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Steel Bridge Girders, Cost Optimization

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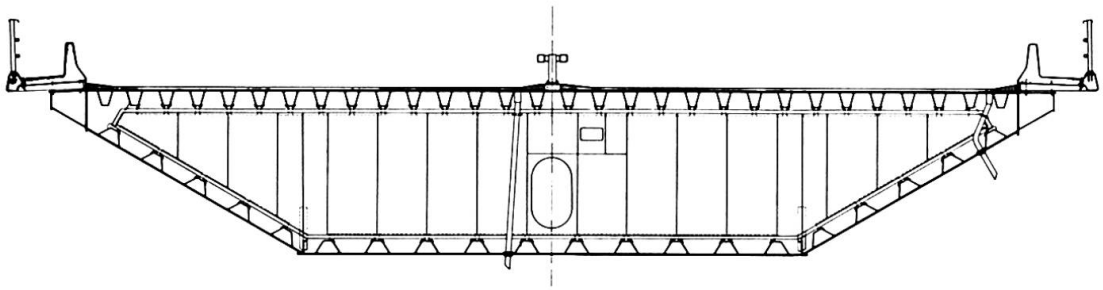
The steel box girder for the 3.3 km long bridge at Farø, Denmark has been made competitive by use of unusual design and construction methods.

A considerable saving has been possible by omission of painting of internal surfaces of the box girder, which amounts to more than 80% of the total steel surface. The corrosion protection of these surfaces is accomplished by ventilation by means of dehumidified air. The six dehumidification units represent low initial investment and are very economical in operation, each covering 5-600 m of bridge girder length. The external surface of the box girder to be painted has been reduced to a minimum by choice of a special cross section shape (refer to Farø bridge cross section below) with smooth exterior permitting an inexpensive initial painting cost and low maintenance.

The girder is composed of uniform steel panels welded by automatic welding, and a special assembly detail between exterior panels and diaphragms each 4 m has been detailed so as to require minimum of tight tolerance control during fabrication.

The box girder has been fabricated in a ship yard, all welded in full span sections each 80 m, and erected by simple lowering directly onto the pier tops. The girder continuity over full bridge length (1.6 km and 1.7 km) is subsequently established by field welding of box girders over the piers.

The bridge connection at Farø, which is part of European main highway E4, is presently under construction and is scheduled for completion Summer 1985.



Farø Bridge Cross Section

STEEL BRIDGE GIRDERS, COST OPTIMIZATION

Fabrication and maintenance costs for steel box girders may be optimized by:

1. Using identical or few types of similar panels.
2. Using simple panel connections for assembly of box cross sections.
3. Minimising the exterior surface area.
4. Corrosion protection of the box interior by dehumidification.

The steel box girders for the Farø Bridges were developed to satisfy the above criteria, and proved to be economically competitive in comparison with post-tensioned concrete box girders.

The internal corrosion protection scheme by circulation of dry air offers significant cost savings.

The dehumidification unit is based on the absorption principle and consist of readily available standard components. The steel surface is completely corrosion protected by relative humidities below 60%.

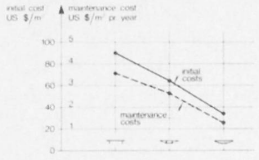
Dehumidification systems have been used in the Lille Bælt suspension bridge box girder since 1970, and the operating costs have been extremely low (approx. 1.5 US Cent per sq.m. per year). A similar installation will be used in the Farø Bridges, presently under construction in Denmark and scheduled for completion in 1985.

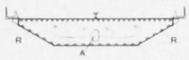
Owner: The Road Directorate, Denmark
Design and Supervision: Cowiconsult, Denmark
Fabrication and Erection: Monberg & Thorsen A/S, Denmark

Corrosion protection of external and internal steel surfaces

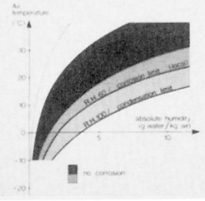
SURFACE AREAS	Girder Types		
A_c deck area	20 m/m	20 m/m	20 m/m
A_e external painted area	72 m/m	50 m/m	24 m/m
A_e / A_c	3.6	2.5	1.2
Protection: external area / internal area	painted / –	painted / dehumidified	painted / dehumidified

COSTS FOR CORROSION PROTECTION PR. m² DECK AREA



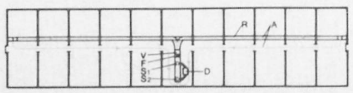


Relative humidity in box girder

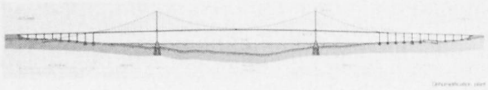


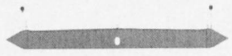
A	Air flow	F	Air filter
R	Hollow stiffening ribs serving as air flow ducts	D	Dehumidifying unit
		S_1, S_2	Fresh air/exhaust damper for ventilation
V	Fan		

Girdersection pr. air cirkulation plant 5 a 600 m



Lille Bælt Bridge 1970



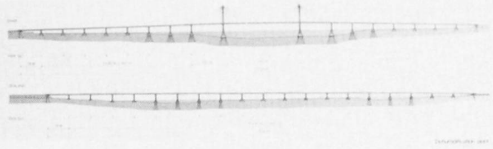


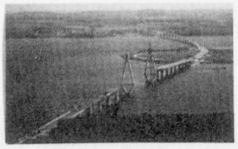
Steel box girder

Total length of girder	1.080 m
Total steel deck area	29.000 m²
Total steel weight in girder	12.000 t

Steel surface	Internal surface	External surface
Area	200.000 m²	42.000 m²
Corrosion protection	Dehumidification plant	Paint

Farø Bridges 1985





Steel box girder

Total length of girder	3.326 m
Total steel deck area	64.000 m²
Total steel weight in girder	23.000 t

Steel surface	Internal surface	External steel surface
Area	320.000 m²	76.000 m²
Corrosion protection	Dehumidification plant For each 500-600 m girder length	Paint
Initial cost	0.10 million US$	2.20 million US$
Maintenance cost	<0.01 million US$/year	0.08 million US$/year