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Preliminary Main Pier Designs for the Great Belt Bridge

Avant-projet des piles principales du pont sur le Great Belt

Vorstudien für die Pfeiler der Brücke über den Grossen Belt

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The design of the main piers for the Great Belt Bridge has during the last decade been investigated in a number of studies.

In the chosen bridge alignment the water depth reaches 55 m, and a direct foundation can be established on Danian Limestone or Paleaocic Marl few meters below.

This paper describes shortly three pier designs, here designated pier A, B and C.

PIER A

For the International Design Competition 1966 a road bridge as shown in figure 1, with a main pier design as shown in figures 2 and 3 was proposed by the author et al [1].

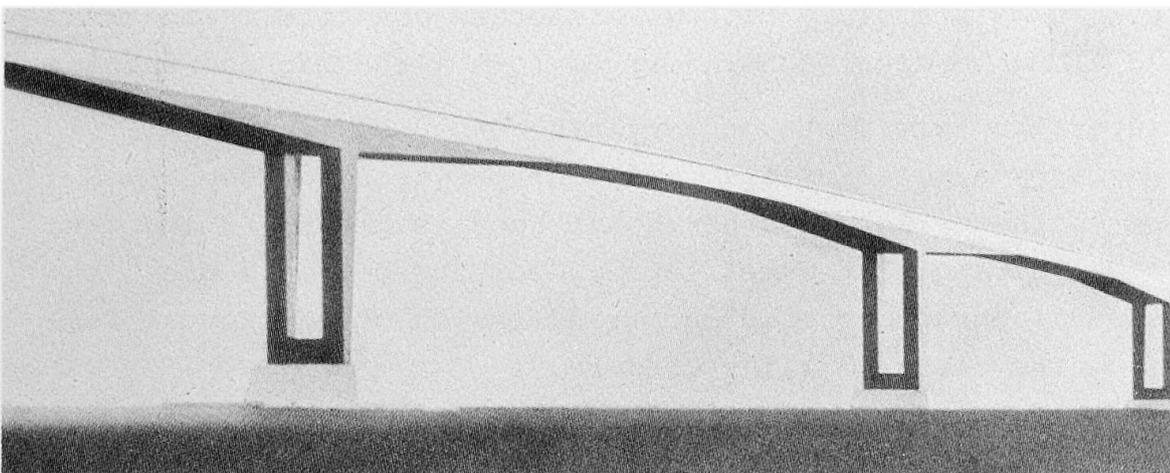


Figure 1. Road bridge designed as a frame with two 400 m wide main spans. From a first prize design by Gimsing, Madsen and Nissen in the International Design Competition 1966.

