. Blockage of the water flow has been reduced significantly and the need for compensation dredging has been dramatically minimized. However, some compensation dredging will still be needed to achieve the Zero Solution. Computer models are being used to calculate the extent of dredging.



Artificial island under construction

(Great Belt A/S)

Financing and Repayment

The financing of the Øresund project is based on the user-pays principle. In practice, construction and other costs during the construction period are being funded by loans from capital markets to be repaid by tolls levied on users of the coast-to-coast link. The income from the tolls will be used to pay for the construction of both the coast-to-coast section and the land works.

The loans are jointly guaranteed by the Danish and Swedish governments. This arrangement, which is rare in capital markets, is due to Øresundskonsortiet's Standard and Poor's Triple A credit rating, which helped secure very favourable terms.

The project economics are influenced by three factors: construction costs, traffic revenues, and interest rates. All three are subject to varying degrees of uncertainty, partly due to the project's extended time frame. Øresundskonsortiet's November 1995 budget set construction costs at Dkr13.9 billion (1990 prices). The budget incorporates the bids for the four major construction contracts for the tunnel, dredging and reclamation, the high bridge, and approach bridges, accounting for about 85% of the direct total construction costs. The contracts for the railway and toll facilities will be signed in the spring and summer of 1997, respectively.

In addition to the actual construction costs, the budget incorporates all costs associated with design, monitoring, administration, etc. However, interest during the construction period has not been included.

Traffic revenue derives partly from a fixed, annual payment of Dkr300 million by the Danish State Railways (DSB) and Swedish railway operators, including the Swedish State Railways (SJ), and partly from tolls from cars, buses and heavy vehicles (HGVs).

Øresundskonsortiet's budget is based on an annual traffic forecast in 2000 of 3 million passenger cars, 560,000 HGVs and 60,000

buses, corresponding to an average of approx. 10,000 vehicles per day.

The revenue from the road link is estimated at Dkr970 million during the first year (1990 prices), based on the traffic forecast and tolls equivalent to the ferry charges in 1990. The tolls will be indexed to inflation.

The traffic volume is expected to increase 1.7% annually on average in the first 20 years. The average real interest—the actual finance cost adjusted for inflation—is expected to amount to 4%, both for the construction period and for the ensuing operational period. Both the actual interest and real interest are likely to fluctuate over the years, but the 4% assumption is expected to be a realistic average over the long term.

Approximately 20% of the project's revenue derives from the railway with the remainder divided almost equally between cars and HGVs/buses.

Based on the above, Øresundskonsortiet can repay all loans 26 years after the Link opens. This calculation includes operating costs for administration, maintenance, and dividends to parent companies (SVEDAB and A/S Øresund). At present, this is expected to be Dkr195 million to each company calculated at 1990 prices from the first year of operation (2000).

The dividends will ensure that the loans for financing the land works will be amortized roughly in line with the debt. When all debts have been repaid, operational profits will accrue to the two governments. ■

Øresund Fixed Link Contractors

Øresundskonsortiet received the first tenders for major contracts in March 1995 when bids were submitted for the dredging and reclamation works in Øresund, and for the tunnel.

In July 1995, the contract for the dredging and reclamation works was awarded to Øresund Marine Joint Venture. The contract sum is about Dkr1.4 billion (1995 prices). Øresund Marine Joint Venture is a joint venture by Per Aarsleff A/S of Denmark, Ballast Nedam Dredging of the Netherlands and Great Lakes Dock and Dredge of the USA. The contract for the tunnel was awarded to Øresund Tunnel Contractors also in July 1995. The contract sum is about Dkr3.8 billion (1995 prices). Øresund Tunnel Contractors is a joint venture by NCC AB of Sweden, Dumez-GTM SA of France, John Laing Ltd., of the UK, E. Pihl & Søn A/S of Denmark and Boskalis Westminster bv of the Netherlands.

Initial construction work began during October 1995 when the dredging vessel *Chicago* started work for Øresund Marine Joint Venture in Flinterenden, the eastern navigation channel.

Øresund Tunnel Contractors has built a concrete plant in the Port of Copenhagen. Segments for the immersed tunnel will be cast here before towing to the tunnel alignment in Drogden, between Copenhagen Airport and the artificial island. The first casting was in December 1996, and the first element will be towed out in the spring of 1997.

In November 1995, the contract for the bridges was awarded to Sundlink Contractors HB. The contract sum is approx. Dkr5.3 billion (1995 prices). Sundlink Contractors HB is a joint venture by Skanska AB of Sweden, Højgaard & Schultz A/S and Monberg & Thorsen A/S of Denmark, and Hochtief AG of Germany.

The contract includes the double-deck elevated bridge as well as the approach bridges. The elevated bridge will be a 1092-m cable-stayed bridge with a 490-m main span and two side spans. The eastern and western approach bridges will be 3739 and 3014 m, respectively.

Sundlink Contractors started casting the caissons for the pylons in Malmö Harbour in July 1996.

Nils Francke

Niles Francke is PR Officer at Øresundskonsortiet and Great Belt A/S. Prior to this appointment, he worked as a newspaper journalist for 10 years.

