Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 79 (1998)

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DOI: https://doi.org/10.5169/seals-59937

Design of the Road/Railway Bridge across the Oeresund

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Summery

The 7,7 km long Øresund Bridge is the major part of the Øresund link between Denmark and Sweden. The bridge is designed with a two level girder for combined road and railway traffic. The span lengths vary from 120m to 140m for the approach bridges to 490m for the cable-stayed part which crosses the navigation channel. This poster focuses on three main features in the detailed design.

1 Pylon foundation

The 203.5m high pylons for the cable-stayed bridge are placed close to the navigation channel, and thus the design of the lower part of the pylons and the caissons has been governed by ship impact. The design requirements describe two types of ship impact: Sideways collision and HOB (Head on Bow) collision. For both types the impact load corresponds to a 295m ship in ballast (85000 tonnes displacement). The corresponding max. impact forces are 560 MN and 438 MN, respectively. For the pylon caissons the dimensions were governed by sideways collision.

The analysis has been carried out as a linear elastic time history analysis on the Global IBDAS model which is also used for the overall design of the bridge. In the chart below the variation of the shear force in the bottom of the caisson together with the applied ship impact force are shown. The dynamic amplification is found to be 1.16. The bearing and displacement capacities were verified by quasi push-over analysis using a 2-D elasto-plastic finite element model.

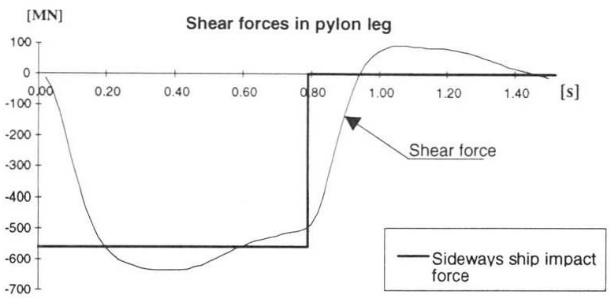

Fig. 1 : Dynamic shear force at level -17 m.

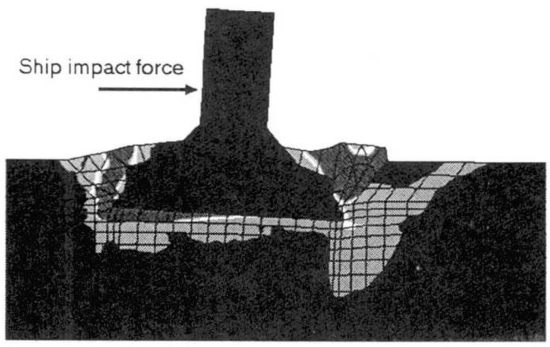

Fig. 2 : Plastic zone development

2 Corrosion protection

The maintenance strategy for the bridge is based on more than 100 years of operation with maintenance costs as low as possible. Therefore, the layout of the truss girders has been based on closed box sections with smooth external surfaces suitable for painting and future maintenance. They will be protected by a 390 microns dry film thickness epoxy based paint system. All internal surfaces will stay unpainted, and the corrosion protection will be based on dehumidification of the inside air by circulating dry air inside the box elements. The dehumidification units for the approach bridges will be placed in the cross beams, and inside the box girder for the railway at the cable-stayed bridge. With dehumidification an environmental friendly and overall cost saving system has been achieved taking in mind that the internal steel area is approx. 490,000 m^2 compared to a 300,000 m^2 external painted area. The principle for dehumidification of the truss girders is shown in fig 3.

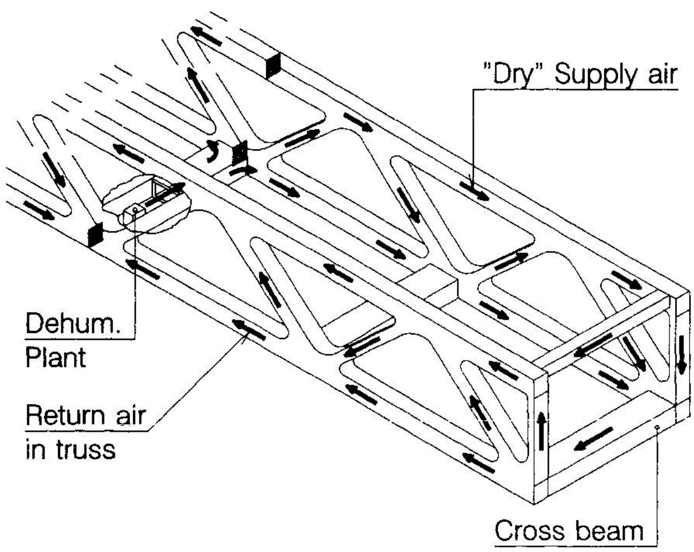

Fig. 3: Dehumidification system

3 High Strength Steel

High strength steel has been used extensively for the two level composite truss girders. In the 6,7 km long approach bridges the railway is carried by concrete troughs, spanning 20m between steel cross beams. The design of the 1,5m high and 2,5m wide cross beams is governed by fatigue, and steel grade S355N (EN10113-2) was found to be most favourable for the cross beams. For the truss girders the design was governed either by the Ultimate or the Accidental Limit State (ULS/ALS). By substituting the traditional grade S355N steel by steel grade S460M (EN10113-3) it was possible to reduce the amount of steel by approx. 15 percent for the approach bridges. For the cable-stayed bridge Steel Grade S420M has been used for the main part of the structure. For the heavy, compact and very stiff Øresund bridge girder the application of high strength steel has shown to be cost-effective.

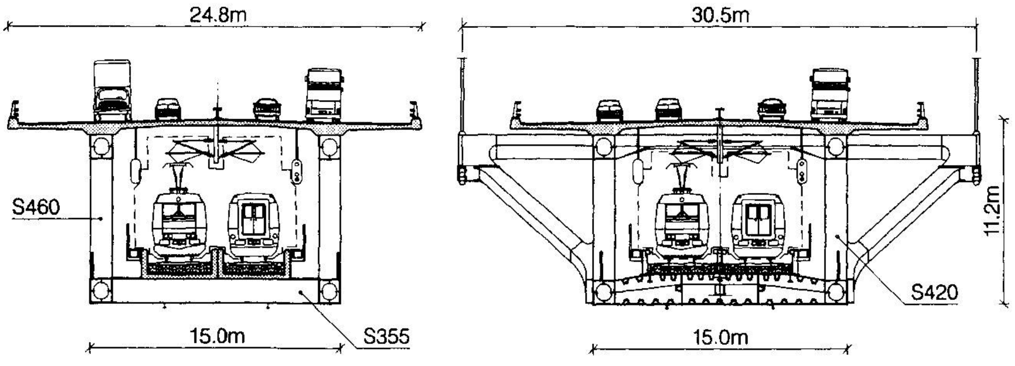

Fig. 4: Cross section of approach and high bridge, respectively