
FIXED LINK ACROSS FEHMARNBELT

Ministry of Transport, Denmark



Financial Analysis

June 2004

FIXED LINK ACROSS FEHMARNBELT

Financial Analysis

June 2004

**The Ministry of Transport
Frederiksholms Kanal 27
DK-1220 Copenhagen K
www.trm.dk**

**Supported by:
The European Commission**

PREFACE

This report has been carried out by Sund & Bælt Holding A/S for the Danish Ministry of Transport.

The report has been presented to the German Ministry of Transport, Building and Housing.

The studies have been supported financially by the European Commission through the TEN-T programme.

The report is available in a Danish version as well.

Ministry of Transport, Denmark

June 2004

TABLE OF CONTENTS	PAGE
INTRODUCTION	1
1. SUMMARY	3
2. FINANCIAL ANALYSIS	6
2.1 Background and objective	6
2.2 Construction budget	7
2.3 Traffic	9
2.4 Tolls, railway payment and estimated revenues	10
2.5 Operating and maintenance costs	13
2.6 Result of April 2004 calculations	14
2.7 Sensitivity analysis of Base Case assumptions	15
2.8 "Borderline" cases and sensitivity calculations	16
2.9 Conclusion of the financial analysis	19
Appendix I: General assumptions in the financial calculations	21
Appendix II: Operating and maintenance costs of a fixed link across Fehmarn Belt	22
Appendix III: Table over revised operation and maintenance costs	29
REFERENCES	30

INTRODUCTION

In June 1999, the first financial analyses on a Fehmarnbelt Fixed Link were reported to the Danish Ministry of Transport and the German Bundesministerium für Verkehr, Bau- und Wohnungswesen in the report: "Economic and Financial Evaluation of a Fixed Link across the Fehmarn Belt, COWI-Planco, June 1999".

The report contains the results of the financial calculations for 8 different technical solutions and for two different financing models one is the so-called BOT model (Build, Operate and Transfer), under which a private enterprise is granted concession to build, finance and operate the bridge for 30 years and eventually transfer it to the governments free of charge, while the other is and a state-guaranteed model similar to the one applied to the Great Belt and Øresund Fixed Links. In the state-guarantee model, an interstate company will undertake to build, finance, operate and own the fixed link.

As a follow up on the "Enquiry of Commercial Interest" (the ECI) completed in 2002, additional financial analyses have been made on a cable stayed bridge across Fehmarnbelt given that the participants of the ECI concurred that this technical solution was the most advantageous one. The results from the ECI were published in the report: "Fehmarnbelt, An infrastructure Investment, Finance and Organisation, June 2002".

Once again, the analysis were conducted on both a BOT model and a state-guarantee model. The calculations showed that a state-guarantee model would be the economically most advantageous solution for the two governments, as the private sector demanded considerable state grants in return for assuming the economic risk associated with the project.

Given that the participants of the ECI had pointed out that the basis for making a decision contained a number of flaws, an update of the traffic forecasts was initiated as was an analysis of the railway sector's ability to pay. These analyses were concluded in the spring of 2003 together with the new financial calculations and published in the report "Financial analysis, traffic forecast and analysis of railway payment, Summary report, May 2003". The financial analyses dealt with the aspects of a cable stayed bridge financed under a BOT model and a state-guarantee model respectively.

Subsequently adjustments to some of the previous assumptions in the financial analyses have been made. In consequence of that it has been found relevant to update the financial analysis.

Primarily it concerns a revision of the operation and maintenance costs carried out on the basis of the experience from and the expectations to operation and maintenance costs in the Great Belt Ltd. and the Øresundsbro Konsortiet.

The general assumptions for the financial calculation have been stated in Appendix I and documentation for the new operation and maintenance costs has been quoted in Appendix II. In Appendix III the detailed operation and maintenance costs are stated.

1. SUMMARY

In 1999 the results of the Feasibility Studies of the Fehmarnbelt Fixed Link Project were reported to the Ministries of Transport of Germany and Denmark. The studies included financial calculations for 8 different technical solutions and for two different financial models: The BOT-model (Build, Operate, Transfer) and the State Guarantee Model.

In 2002 as part of an Enquiry of Commercial Interest (ECI) additional financial analyses have been made on basis of the "Cable Stayed Bridge" solution which was seen as the most advantageous solution.

In May 2003 new financial analysis were published on basis of an update of the traffic forecasts and a new analysis of the railway sectors ability to pay.

The ongoing discussions of the possible realisation of the project have revealed a need for an adjustment of some of the assumptions in the previous financial analyses.

Compared with the 2003 calculations, assumptions in the new financial analyses (labelled April 2004) have been changed as follows:

- Opening year changed from 2012 to 2015
- Construction budget is increased by 135 m EUR (2003 prices)
- Reduction of operating and maintenance costs as well as re-investments to an average of 54 m EUR annually (2003 prices)
- Real interest rate reduced to 3.5 %
- Traffic growth rates of 1.7% per year in the period 2015-2039 and no traffic growth hereafter.

The opening year has been changed, since it is no longer realistic that a Fehmarnbelt Fixed link will open in 2012. Instead, it is assumed that construction works commence in 2008 and conclude by the end of 2014.

Fixed Link across Fehmarnbelt

Given the uncertainty of the construction budget for this type of project, the budget has, out of prudence, been increased by 135 m EUR. The total available reserves thus amount to approximately 675 m EUR.

Based on the experience from and estimates for the operation and maintenance costs of the Great Belt and Øresund Fixed Links (including reinvestments), the operation and maintenance costs incurred by the Fehmarnbelt Fixed Link are estimated to amount to a total of 54 m EUR (2003 prices) annually on average during the first 40 operational years.