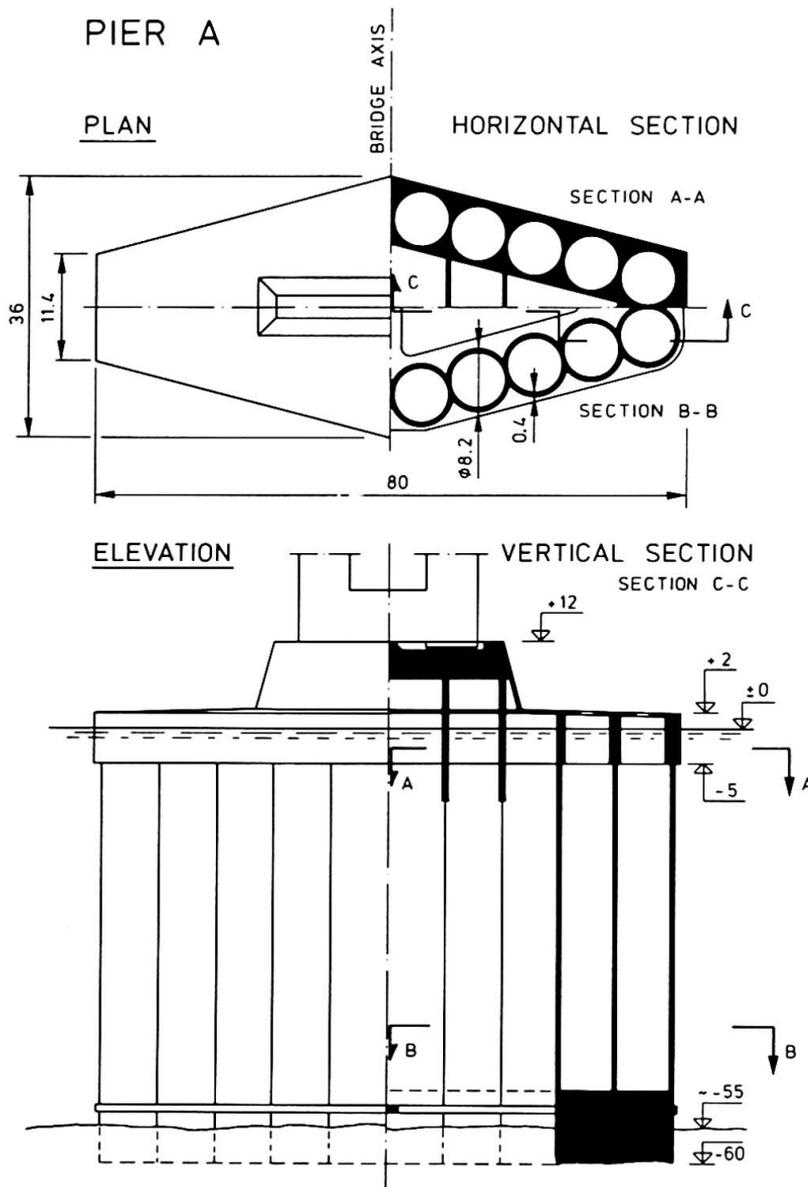


Figure 2.

Main pier design for the bridge shown in figure 1.

This pier, founded 60 m below water level, should be designed for very large forces from ice pressures and collision (equivalent static collision force: 120 MN).

The pier consists of 20 hollow reinforced concrete cylinders joined along vertical generators to form a rhombic box section.

The superstructure rests on a plinth connected to the wall of cylinders by a covering slab and four prestressed deep beams. On top of the cylinders a hexagonal hood is placed to increase the local strength at water level. Near the bottom a prestressed diaphragm assures the transmission of horizontal forces from the earth to all cylinders.

The construction of the pier should start in a dry dock by casting the lower part. After placing of temporary bulkheads

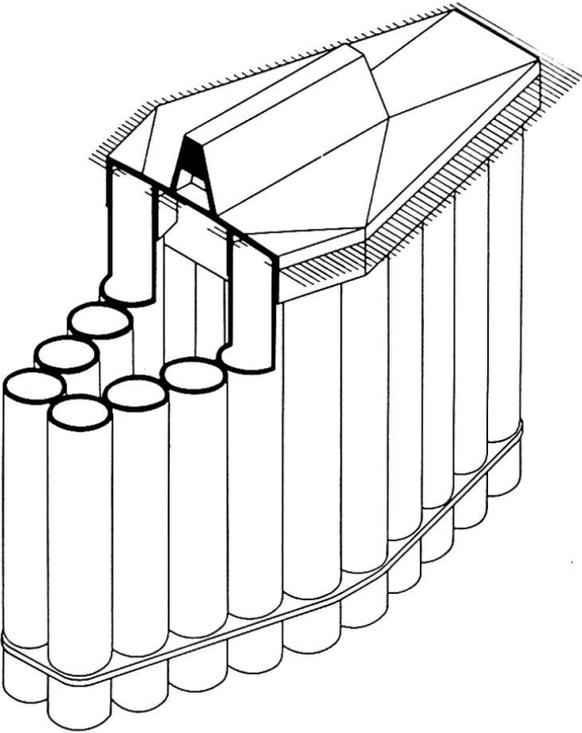


Figure 3.

