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I

**The Farø-Bridges in Denmark: aesthetical considerations**

Considérations esthétiques sur les ponts Farø au Danemark

Farø-Brücken in Dänemark: Überlegungen bezüglich der Aesthetik

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**SUMMARY**

The political influence on the project and alternative solutions of two highway bridges in Denmark are mentioned. The development of the tender design was based on an aesthetical principle and on the respect for coastal scenery. An aesthetical evaluation is made of two alternatives proposed by tendering contractors. The author presents his reflections on the Danish system of tender and the working conditions of an aesthetical advisor.

**RESUME**

L'article mentionne l'influence des politiciens sur le projet et les variantes de deux ponts routiers au Danemark. Le concours de projets était basé sur des principes esthétiques et sur le respect du paysage côtier. Un jugement esthétique est porté sur deux variantes. L'auteur présente ses réflexions sur le système de concours au Danemark et sur les conditions de travail d'un conseiller en esthétique.

**ZUSAMMENFASSUNG**

Der Artikel bespricht den Einfluss der Politik beim Brückenbau anhand von zwei Varianten. Beim Wettbewerb mussten die Aesthetik und der Landschaftsschutz berücksichtigt werden. Der ästhetische Eindruck wurde anhand zweier Varianten ermittelt. Der Autor spricht über seine Eindrücke bezüglich des Wettbewerb-Verfahrens in Dänemark und beschreibt die Arbeitskonditionen eines Beraters in Aesthetik.



## 1. INTRODUCTION.

The E 4 motor road connects Haparanda, in Northern Sweden with Lissabon in the South. It passes through Denmark from Helsingør with the ferry connection to Sweden, to Rødby with the ferry connection to Germany. (fig. 1.)

The Farø-bridges shall carry this road across Danish domestic waters between Sjælland and Falster via the islet Farø, hence the name of the bridges. On the islet is an interchange with connection to the local road system serving the other islands in the region, in order that the motor road and the bridges may further needed development in the area.

Up to now the project is one of the largest projects in Denmark. The size of the project and the fact that the bridges are located on an international road endow it with national pride. The importance of both technical and aesthetical qualities of the structures of the bridges and the road alignment is indispensable and demands utmost attention.

The decennium, however, during which the project has been under way has in Denmark, as also in other countries, been characterized by both political and economical instability. The politicians, in search of objects for saving money and gaining votes have influenced the progress of the project causing:

- Review of prior decisions with regard to the alignment of the road.
- Analysis of stagewise execution of both the road and the bridges.

As a matter of fact the project has been the cause of debates in the Folketing right up to the afternoon of 14th May, when the contracts for execution of the project were signed.

The alignment for the bridges via Farø originated in 1963, from civil engineer P.L. Hee (fig. 2).

Work on the project commenced in 1970. Christiani & Nielsen was engaged by the Road Directorate as consultants in order to end up with a tender project.

## 2. HIGH OR LOW LEVEL BRIDGE:

A navigation channel is located close to the coast of Sjælland and the immediate conclusion was, that the bridge between Sjælland and Farø should be a high level bridge.

An early Christiani & Nielsen proposal substituted this high level bridge with a low level bridge combined with a dredged channel between Farø and the island Bogø (fig. 3). The proposal was good and revealed how an effort to solve functional problems with fantasy instead of traditionally, can succeed. Besides