Based on the trends within the international loan markets during the past 10 years, provisions have been made for a lower real interest rate than the 4% applied in previous financial analyses. The real interest rate in this scenario has thus been reduced by 0.5% to 3.5% p.a.

In previous forecasts, traffic volumes were assumed to grow throughout the debt payback period, but out of prudence, growth rates have now been calculated to peter out after 25 years, which means that traffic volumes will only grow during the period from 2015 and up to and including 2039.

Analyses have only been made on a cable stayed bridge with 4 car lanes and 2 railway tracks financed by state-guaranteed loans raised on the international loan market; in other words, a state-guarantee model as known from the Great Belt and the Øresund Fixed Links.

The changes in assumptions mentioned above result in the following changes in the debt payback periods.

Table 1.1: Changes in the Fehmarnbelt project debt payback periods

Years	Traffic Scenario A		Traffic Scenario B	
	Change	Debt payback period	Change	Debt payback period
Base Case, February 2003		37		33
Opening year 2015	-3	34	-2	31
Additional reserve	2	36	2	33
Reduced operating and maintenance costs	-7	29	-6	27
Reduced real interest rate	-2	27	-2	25
Stop of traffic growth in 2040	0	27	0	25
Base Case, April 2004	-10	27	-8	25

The debt payback period has been calculated at 25-27 years, which is 8-10 years less than calculated in (February 2003).

The effects of the changed assumption in the table above have been calculated in the shown order, and cannot be considered as partial effects relative to the (February 2003 calculations). This means that the summed up change in the debt payback period remains the same, irrespective of the order of assumptions. However, any change in the individual assumption will have a possible different effect if placed differently in the order.

From table 1.1 it can be seen that the most important change in the assumptions for the repayment period is the reduced operation and maintenance costs.

In order to assess the robustness of the project against other cases of the central parameters, a large number of sensitivity calculations have been completed.

The sensitivity calculations show that the project seems to be quite robust to changes in the central parameters, but also that a simultaneous change of the parameters in the same direction can influence the payback periods more significantly.

2. FINANCIAL ANALYSIS

2.1 Background and objective

In connection with the ongoing discussions of the possible realisation of the project, it has been established that some of the assumptions in the previous financial analyses need to be adjusted.

Compared with the 2003 calculations, assumptions in the new financial analyses (labelled April 2004) have been changed as follows:

- Opening year changed from 2012 to 2015
- Construction budget is increased by 135 m EUR (2003 prices)
- Reduction of operating and maintenance costs as well as re-investments to an average of 54 m EUR annually (2003 prices)
- Real interest rate reduced to 3.5 %
- Traffic growth rates of 1.7% per year in the period 2015-2039 and no traffic growth hereafter.

The opening year has been changed, since it is no longer realistic that a Fehmarnbelt Fixed link will open in 2012. Instead, it is assumed that construction works commence in 2008 and conclude by the end of 2014.

Given the uncertainty of the construction budget for this type of project, the budget has, out of prudence, been increased by 135 m EUR. The total available reserves thus amount to approximately 675 m EUR.

Based on the experience from and estimates for the operation and maintenance costs of the Great Belt and Øresund Fixed Links (including reinvestments), the operation and maintenance costs incurred by the Fehmarnbelt Fixed Link are estimated to amount to a total of 54 m EUR (2003 prices) annually on average during the first 40 operational years.

Based on the trends within the international loan markets during the past 10 years, provisions have been made for a lower real interest rate than the 4% applied in previous financial analyses. The real interest rate in this scenario has thus been reduced by 0.5% percentage points to 3.5% p.a.

In previous forecasts, traffic volumes were assumed to grow throughout the debt payback period, but solely out of prudence, growth rates have now been assumed to peter out after 25 years.

Analyses have primarily been made on a cable stayed bridge with 4 car lanes and 2 railway tracks financed by state-guaranteed loans raised on the international loan market; in other words, a state-guarantee model as known from the Great Belt and the Øresund Fixed Links.

In the following the key assumptions and the results of the financial analyses are presented. Section 2.2 provides an outline of the construction budget. Section 2.3 and 2.4 elaborate on the assumptions associated with revenues, i.e. road traffic, tolls and railway payments. Section 2.5 then provides an account of the estimated operation and maintenance costs, and section 2.6 and 2.7 present the results of the calculations. The presentation in section 2.7 includes a number of sensitivity calculations, to which the presentation of an optimistic and a pessimistic case scenario with sensitivity calculations are added in section 2.8. Section 2.9 provides a conclusion of the financial analyses. Appendix I provides an overview of the assumptions related to the financial calculations.

2.2 Construction budget

The total construction budget has been made on the basis of the comprehensive studies conducted by the consultants COWI-Lahmeyer and published in January 1999. The construction budget has subsequently been adjusted by Sund & Bælt based on the experience gained from the construction activities on the Great Belt and the Øresund Fixed Links.

Furthermore, the construction budget has, out of prudence, been increased by an additional reserve of 135 m EUR (2003 prices). The investment is estimated to be capitalised during the period from 2008-2014.

The construction budget contains the following items:

Table 2.1: Cable stayed bridge across Fehmarnbelt, construction budget (2008-2014)

m EUR	
Current prices	
Construction costs	3,561
Design and supervision	194
Project developer's organisation	168
Risk premium and insurance	146
Reserves	392
COWI-Lahmeyer report (1999)	4,461
Additional construction costs	125
Preparation of operations	48
Additional reserves	171
Construction budget, total	4,805

The financial calculations allow for the assumption that investments will be fully financed by state-guaranteed loans at a long-term real interest rate of 3.5% and an expected inflation rate of 2.5%.