Isometric projection of the pier design shown in figure 2.

the pier can be floated to deeper water and the remaining part cast in slip forming. When placed in final position the temporary bulkheads are removed and excavation inside cylinders carried out. Finally, concrete plugs are cast under water at the bottom of all cylinders.

PIER B

1970-72 a Technical Commission appointed by the Ministry of Public Works made a comparative study of different solutions for the Great Belt crossing, among these the cable-stayed bridge shown in figure 4. [2].

Here a more solid pier structure, as shown in figure 5, was proposed. The pier is composed of square wells, 42 in the lower and 20 in the upper part.

In principle this pier should be constructed as pier A, with the exception that temporary steel tubes had to be added to prolong the outer wells during floating and excavating.

A dynamic investigation of the collision case gave the following results:

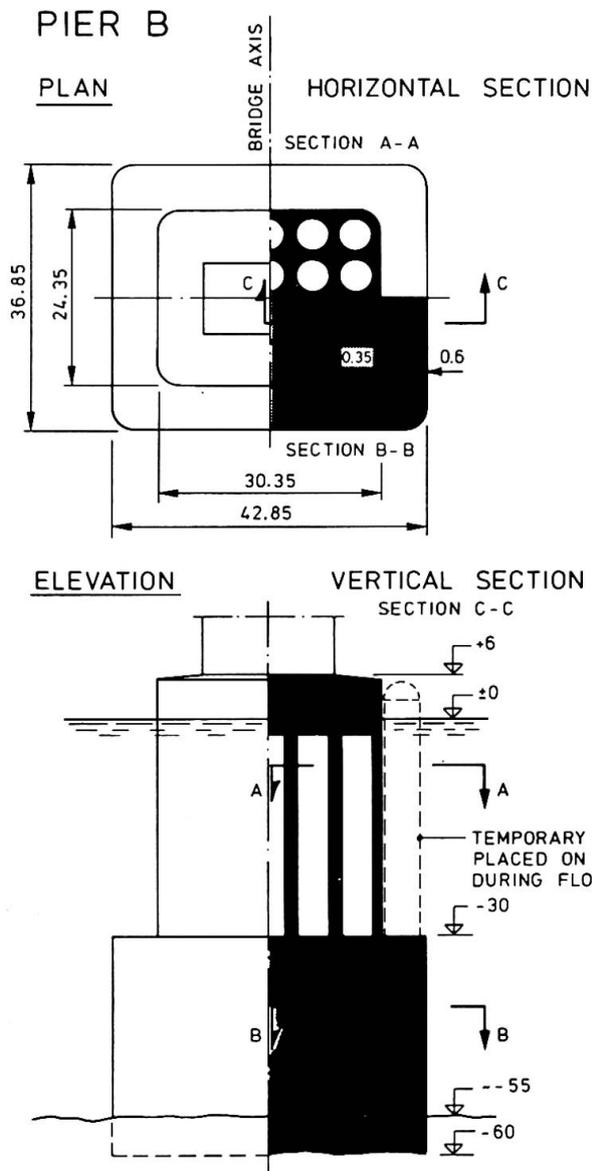
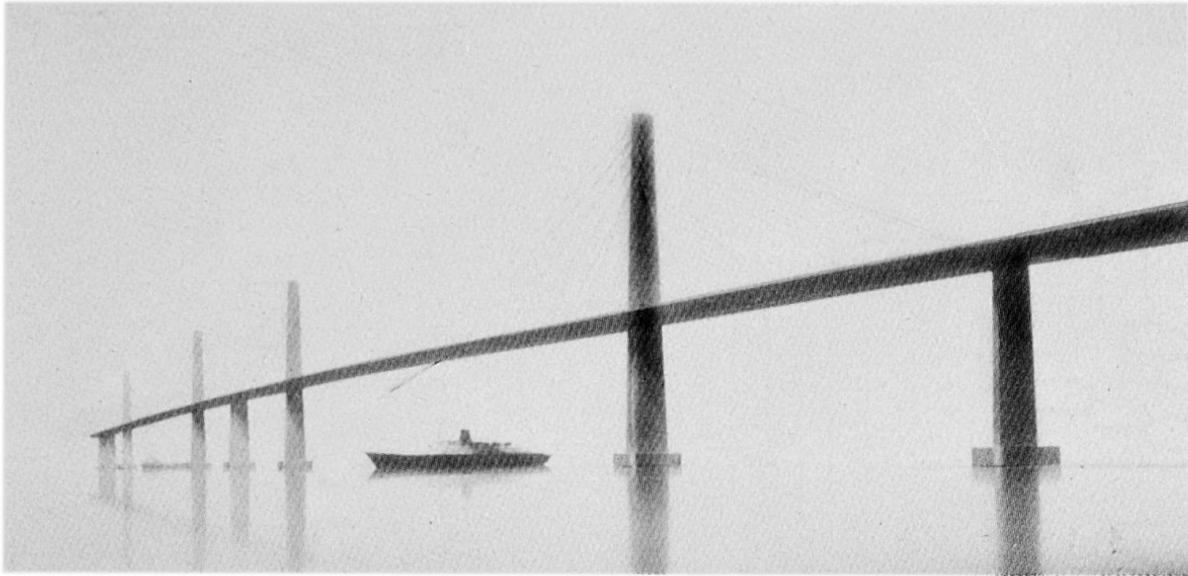


