The New Storstrøm Bridge - Nonlinear Dynamic Ship Impacts

Martin N. Svendsen, Paola Bertolini, Frederik Vind

Ramboll

Contact: mnns@ramboll.com

Abstract

The New Storstrøm Bridge in Denmark is a 3800m long concrete girder bridge with 44 standard spans of mostly 80m and two navigational spans of 160m which are stay cable supported. The foundations are constructed as direct pad foundations, i.e. with the ability of the caissons to slide and rotate on gravel beds. The bridge supports two high-speed railway tracks and two lanes of road traffic. The waters of Storstrømmen are prone to high naval activity and this, in combination with relatively flexible foundations and high dynamic sensitivity of the girder due to train runability requirements, implies that ship impact scenarios are a critical design parameter. In the present paper, nonlinear dynamic ship impacts performed for the detail design are presented. The simulations include nonlinear representation of soil stiffnesses as well as ship indentation properties. Also, nonlinear geometric effects and strongly nonlinear bearing uplift effects are considered. Detailed descriptions of the complex structural response mechanisms occurring during critical ship impacts are provided and the influence of girder/pier tie-down cables on uplift magnitudes are presented.

Keywords: Structural dynamics; ship impact; computational design; bearing uplift, major bridges.

1 Introduction

The New Storstrøm Bridge in Denmark is a 3800m long concrete girder bridge with 44 standard spans of mostly 80m and two navigational spans of 160m which are stay cable supported. The foundations are constructed as direct foundations, i.e. with the ability of the caissons to slide and rotate on gravel beds. The bridge supports two high-speed railway tracks and two lanes of road traffic. Ramboll has been the main structural designer of the detailed design.

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The general arrangement of the bridge is shown in Figure 1. The bridge consists of three frames; the north frame, the central frame and the south frame. The longitudinal stability of the north and south frames is ensured by fixed piers at 14-12N and 13-15S respectively and by 1C for the central frame. All other piers and abutments have longitudinal sliding bearings. The three frames are connected by longitudinal shock transmission units