The loan interest rate is thus estimated to be approximately 6.1%.

Furthermore it is assumed that the project will be subsidized by the EU Commission under the so-called TEN programme. These subsidies are estimated to account for 10% of the investment, corresponding to 481 m EUR in current prices.

The items "Risk premium and Insurance", "Reserves" and "Additional reserves" in the construction budget account for a total of 709 m EUR and can be considered to be the total project reserve.

It is estimated that out of this amount, approximately 34 m EUR will need to be used for insurance policies during the construction period, i.e. that the budget at present includes approximately 675 m EUR in available reserves.

Since, the construction budget has been prepared on the basis of information on construction costs of the Øresund Fixed Link, which in scope and nature are comparable with the Fehmarn Project, a reserve of 675 m EUR is estimated to be

sufficient for completing the project, provided that the technical or regulatory requirements for building the fixed link are not changed considerably.

During the construction period, interest will be accrued to the construction cost, and the table below shows a construction budget inclusive and exclusive of interest, in current prices, in real term 2004 prices and in net present value.

The complete construction budget for a Fehmarn Belt Fixed link can thus be presented as follows:

Table 2.2: Construction budget, cable stayed Fehmarnbelt Fixed Link opening in 2015.

	m EUR ²⁾	
	Excl. construction interest	Incl. construction interest ¹⁾
Current prices	4,805	5,663
Real term 2004 prices	3,987	4,714
Net present value ³⁾ 2004	3,080	3,618

1) State-guaranteed financing and with TEN-support of 481 m EUR in current prices

2) 1 EUR = DKK 7.4.

3) Discount rate of 6.1 %

2.3 Traffic

Revenues estimated in the financial analysis are calculated on the basis of the updated traffic forecast prepared by the FTC (Fehmarnbelt Traffic Consortium) and published in the report "Fehmarn Belt Forecast 2002, Final Report, April 2003". The forecast has been prepared on the basis of the two alternative scenarios (Traffic Scenario A and Traffic Scenario B) reflecting different expectations for cost development within road traffic, train traffic and air traffic.

The forecast has been prepared for 2015 and thus concurs with the estimated opening year of the Fehmarnbelt Fixed Link. The financial analysis assumes that road traffic on the fixed link will have a 4-year penetration period on the market – a so-called "ramp-up period". This means that 4 years will pass until the traffic is expected to reach the forecasted level.

The financial analyses thus assumes that traffic during the years 2015-18 will be 20%, 15%, 10% and 5% lower, respectively, than the forecasted traffic volumes.

The table below shows the traffic forecast, with and without "Ramp-up".

Table 2.3: Traffic forecast for the road traffic across the Fehmarnbelt Fixed Link, year 2015

Number of vehicles per day	Traffic Scenario A		Traffic Scenario B	
	FTC forecast	FTC forecast incl. Ramp-up	FTC forecast	FTC forecast, incl. Ramp-up
Passenger cars	7,496	5,997	7,786	6,228
Lorries	1,132	906	1,238	990
Buses	129	103	129	103
Total	8,756	7,006	9,153	7,321

Furthermore, it is assumed that the future traffic growth for the period 2015 up to and including 2039 is 1.7% per year.

Historically, traffic volumes across Fehmarnbelt (total ferry traffic at Rødby and Gedser) have been subject to major fluctuations. On average, traffic growth rates for passenger cars and lorries during the period 1970 – 2003 were approximately 3.7%. Against this background, an annual traffic growth rate of 1.7% can be considered a conservative estimate.

The table below illustrates the estimated traffic development during the period 2015-2019, including the ramp-up period as well as the underlying traffic growth rate of 1.7%.

Table 2.4: Estimated traffic development during the period 2015-2019

Number of vehicles per day	2015	2016	2017	2018	2019
Traffic Scenario A	7,006	7,570	8,152	8,751	9,308
Traffic Scenario B	7,321	7,912	8,520	9,146	9,791

Due to the "ramp-up" period it is assumed that annual growth rates in traffic will be rather high (6-8% per year) during the first 5 years after the opening. A similar pattern in traffic development has been observed after the opening of the Øresund Fixed Link, which has seen a recent increase in traffic growth rates of more than 10%.

2.4 Tolls, railway payment and estimated revenues

Fixed Link across Fehmarnbelt

The toll rates included in the financial analysis are identical with the ones applied in the traffic forecast, which were based on fares for the ferry service Rødby-Puttgarden in 2002. For passenger cars the list price of 47 EUR¹ (2002 prices, incl of VAT) has been applied.

As for lorries and buses, the calculated average price has been applied, i.e. less discounts.

Having been adjusted for inflation, the current ferry fare for a passenger car corresponds to 64 EUR (2015 prices). It is assumed, as mentioned above, that the Fehmarnbelt toll rates after the opening of the fixed link will equal the ferry fare. In this connection it should be noted that in accordance with applicable EU directives, passenger cars transported by ferry pay no VAT, whereas passenger cars crossing a Fehmarnbelt Fixed Link must pay VAT. The net result of this difference means reduced revenues for the fixed link equalling the VAT on payments made by passenger cars. When combining the Danish and German VAT rates into a rate of 20.5%, the reduction caused by VAT is approximately 11 EUR per passenger car. The revenues generated for the project are thus approximately 53 EUR (2015 prices) per passenger car.

The table below states the tolls assumed for the opening year. During the period from 2002 to 2015, an annual inflation rate of 2.5% has been included.