Figure 4.

Combined road and rail bridge designed as a cable-stayed bridge with two 600 m wide main spans. From the investigations made by the Technical Commission 1971.

Figure 5.

Main pier design for the bridge shown in figure 4.

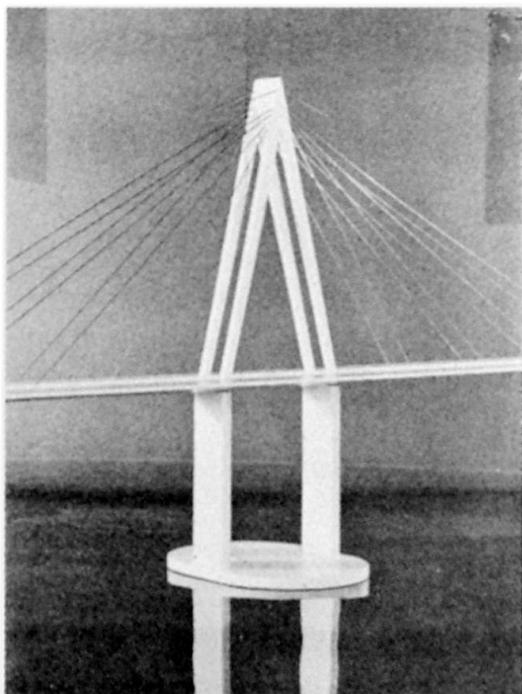
A collision by a ship of maximum 14.000 tdw going at full speed, or a tanker of 100.000 tdw drifting abeam at current speed would only give local damage.

A collision by a tanker of 100.000 tdw going at full speed will give a permanent horizontal displacement of 0.1 m at water level. In the superstructure this displacement only induces a flexural stress of 90 MPa and consequently no danger of collapse would exist.

PIER C

Recently, the author has made a study of a cable-stayed bridge with two main spans separated by a triangular pylon structure (figure 6).

The corresponding pier structure, shown in figure 7, contain a wall of cylinders as in pier A, but the number is increased to 26 due to the larger width required to give support for the double pier shafts.