Fig. 1 E4 In Denmark

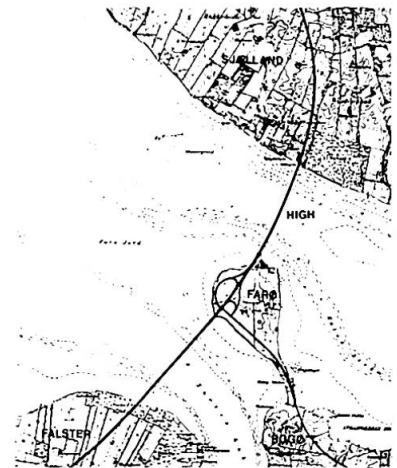


Fig. 2 Bridge alignment

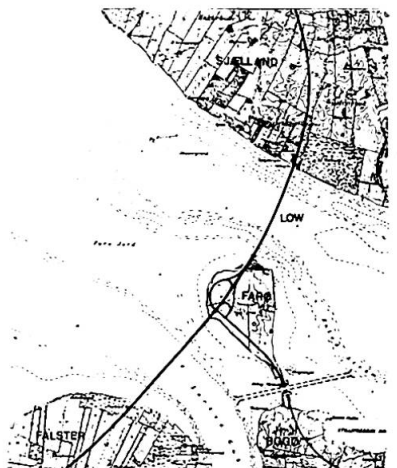


Fig. 3 C&N proposal

the overall cost of the project would be reduced. Such deviation is, however, often met with opposition from the establishment. So, such a chance for better technical and aesthetical qualities are often subdued, as it also happened in this case.

Let us compare a high level bridge with a low level bridge between Sjælland and Farø from an aesthetical point of view.

In general horizontal and vertical lines in a drawing on the drawingboard are dominant lines, which reveal the deviation and gradients of other lines in the drawing.

In the nature the trees indicate the vertical, whereas the horizontal can only be perceived where there is a watersurface.

In a coastal area where the watersurface is dominant the deviations from the horizontal will be revealed clearly. Harmonious longitudinal profiles across a watersurface are important. Viewing a stretch of water between two coasts, the spontaneous perception is that the depth is greater in the middle. The location of the navigation channel close to the coast of Sjælland causes an oblique, longitudinal profile for the high bridge. The level of the road over the coastline of Sjælland is 27 m and at the abutment at Farø 7 m. This is not spontaneously understandable for an observer and leaves the impression of an awkward, slanting bridge for which there is no direct, logical answer. Besides:

- The high level bridge is conspicuous in the coastal surroundings. (fig. 4).
- Going North, the more close you get to the coast of Sjælland the higher is the level of the road, which appears unusual, and the traveller on the bridge will hardly get in visual contact with neither land nor sea.
- The switchback effect is obvious.
- The low bridge does not interfere drastically with the coastal areas. (fig. 5)
- The traveller on the bridge will get in close contact with both sea and land giving him an exciting experience of the coastal scenery.
- The switchback feeling is eliminated.



Fig. 4 High level bridge.



Fig. 5 Low level bridge.

The aesthetical qualities of the low level bridge had, however, less political backing than the yacht clubs aversion against changing existing sailing conditions, which would be least curtailed by a high level bridge. So, a high level bridge it shall be.

### 3. TENDER DESIGN.

#### 3.1 Legislation.

In 1976 the Folketing passed legislation authorizing the execution of the Farø-bridges as two high level bridges, one between Sjælland and Farø and another between Farø and Falster, 1.6 km and 1.7 km long respectively.

The navigation span in the Farø-Falster bridge with a clearance, 260 m wide and 26 m high, carried by a cable-stayed structure, not previously built in Denmark.



### 3.2 Landscape.

Both fig. 6 and fig. 7 might give an idea of the beautiful and characteristic Danish coastal scenery, where the bridges are to be built.

High embankments built out in the water have often been introduced in order to minimize construction cost by reducing the length of the actual bridge construction. But not only do such embankments add alien elements to the façade of the bridge, they also destructively interrupt the continuity of the coastline.

The artificial, dominant shape of embankments is incoherent with the coastal scenery. Only by close co-operation with the environment authorities has it in the Farø project been possible to dispose of embankments, in spite of increased cost, to the benefit of the impression of a simple transition between land and bridge and of the present recreational value of the coastal area. It adds greatly to the simplicity and elegance of the bridges that there has been a mutual understanding on this question.

### 3.3 Pursuit of an Aesthetical Principle.

The statical solutions of a structure, considered by the engineer, implies the embryo for the development of aesthetical qualities in the final structure.