Table 2.5: Tolls for crossing the Fehmarnbelt Fixed Link

EUR, excl of VAT 2015 prices	April 2004 Calculations
Passenger cars	53
Lorries	262
Buses	289

In addition to the revenue generated from the road section, it is expected that the railway running on the Fehmarnbelt Fixed Link will generate revenues as well. These revenues are established on the basis of the report "Fehmarn Belt Fixed Link, Analysis of Rail Infrastructure Payment" prepared by TetraPlan in March 2003.

¹ For calculation purposes it is assumed that the discounts granted to short-term shopping trips are set off by the higher prices to be paid by drivers with vans and trailers.

Railway payments are calculated to equal the railway operator's direct savings in operating costs and infrastructure charges paid to the infrastructure managers when the traffic forecast for rail traffic are assumed to be the basis. The time gained as a passenger and carrier by not having to drive the approximately 160 km longer route via the Great Belt has not been priced and included in the calculations on railway payment.

Savings have been calculated at 55 m EUR and 45 m EUR in 2002 prices for Traffic Scenario A and Traffic Scenario B, respectively. In these calculations, railway payment has been set at an amount of 50 m EUR annually, which, when adjusted for inflation, corresponds to 69 m EUR in current prices in the expected opening year of 2015.

The table below illustrates the estimated project revenues for the opening year of 2015.

Table 2.6: Estimated revenues in 2015

Million euros 2015 prices	Traffic Scenario A	Traffic Scenario B
Passenger cars	116	121
Lorries	87	95
Buses	11	11
Total revenues, road	214	227
Railway	69	69
Total revenues	283	296

Revenues are believed to increase in the following years as a result of the assumed traffic growth on the road section. Furthermore, revenues in nominal prices are expected to increase in general as a result of the estimated inflation of 2.5% per year.

2.5 Operating and maintenance costs

Based on the experience of bridge operation on the Great Belt and the Øresund Fixed Links and the two operating companies' cost estimates for maintenance and extraordinary maintenance (reinvestments), Sund & Bælt has prepared an overview of the maintenance costs for the first 40 years of the operational period as regards a Fehmarnbelt cable stayed bridge solution. A detailed statement of the operation and maintenance costs can be found in Appendix II.

The two bridge companies' experience has provided the basis for the Fehmarnbelt project assumptions that annual basic operation and maintenance costs during the operational period will amount to 38 m EUR (2003 prices).

Øresundsbro Konsortiet has made a plan for the estimated extraordinary maintenance costs (reinvestments) of the cable stayed bridge during the first 40 operating years. The operation and extraordinary maintenance costs on the Øresund Fixed Link have been up-scaled costs to calculate the extraordinary maintenance costs likely to be incurred on the approximately 19 km long cable stayed bridge across Fehmarnbelt. Thus annual basic cost plus the estimated extraordinary maintenance costs equal the total operating and maintenance costs.

The February 2003 calculations estimated the average annual maintenance and operating costs to be 89 m EUR (2003 prices). At present, the average operating and maintenance costs are estimated to amount to an average of 54 m EUR annually over 40 years.

The distribution of the operating and maintenance costs over time is enclosed as an Appendix and from this paper it appears that assumptions have been made for a fixed annual cost and periodical extraordinary maintenance costs (including reinvestments) on the road and railway section. The extraordinary maintenance costs for the structure have been ascribed to the road section.

Since the two bridge companies do not have lengthy experience in operation and maintenance, a reserve of approximately 10% has been set aside in the 54 m EUR mentioned.

The basic operating and maintenance cost has been reduced compared to the previous financial analyses, but especially a more correct distribution of the additional maintenance costs over time will have an effect on the project debt payback period (see below).

2.6 Result of April 2004 calculations

The changes in assumptions mentioned above result in the following changes in the debt payback periods.

Table 2.7: Changes in the Fehmarnbelt project debt payback period

Years	Traffic Scenario A		Traffic Scenario B	
	Change	Debt payback period	Change	Debt payback period
Base Case, February 2003		37		33
Opening year 2015	-3	34	-2	31
Additional reserve	2	36	2	33
Reduced operating and maintenance costs	-7	29	-6	27
Reduced real interest rate	-2	27	-2	25
Stop of traffic growth in 2040	0	27	0	25
Base Case, April 2004	-10	27	-8	25

The debt payback period has been calculated at 25-27 years, which is 8-10 years less than calculated in 2003.

The effects of the changed assumption in the table above have been calculated in the shown order, and cannot be considered as partial effects relative to the 2003 calculations. This means that the summed up change in the debt payback period remains the same, irrespective of the order of assumptions. However, any change in the individual assumption will have a possible different effect if placed in another order.

From the table it appears that the change of the opening year means a 2-3 years shorter debt payback period given that the traffic level is approximately 5% higher in 2015 than in the previously estimated opening year of 2012 and thus higher for the entire operational period.

The higher capital investment means – the other assumptions remaining unchanged – a debt payback period extended by 2 years.

The reduced operating and maintenance costs reduce the debt payback period by 6-7 years. The operating and maintenance costs including a 10% reserve are assessed to be realistic on the basis of the experience gained from the Great Belt and Øresund.

The assumption of a lower real interest rate will naturally result in a lower debt payback period and in this case 2 years.

The assumption that traffic growth will stop after 25 years has no marked effect in this case, given that debts by that time more or less have been repaid.

2.7 Sensitivity analysis of Base Case assumptions

In order to assess the robustness of the project against other cases of the central parameters, a large number of sensitivity calculations have been completed. The tables below illustrate debt payback periods when the above Base Case, April 2004 is varied in terms of the most sensitive parameters – traffic growth and real interest rate. Such calculations, however, cannot provide facts on probability of the different scenarios.