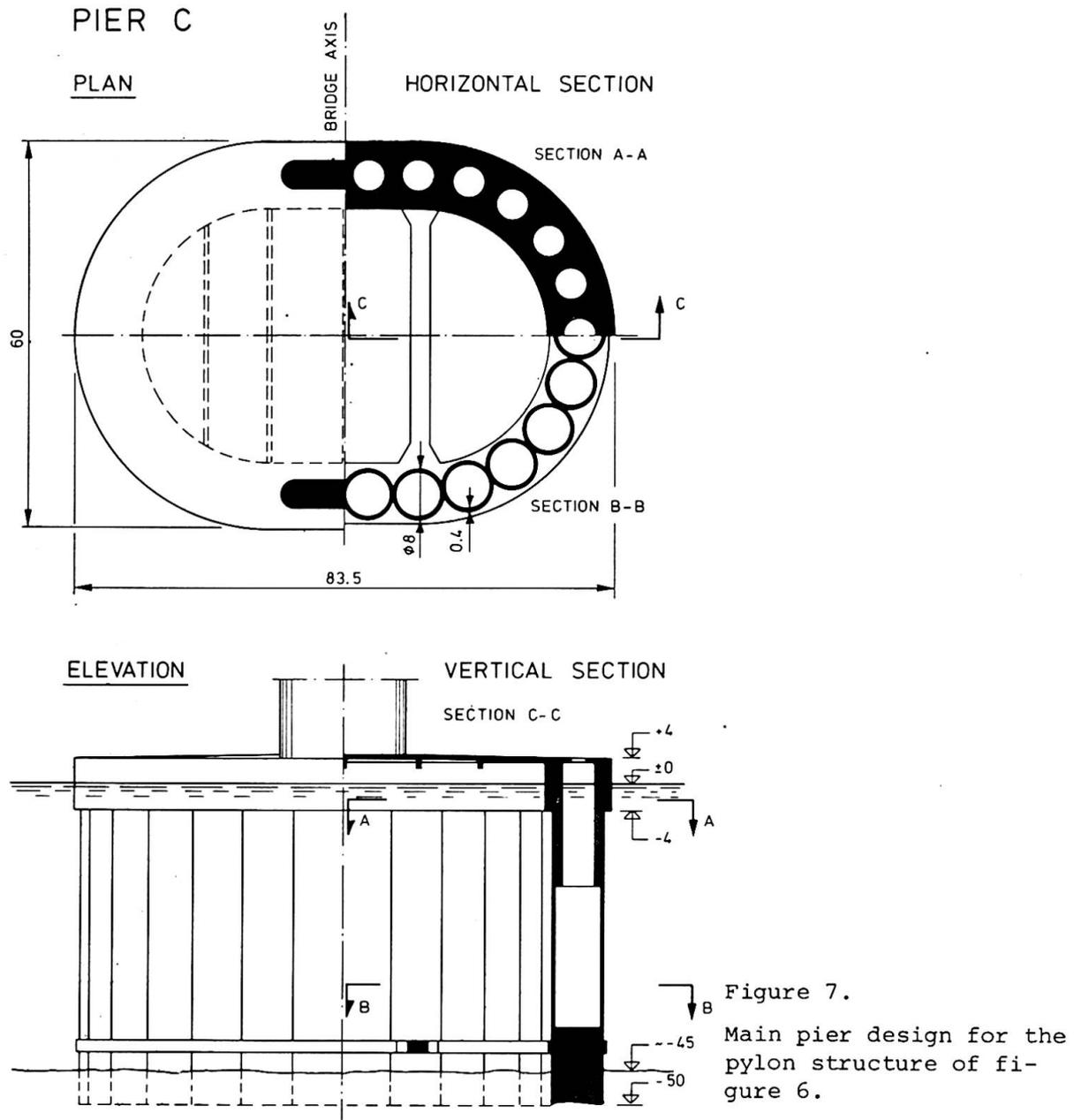
Despite the significantly larger outer dimensions pier C requires only slightly larger quantities than pier B. This is due to the hollow design, which also gives an advantageous increase of the stability.

Figure 6.

Triangular pylon structure investigated by the author 1975.

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SUMMARY - Preliminary investigations have indicated that the main piers for the Great Belt Bridge can advantageously be constructed by using hollow concrete caissons.

RESUME - Les études préliminaires ont montré que les piles principales du pont sur le Great Belt pouvaient être avantageusement réalisées à l'aide de caissons creux en béton.

ZUSAMMENFASSUNG - Vorstudien für die Pfeiler der Brücke über den Grossen Belt haben gezeigt, dass Caissons aus Beton Vorteile bieten.