**Zeitschrift:** IABSE reports = Rapports AIPC = IVBH Berichte
**Band:** 82 (1999)

**Artikel:** Getting the balance right: the Øresund bridge: design concept
**Autor:** Nissen, Jørgen / Rotne, Georg
**DOI:** https://doi.org/10.5169/seals-62105

# Getting the Balance Right
# The Øresund Bridge - Design Concept

**Jørgen NISSEN**
Director
Ove Arup & Partners
London, United Kingdom

Jørgen Nissen is Director of the ASO Group, the bridge consultant to Øresundskonsortiet.

**Georg ROTNE**
Associate Professor
Royal Academy of Fine Arts
Copenhagen, Denmark

Georg Rotne is the ASO Group's architect.

## Abstract

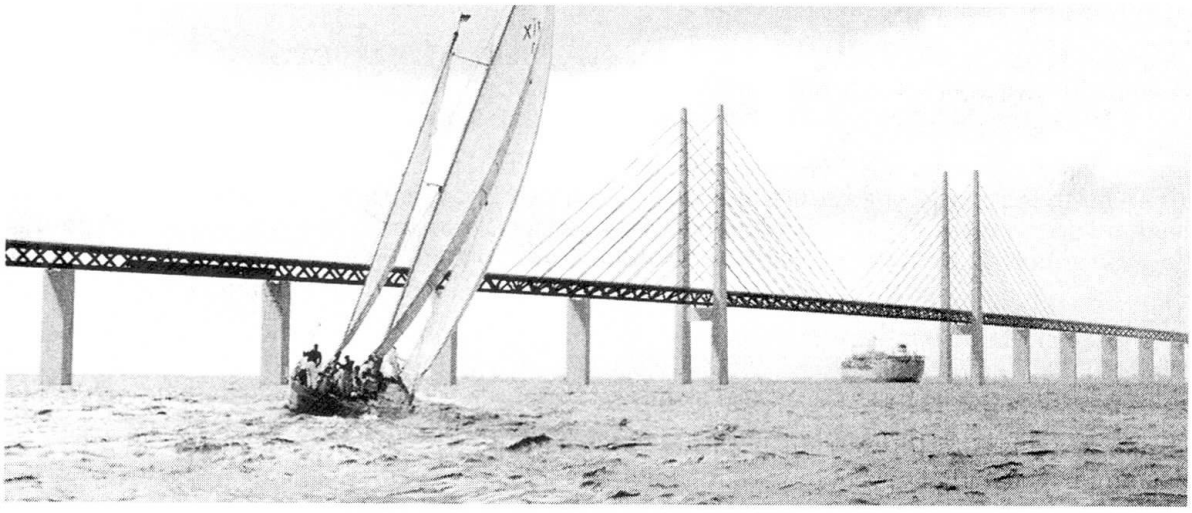
Vitruvius set the agenda: good architecture is about the proper balance of Firmitas, Utilitas and Venustas - or firmness, commodity and delight. And so during the Renaissance designs for bridges, as for buildings, aimed to meet this ideal.

With the invention of industrialised processes and new materials and technology, a new profession was created: the engineer. The new materials and technology were used in the building of bridges and other structures. Firmness in particular was the domain of the engineer; commodity was interpreted as function but more interest was shown in inventiveness and efficiency than in delight.

The first engineers built remarkable bridges of iron, and later of steel and reinforced concrete. They used a rational and economic design approach – form follows function – which worked hand in hand with the current belief in progress.

Following the end of the Second World War, an urgent need for new infrastructure meant that bridges, like other structures, became more and more mass-produced. Efficiency dominated; which left little room for inventiveness and experimentation.

Sometimes architects were involved in the design of the more prestigious bridges, but mostly in a secondary role. This has now changed. Architectural competitions are increasingly being held for bridges. Delight is firmly back on the agenda.



**The Øresund Bridge**

The Øresund Bridge is very long. Technical, functional and economic issues are critical. It includes approaches, where shorter spans are suitable and a much longer span over the navigation channel. The structure should appear as a whole and not a collection of parts; it should be economic for the approach spans as well as for the main span.

A small team of designers developed the design concept. A larger team, which also included the client and various public authorities, developed the tender design, and the contractor's team carried out the detailed design within a design and construct contract. And because it is very large, the client had divided the project into a number of contracts to be handled by different contractors, and different teams might therefore handle the final design. The continuity of the design process would thus be broken. In these circumstances, how is it possible to ensure unity and the proper balance of firmness, commodity and delight?

The right design would ideally be functional, economic and beautiful. Given the huge scale of the project, emphasis should be put on developing a consistent and robust design befitting the unique site.

It is often the relationship to its site that gives a bridge its special character. This bridge would stand in a seascape without any dramatic natural forms to set it against. The landscape on both sides is gentle and friendly, with small and rolling hills and curved coastlines where the land merges with the sea. The bridge rises gradually from the tunnel at the artificial island like from a hole in the sea. The Link would often be seen at a distance: from the shores, the sea and the air. Those travelling on the bridge would mostly see it at speed, but they could, given a suitable design, have exceptional views of the sea, the islands, the coastlines and the cities of Copenhagen and Malmö.

A small team of engineers and an architect, working alongside each other, created the competition design. They shared an approach to design that had been formed over some years as they worked together on a number of other bridge projects.

Our design strategy was to use a simple and straightforward design: to express function and structure in a direct way without unnecessary detail. We used well proven design concepts, materials and construction methods to create a strong and robust form, capable of safely being divided into smaller parts, which could be detailed by different contractors and still make a harmonious and coherent whole.

The form of the alignment is important for the experience of the journey across the bridge. We chose a curved alignment to give a more interesting journey across the Øresund.

We also decided to separate the road and the railway traffic on the whole Link, a decision that meant that the bridge would have two levels. The Link should provide a dual two-lane motorway and two tracks for high-speed passenger trains and heavy goods trains. Separating the traffic gives obvious operational advantages and flexibility. During lane closures, whether caused by accidents or maintenance, road traffic can be directed onto the other carriageway, and on the railway, crossovers can be placed freely. With the motorway carried at the upper level and the railway below it, users are also given ample comfort and security. Cars are separated from the high-speed trains and travellers can have free and excellent views of the Øresund.

We decided finally that the high bridge would be cable-stayed. For a two-level bridge, the most economical structure is to use steel trusses with diagonals connecting the upper and lower decks. The deep girders naturally lead to longer approach spans, which has environmental advantages and gives a lighter and more elegant appearance. They are also rigid enough for a cable-stayed bridge to comfortably span the Flintrännan navigation channel with a main span of 490m.

The full illustrated paper describes the design of the bridge, the design process and the issues which the design team considered important in "Getting the Balance Right".