Table 2.8: Sensitivity calculations for Base Case, April 2004, Traffic Scenario A

Debt payback periods, years	Traffic growth*	Real interest rate		
		3%	3.5%	4%
Railway payment: 50 m EUR annually				
Construction budget 4.7 bn EUR (incl. construction interest, 2004 prices)	2.2 % ann.	23	25	27
Operation and maintenance: 54 m EUR annually	1.7 % ann.	25	27	29
EU grants: 10 % of construction budget	1.2 % ann.	26	28	32

* Until 2040

The Sensitivity calculations show that the debt payback period for the Base Case under Traffic Scenario A assumptions will vary between 23 years and 32 years.

The 23 years are reached when assuming an annual traffic growth of 2% and a 3% real interest rate per year. In the opposite case the debt payback period increases to 32 years when assuming an annual traffic growth of 1,2%, and a real interest rate of 4% annually

Table 2.9: Sensitivity calculations for Base Case, April 2004, Traffic Scenario B

Debt payback periods, years	Traffic growth*	Real interest rate		
		3%	3.5%	4%
Railway payment: 50 m EUR annually Construction budget 4.7 bn EUR (incl. construction interest, 2004 prices) Operation and maintenance: 54 m EUR annually EU grants: 10 % of construction budget	2.2 % ann.	22	23	26
	1.7 % ann.	23	25	27
	1.2 % ann.	25	27	29

* Until 2040

Under Traffic Scenario B, the debt payback period varies between 22 years in the best case and 29 years in a situation of less favourable conditions. The longest and shortest debt payback periods appear in the same combinations of assumptions mentioned above under Traffic Scenario A.

2.8 "Borderline" cases and sensitivity calculations

In order to test the robustness of the project economy further, two so-called "borderline" cases have been made, the first one being an optimistic case, the second a pessimistic case in which a number of parameters (railway payment, construction costs and operating and maintenance costs) simultaneously develop in either in a positive or a negative direction. The probability of a process where all parameters move in the same positive or negative direction has not been assessed, but is estimated to be small.

The optimistic case allows for the following:

- Railway payment is increased by 20% from 50 m EUR per year to 60 m EUR per year.
- Construction budget is reduced by 10%, ie to 4.2 bn EUR (2004 prices, including construction interest).
- Operating and maintenance costs are reduced by 10% from 54 m EUR pr. year to 49 m EUR per year.

All other assumptions remain the same relative to the Base Case, April 2004 described above. In the optimistic case, traffic growth and the real interest rate vary in the same manner as under Base Case, April 2004.

Table 2.10: Optimistic Case, April 2004, Traffic Scenario A, opening year 2015

Debt payback periods, years	Traffic growth*	Real interest rate		
		3%	3.5%	4%
Railway payment: 60 m EUR annually (+20 %) Construction budget 4.2 bn EUR (-10 %) (incl. construction interest, 2004 prices) Operation and maintenance: 49 m EUR annually (-10 %)	2.2 % ann.	20	21	23
	1.7 % ann.	21	22	24
	1.2 % ann.	22	23	25

* Until 2040

Table 2.11: Optimistic Case, April 2004, Traffic Scenario B, opening year 2015

Debt payback periods, years	Traffic growth*	Real interest rate		
		3%	3.5%	4%
Railway payment: 66 m EUR annually (+20 %) Construction budget 4.2 bn EUR (-10 %) (incl. construction interest, 2004 prices) Operation and maintenance: 49 m EUR annually (-10 %)	2.2 % ann.	20	20	22
	1.7 % ann.	20	21	23
	1.2 % ann.	21	22	24

* Until 2040

According to the optimistic case, debts can be repaid within 20 years, when optimistic assumptions are combined with an annual traffic growth of 2,2% annually under Traffic Scenario B and a real interest rate of 3% during the entire project period. By contrast, it will last 24 years before debts are repaid if the annual traffic growth is 1,2% under Traffic Scenario A and the real interest rate is 4% during the entire project period.

In the pessimistic case, changes are made to the same parameters as in the optimistic case, however in the opposite direction. The changes are as follows:

- Railway payment is reduced by 20% from 50 m EUR to 40 m EUR per year.

Fixed Link across Fehmarnbelt

- Construction budget is increased by 10%, ie to 5.2 bn EUR (2004 prices, incl construction interest)
- Operating and maintenance costs are increased by 10% from 54 m EUR to 59 m EUR.

All other assumptions remain unchanged relative to the Base Case, April 2004 described above. Likewise traffic level and real interest rates vary in the same manner in this case as in Base Case, April 2004.

Table 2.12: Pessimistic Case, April, 2004, Traffic Scenario A, opening year 2015

Debt payback periods, years	Traffic growth*	Real interest rate		
		3%	3.5%	4%
Railway payment: 40 m EUR annually (-20 %)	2.2 % ann.	27	30	33
Construction budget 5.2 bn EUR (10%) (incl. construction interest, 2004 prices)	1.7 % ann.	29	32	37
Operation and maintenance: 59 m EUR annually (+10%)	1.2 % ann.	32	37	43

* Until 2040

Table 2.13: Pessimistic Case, April, 2004, Traffic Scenario B, opening year 2015

Debt payback periods, years	Traffic growth*	Real interest rate		
		3%	3,5%	4%
Railway payment: 40 m EUR annually (-20 %)	2.2 % ann.	26	28	30
Construction budget 5.2 bn EUR (10%) (incl. of construction interest, 2004 prices)		27	30	33
Operation and maintenance: 59 m EUR annually (+10%)		30	33	38

* Until 2040

The tables show that the pessimistic assumptions combined with a 4% real interest rate per year and an annual traffic growth of 1,2% will result in debt payback periods of 38 and 43 years for Traffic Scenario B and A, respectively. Debt payback periods of this magnitude require combined pessimistic assumptions with regard to both reduced railway payment, increased construction cost beyond the incorporated reserves, increased operation and maintenance costs beyond the incorporated reserves and very low growth in traffic op until the year 2040., On the other hand, the tables show that even in the pessimistic case is it possible to obtain favourable debt payback periods of 25-26 years if the annual traffic growth is 2,2% and real interest is 3% annually during the entire project period. In most of the pessimistic cases the debt payback periods exceed 25 years the assumption about stop for traffic growth after 25 years..