It soon became evident that in order to create the impression of the bridge connection between Sjælland and Falster as one continuous structure, it was necessary to bring about a coherence between the high level bridge from Sjælland to Farø and the approach spans to the cable-stayed spans of the Farø-Falster bridge. Their structures were to be alike.

In order to follow the same intention, uniformity should be accentuated by using the same material from coast to coast. The tender project assumed a re-inforced concrete construction. (fig. 6).

Also it was decided to use structural elements of uniform nature and to reduce their numbers to a minimum.



Fig. 6 Aerial view of tender project.

Out of these considerations evolved the principle of using the same bridge girder of constant height as the primary element of continuity, and the supporting structures, the piers and the pylons, as the secondary elements.

Naturally the design of the cable-stayed section of the Farø-Falster bridge was by far the most interesting, but it is also the most aesthetically important, single element of the bridge connection to solve. The pylons are prominent and dominant features of the structure. They are exposed to views from wide areas. (fig. 7).

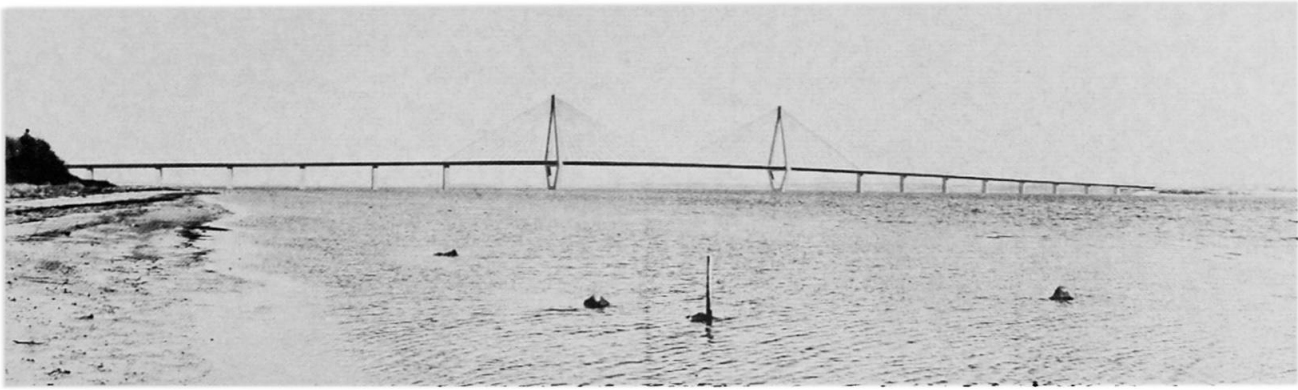


Fig. 7 Bridge Farø-Falster tender project.

As expert advisor for the cable-stayed section Christiani & Nielsen secured the co-operation of professor dr. ing. Fritz Leonhardt. The statical solution of the suspension of the bridge girder in the pylons was precious and furthering for the aesthetical qualities of this important detail. The bridge girder was suspended in stays and is, at the passage through the pylon, only stabilized by bearings, thus giving the structure elegance by the impression of the bridge girder floating freely through the pylons. (fig. 8 & 9).

The A shape of the pylon is chosen after an analysis of other types of pylons, such as center pylon, frame pylon and their suitability with regard to the arrangement of the stays i.e. suspension along the edge or in the center line of the bridge girder. The cross section of the bridge girder favoured the suspension in the center line.

