The New Storstrøm Bridge – Prestressed Box Girder Design

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Abstract

The New Storstrøm Bridge is a 3.8 km long combined rail and road bridge currently under construction. It will be Denmark's third longest bridge. It comprises two approach viaducts with 44 spans, typically 80 m long, and a single-tower cable stayed bridge located centrally within the strait crossing, with two 160 m navigational spans. The 25 m wide deck is a prestressed concrete box girder with a unique asymmetric cross section and wide cantilevers. It carries a two-track, high speed railway and a carriageway comprising a two-lane road and a combined pedestrian-cycle. The tight construction schedule imposed to the Design & Build Contract requires the use of full prefabrication of the box girder. A span-by-span construction method based on the erection of typically 73 m-long precast segments is adopted. This paper presents the main challenges of the box girder design due to the construction method, the unusual cross-section and the heavily asymmetric traffic loading.

Keywords: asymmetric; prestressed box girder; road and railway bridge; cable-stayed bridge; full-span precast; prefabrication; deck lifting; deck distortion

1 Introduction

The key features of the structural system, the erection method, and the analysis and design of the prestressed box girder are presented in this paper. The focus is placed on the peculiarity of the asymmetric box girder design, significantly governed by the eccentric traffic loads, as well as on the construction method constraints, such as the capacity limits of the lifting equipment requiring optimization of the material distribution. Changes to the early-phase concept to optimize and accelerate the erection are also presented.

2 Structural system

2.1 Structural frames and articulation

The general arrangement of the bridge is shown in Figure 1. The bridge consists of three principal structural frames: a North approach viaduct frame from the North abutment to pier P6N, a corresponding South approach viaduct frame from the South abutment to pier P6S, and a central frame between P6N and P6S incorporating the two cable-stayed spans. Expansion joints are provided at both abutments and piers P6N and P6S.

The box girder deck is supported at the piers and abutments on pairs of transversely free and guided bearings, see [1], except at the piers subject to the largest ship impact loads where the guided bearings are replaced by free bearings and large shear key devices (see [2] for ship collision details).

The longitudinal fixity of the North and South frames is provided by three adjacent longitudinally 'fixed' piers located approximately at the mid-point of each frame, i.e. at P14N-P12N and P13S-P15S, respectively, where longitudinally fixed bearings are provided. The longitudinal fixity of the central frame is offered by the monolithic connection between the girder and the pylon P1C, denoted as