2.9 Conclusion of the financial analysis

In the April 2004 analysis, the debt payback period for the Fehmarnbelt project is financed 100% by state-guaranteed loans granted at a term of 25-27 years' maturity, depending on the underlying traffic scenario.

Compared with the calculations made in 2003, the new calculations show a debt payback period which is 8-10 years shorter.

The primary cause of this is the revised operating and maintenance costs calculated on the basis of experience from and expectations for this type of expenditure in Øresundsbro Konsortiet and the Great Belt A/S.

The other changes that all together cause a reduction of the debt payback period have partly been made to adjust the calculations according to the changes in

estimated start of operations and the real interest rate applied, and, partly out of prudence, to allow for a more flexible construction budget and a limited time span for traffic growth.

The sensitivity calculations show that the project is sensitive to changes in real interest rate whereas the project to a lesser extent is influenced by changes in the estimated traffic growth rates. The Base Case April 2004 thus shows that the debt payback period spans from 22 to 32 years.

The analysis also shows that the debt payback period will be strongly affected by changes simultaneously pointing in the same direction. The borderline scenarios provided illustrate the project's "borders" in the positive as well as the negative direction. The probability of a development in which all parameters are moving in the same positive or negative direction has not been assessed but is estimated to be small .

Appendix I: General assumptions in the financial calculations

Construction costs (m EUR in current prices)	4,805
Operating costs (m EUR in 2015 prices)	51
Real interest	3.5 %
Inflation	2.5 %
Discount rate	6.1 %
Depreciation	Historic acquisition value
Debt instalments	Annuities principle
Corporate tax	34 %
Traffic growth rate	1.7 %
Lending fees	1.5 %
Ramp-up-period – traffic	4 years
TEN-support (m EUR, current prices)	481 (10 %)
Railway payments (m EUR in 2015 prices)	69
Opening year	2015

Appendix II: Operating and maintenance costs of a fixed link across Fehmarn Belt

1. Introduction

In the previous financial calculations on the Fixed Link, a number of assumptions have been made on the operating, maintenance and reinvestment costs. These assumptions have been based on a report prepared as part of the feasibility studies: "Cost Analysis, Doc. No. 28110-T-N-2B-016, Rev. 01, dated November 9th 1999 and the memo "Fehmarn Belt Feasibility Study, Revisiting the O&M cost assessments", 31 July 2000, prepared by COWI-Lahmeyer at the request of the Danish Ministry of Transport.

The estimates on operating, maintenance and reinvestment costs are of great significance to the overall project economy, in view of the fact that these costs according to the above mentioned reports equals app. 2,5% of the annual constructions costs. Consequently, operating and maintenance costs made over a 30-year period will correspond to approximately 22% of the construction investments. Therefore, it is important to validate the assumptions regarding this topic on which the financial calculations are based.

This memo seeks to compare the operating, maintenance and reinvestment costs estimated by COWI-Lahmeyer on a 4+2 cable stayed bridge across Fehmarn Belt with the experience and estimates made by A/S Great Belt and especially Øresundbro Konsortiet after the opening of the two fixed links in 1998 and 2000, respectively.

COWI-Lahmeyer estimate

COWI-Lahmeyer's estimates on operating, maintenance and reinvestment costs are based on the principle that a large number of the repair and maintenance costs are fixed as a percentage of the investment costs of the components in question, whereas other costs are stated as fixed amounts. For instance, the annual maintenance and repair costs (reinvestment) of the bridge are assumed to be approximately 1% of the original investment annually, whereas the annual repair costs and, for instance, the VTS system expenses as well as user payment facilities are estimated to be 7%.

Fixed Link across Fehmarnbelt

Furthermore, expenses for administration, marketing, staff, insurance, and consultancy services, etc are stated as a fixed 11% of the other operating and maintenance costs.

All in all, COWI-Lahmeyer's estimate results in average annual operating, maintenance and reinvestment cost of a little less than DKK 720 million (2003 prices) over a 100-year period (lifetime). This equals 2.5% of the original construction investment.

These annual expenses are divided into different categories as stated in table 1.

Table 1: Annual operating, maintenance and reinvestment costs according to COWI-Lahmeyer estimate.

DKK million (2003 prices)	Cable stayed bridge (4+2)
Operating costs	245
Maintenance and reinvestment of installations, buildings, road surfaces and tracks	320
Maintenance and reinvestments of fixed installations	65
Reserve and risk premium	90
Operating, maintenance and reinvestments, total	720

Maintenance and reinvestment costs of the bridge structure, buildings, road surfaces and railway tracks are estimated to increase on a linear basis from DKK 0 to DKK 320 million annually during the first 15 operation years. After this period, costs are expected to stabilise at this level.

It is thus the opinion of COWI-Lahmeyer that in the first 40 years after opening of the bridge, the average annual reinvestment costs will be as stated in table 2 below.