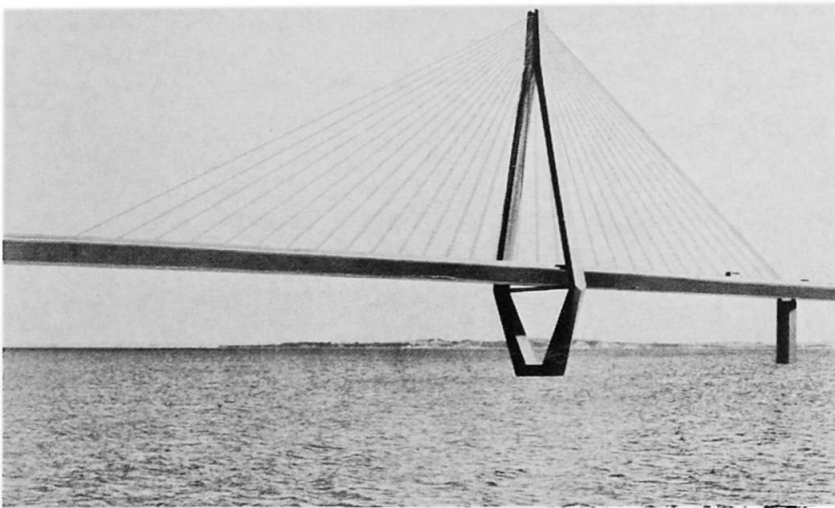


Fig. 8 Pylon of tender design.



Fig. 9 Detail.

The upper A-shape of the pylon was a suitable and also an economical solution compared with a center pylon, which of course would require a wider cross section of the bridge girder.

The upper part of the pylon is supported by the lower parts slanting legs, hereby reducing the dimensions of foundation, and by the same time in a simple manner establish the, in Danish waters, necessary provision of a sharp edge to break the ice, thereby reducing pressure on the pylon.

All piers are given a similar "ice knife" in their cross section. In order to follow the principle of simplicity the cross section of the piers is continued through the watersurface, instead of introducing a special icebreaking footing.





#### 4. FINAL DESIGN.

##### 4.1 Tender Results.

Tenders were opened on 1. November 1980. Amongst the alternative projects produced by the bidders, two were of special interest, due to their price. One was a re-inforced concrete construction and the other a combination of a superstructure in steel and a substructure in re-inforced concrete.

##### 4.2 Aesthetical Evaluation of Alternatives.

Both projects had another statical principle of the cable-stayed structure than that of the tender project. The pylon and the bridge girder were in both alternatives solidly built together.

The deviation from the statical principle of the tender project is destructive for the elegance of the structure. The continuity of the bridge girder is interrupted, and the impression, that the girder floats through the pylon has disappeared. From an aesthetical point of view an inconsiderate disposition.

The pylon of the concrete project (A) is apparently given a shape deriving entirely from technical demands without considerations of proportions, characteristics and contrasts. (Comparison fig. 10 & 11).

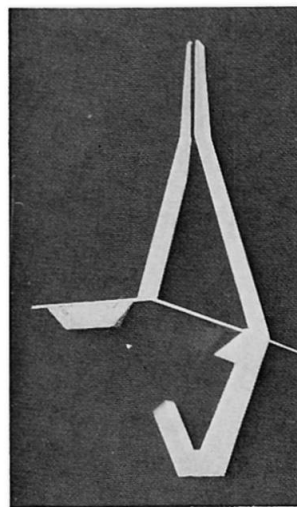
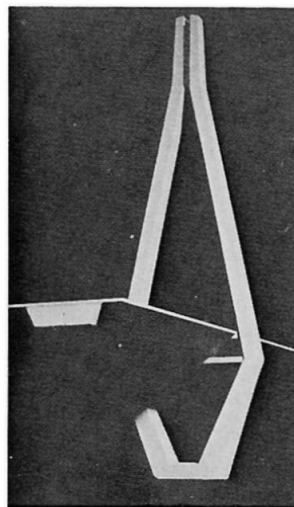


Fig. 10 Tender proj. Fig. 11 Project A

The clear separation of elements in the tender project, the supported and the supporting members, is destroyed. The girder becomes part of the pylon and vice versa.

Also the height of the pylon is reduced to 95 m compared with the tender projects 102 m. The height of the pylon is important with regard to monumentality and proportion in relation to the entire length of the bridge. (ref. fig. 7).

The pylon of the combined steel and concrete project (B) is divided in an upper steel section and a lower concrete section. This appears to be destructive for the coherence and shape of the most dominant element of the bridge connection. (Comparison fig. 12 & 13).