Table 2: Average reinvestments, Fehmarn Belt, according to COWI-Lahmeyer estimates, periods after opening.

DKK million (2003 prices)	year 0-10	year 11-20	year 21-40	year 0-40
Reinvestments and maintenance of construction (excl. fixed installations)	105	290	320	260

Experience and expectations from Øresund and the Great Belt

The road section of the fixed link across the Great Belt was inaugurated in June 1998, which yields a mere 6 years of experience with operation and maintenance. The fixed link across Øresund was inaugurated in July 2000, which yields only 4 years of experience in operation and maintenance. The table below illustrates the two companies' actual operating and maintenance costs recorded for the preceding operating period.

Table 3: Actual operating and maintenance costs

DKK million (2003 prices)	1998	1999	2000	2001	2002	2003
A/S Storebælt	305	285	315	285	280	260
Øresundsbro Konsortiet				325	290	280

As seen in the table the operating and maintenance costs incurred by the two fixed links amount to less than DKK 300 million annually.

However, the operating and maintenance costs of the two fixed links are not immediately comparable, given that the two solutions differ considerably in a number of crucial points, e.g. technical design and organizational structure. The most significant differences are:

- Øresundsbro Konsortiet incurs considerable expenses on maintenance of the many technical installations in the immersed tunnel under Drogden.
- Øresundsbro Konsortiet incurs expenses on operation and maintenance of the railway on the Øresund Fixed Link and for administration of infrastructure, whereas these tasks (including maintenance of the East Tunnel and part of the West Bridge structures) at the Great Belt have been assigned to the Danish National Railway Agency.
- A/S Storebælt incurs significantly higher expenses on maintenance of the East Bridge, the fact being that a suspension bridge of such dimensions is more expensive to maintain than the cable stayed bridge across Øresund.
- A/S Storebælt incurs expenses on operation and maintenance of VTS systems, which are not installed on the Øresund Fixed Link.

Reinvestments

A fixed link across Fehmarn Belt in the form of a 4+2 cable-stayed bridge should be expected to have a number of technical and organizational similarities with the Øresund Fixed Link. The estimated reinvestment costs incurred by the Øresund Fixed Links can thus be used as a guideline to assess reinvestment requirements for a Fehmarn Belt Fixed Link whilst bearing in mind the differences between the two facilities, primarily as regards length and dimension of the structure.

The reinvestment costs of the Fehmarn Belt Link have been calculated on the basis of the estimates made by Øresundsbro Konsortiet. The estimates have been split into a road part and a railway part. The basis for the road part is the 4+2 cable stayed bridge (including structures) and the basis for the railway part is the railway on the entire link.

Reinvestments include expenses that are incurred in addition to operating and maintenance costs. Planning of reinvestments is made on the basis of the information provided by the executing contractors during the tender process in terms of lifetime for the individual components and on the general experience within operation and maintenance of similar structures, installations and equipment.

Reinvestments in the infrastructure itself, i.e. steel and concrete structures, have been included in the road section calculations, whereas the railway reinvestments only comprise the railway technical installations and equipment. In this connection it should be mentioned that within the period considered there is some uncertainty as to precisely when these reinvestments will become necessary.

Øresundsbro Konsortiet's reinvestment plan, as far as the road section is concerned, includes reinvestments every 5 years, starting 8 years after opening, i.e. 2008. As regards the railway section it is estimated that minor reinvestments will be required each year, starting in 2005. The reinvestment plan and the average annual reinvestment costs in the first to years of operation are stated in the tables below.

Table 4: Øresundsbro Konsortiet's reinvestment plan (road section) the year after opening and up until operation year 40

DKK million 2003 prices	+8 yrs	+13 yrs	+18 yrs	+23 yrs	+28 yrs	+33 yrs	+38 yrs	Total
Road section	20	140	60	240	140	225	15	840

Table 5: Reinvestments on average per year, period after opening.

Fixed Link across Fehmarnbelt

DKK million 2003 prices	year 0-10	year 11-20	year 21-40	year 0-40
Road section	2	20	30	20
Railway section	2	15	15	10
Total	4	35	45	30

These average annual reinvestment costs of DKK 30 million must be added to the operating and maintenance costs amounting to a little less than DKK 300 million per year. The total operating, maintenance and reinvestment costs of the road section of the Øresund Fixed Link and the railway section thus constitute approximately DKK 330 million annually in the first 40 operation years.

The reinvestment plan for the Øresund Fixed Link can, based on the technical similarities considering the different lengths of the two structures, be transferred to Fehmarn Belt. This is done by a scale-up of Øresundsbro Konsortiet's estimated reinvestments at a 19:8 ratio, the bridge section of the Øresund Fixed Link being 8 km long and a bridge solution across Fehmarn Belt being approximately 19 km long. As far as the railway section is concerned, reinvestments should be scaled up at a 19:16 ratio, thus reflecting the relative lengths of the railway.

The scaled up reinvestment plan for Fehmarn Belt results in the following:

Table 6: The Fehmarn Belt reinvestment plan based on a scale-up of Øresundsbro Konsortiet's reinvestment plan (road section), year after opening until operation year 40

DKK million. (2003 prices)	+8 yrs	+13 yrs	+18 yrs	+23 yrs	+28 yrs	+33 yrs	+38 yrs	Total
Road section	45	330	145	570	335	530	40	1995

Fixed Link across Fehmarnbelt

Table 7: Average reinvestments per year, period after opening.

DKK million (2003-prices)	yrs 0-10	yrs 11-20	yrs 21-40	yrs 0-40
Road section	5	50	75	50
Railway section	5	15	15	15
Total	10	65	80	65

Based on Øresundsbro Konsortiet's current estimates for reinvestments required in connection with the road section and the railway engineering systems, upgraded to comply with the length of a fixed link across Fehmarn Belt, the annual reinvestments required will amount to approximately DKK 65 million.

Comparison between the COWI-Lahmeyer estimate and a reinvestment plan based on Øresundsbro Konsortiet's estimates.

The table below shows the estimated annual costs of a fixed link across Fehmarn Belt for reinvestments, operating and maintenance costs the first 40 years based on the COWI-Lahmeyer estimate and Øresundsbro Konsortiet's estimates for reinvestments required for the bridge section of the Øresund Fixed Link and the railway technical installations.

Table 8: Estimated annual costs of a fixed link across Fehmarn Belt for reinvestments, the first 40 operation years

DKK million (2003 prices)	year 0-10	year 11-20	year 21-40	year 0-40
COWI-Lahmeyer	105	290	320	260
Scale-up from Øresundsbro Konsortiet	10	65	80	65
Difference	95	225	240	195

The table shows that the reinvestments calculated on the basis of the above simplified scale-up of Øresundsbro Konsortiet's estimates on reinvestments in the road section and its railway engineering installations are considerably lower than the COWI-Lahmeyer estimate.

This difference in reinvestment costs naturally has a bearing on the total average annual costs.

Fixed Link across Fehmarnbelt

According to the COWI-Lahmeyer estimate, the average costs the first 40 operation years, when allowing for the development in reinvestment costs, is approximately DKK 660 million per year.

When considering the Great Belt and Øresund Fixed Link operating and maintenance costs of less than DKK 300 million and adding reinvestment costs in accordance with the scaled-up reinvestment plan from the Øresund Fixed Link estimates, the total average annual costs amount to approximately DKK 360 million or a little less than 55% of the COWI-Lahmeyer estimate. The differences in absolute figures are illustrated in the table below.

Table 9: Estimated annual costs of a fixed link across Fehmarn Belt including reinvestments as well as operating and maintenance costs the first 40 operational years.

DKK mill. (2003 prices)	year 0-10	year 11-20	year 21-40	year 0-40
COWI-Lahmeyer	505	690	720	660
Scale-up from Øresundsbro Konsortiet	305	360	375	360
Difference	200	330	345	300

It should be emphasized that both COWI-Lahmeyer and Sund & Belt's estimates on the operating and maintenance cost as well as the reinvestment expenses are associated with a some uncertainty, amongst others because of the project's actual level of development.

A detailed table containing the revised operation and maintenance costs can be found in Appendix III.

Appendix III: Table over revised operation and maintenance costs

MEUR – 2003-prices

Year	-8 2007	-7 2008	-6 2009	-5 2010	-4 2011	-3 2012	-2 2013	-1 2014	1 2015	2 2016	3 2017	4 2018	5 2019
Operating Costs	0	0	0	0	0	0	0	0	-38	-38	-38	-38	-38
Maintenance Road	0	0	0	0	0	0	0	0	0	0	0	0	0
Maintenance Rail	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	-38	-38	-38	-38	-38

Year	6 2020	7 2021	8 2022	9 2023	10 2024	11 2025	12 2026	13 2027	14 2028	15 2029	16 2030	17 2031	18 2032
Operating Costs	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38
Maintenance Road	0	0	0	-13	0	0	0	0	-95	0	0	0	0
Maintenance Rail	-1	-1	-1	-1	-1	-1	-3	-3	-3	-3	-3	-3	-3
Total	-39	-39	-39	-51	-39	-39	-41	-41	-136	-41	-41	-41	-41

Year	19 2033	20 2034	21 2035	22 2036	23 2037	24 2038	25 2039	26 2040	27 2041	28 2042	29 2043	30 2044	31 2045
Operating Costs	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38	-38
Maintenance Road	-42	0	0	0	0	-165	0	0	0	0	-97	0	0
Maintenance Rail	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3
Total	-82	-41	-41	-40	-40	-205	-40	-40	-40	-40	-137	-40	-40

Year	32 2046	33 2047	34 2048	35 2049	36 2050	37 2051	38 2052	39 2053	40 2054
Operating Costs	-38	-38	-38	-38	-38	-38	-38	-38	-38
Maintenance Road	0	0	0	-13	0	0	0	0	-95
Maintenance Rail	-1	-1	-1	-1	-1	-1	-3	-3	-3
Total	-39	-39	-39	-51	-39	-39	-41	-41	-136

Total DKK	Avg. DKK
-11,351	-284
-4,318	-108
-587	-15
-16,256	-406

REFERENCES

1. COWI-Planco, Economic and Financial Evaluation of a Fixed Link Across the Fehmarn Belt, June 1999.
2. Trafikministeriet, Femer Bælt-Forbindelsen, Forundersøgelser – Resumérapport, marts 1999.
(Dänisches Verkehrsministerium, Die Verbindung über den Fehmarnbelt, März 1999).
3. Fehmarnbelt Development Joint Venture, Fehmarnbelt, Finance and Organisation, June 2002.
4. Fehmarnbelt Traffic Consortium, Fehmarn Belt Forecast 2002, March 2003.
5. TetraPlan A/S, Fehmarn Belt Fixed Link, Analysis of Rail Infrastructure Payment, March 2003.
6. Trafikministeriet & Bundesministerium für Verkehr, Bau- und Wohnungswesen, Financial Analysis, Traffic Forecast and Analysis of Railway Payment, Summary Report, March 2003