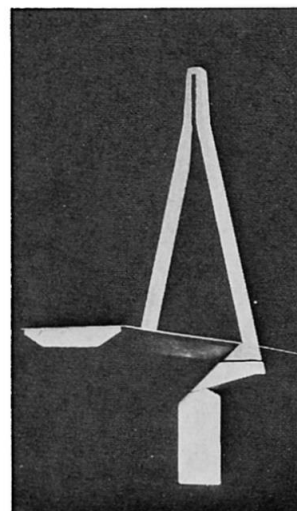
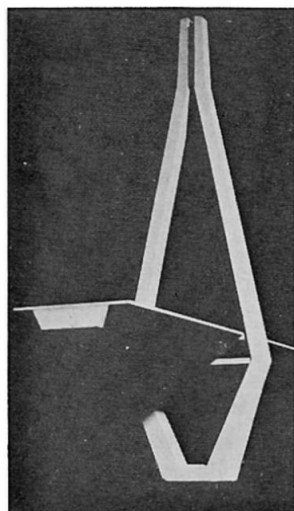


Fig. 12 Tender proj. Fig. 13 Project B

Also in this alternative the impression of the continuity of the bridge girder has disappeared, as well as the clear separation in the supporting and supported members of the structure.

The height of the pylon is reduced in this case to 92 m., so the same comments as stated for project (A) are relevant.

The use of different materials with different properties may look acceptable in a drawing, but their different nature and character may be less acceptable in reality.

Painting the steel to look like concrete or painting the concrete with the colour of the steel does not solve the problem. It is a too obvious falsification.

#### 4.3 The Chosen Design.

The bridges shall now be constructed as a combination of the two alternatives i.e. the superstructure with a box girder of steel and the substructure including the pylons to be constructed in re-inforced concrete. (Comparison fig. 14 & 15).

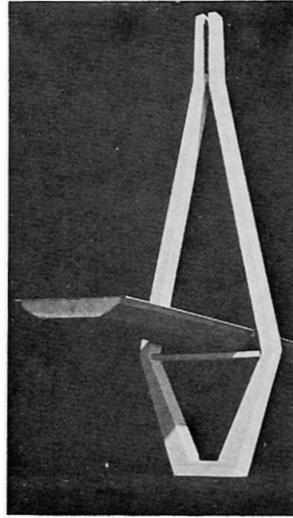


Fig. 14 Pylon Tender project. Steelgirder project B.

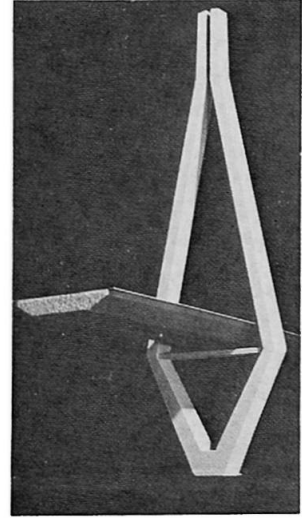


Fig. 15 Pylon proj. A. Steelgirder project B.

#### 5. REFLECTIONS.

It is apparent, that the Danish system of tendering, allowing for alternatives from the contractors - who have only comparatively short time for the design - might result in the abandonment of thoroughly studied aesthetical qualities, if money can be saved.

The arguments for technical qualities are not so easily disposed of, because they deal with realities, which can be proved, contrary to aesthetical qualities, which are of an abstract nature.

Working as an aesthetical advisor, my experience is, that unless arguments for aesthetical values can be combined with a good technical solution and acceptable economy, the chances of their influence will be small.

However, even if a solution is found which fulfils technical, economical and aesthetical aspects, it must be realized that such a solution may not be politically acceptable, and up till now there are, alas, too many examples of "selling out" of aesthetical qualities.

It appears, however, that people are increasingly interested in the more abstract values of life. In this respect, man made structures of any kind in any place are important parts of our environment. So, a carefull and thorough analysis of their aesthetical and environmental qualities appears to become indispensable.

We ought to consider more the importance of making structures in which we can take pride, and which will be enjoyable also for future generations.

How to convey this to our politicians and decision makers, so that they may act with integrity and responsibility ?



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