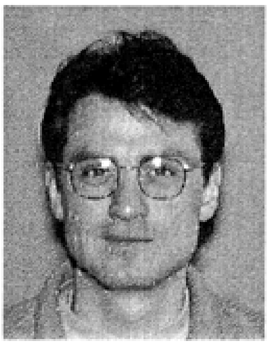
Presented as a poster on the 15th IABSE Congress, June 16-20, 1996, Copenhagen, Denmark

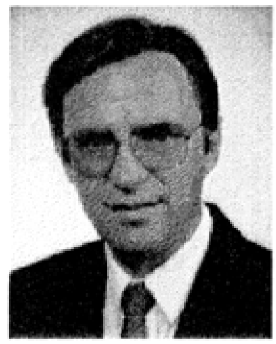
Pier Protection of the New Sidney Lanier Bridge

Henrik Gluver
M.Sc., PhD
COWI
Consulting Engineers and
Planners AS
DK-2800, Lyngby, Denmark

Dan Olsen
Head of Department
COWI
Consulting Engineers and
Planners AS
DK-2800, Lyngby, Denmark

Paul E. Bach
President
Ben C. Gerwick Inc.
San Francisco
CA 94111, USA





1. Sidney Lanier Bridge Replacement Project

Most traffic to and from the harbour in Brunswick, Georgia, pass the Sidney Lanier Bridge which crosses Brunswick River about 0.5km from the harbour. A central lift span presently provides a horizontal clearance of only 76m, and due to specific navigational difficulties the bridge have been declared to be a navigational obstruction alterable under the Truman-Hobbs Act. A replacement bridge is therefore to be constructed 46m further down the river, featuring a cable stayed main bridge with a horizontal clearance of 316m.

The risk of collisions is thereby significantly reduced but not eliminated. Hence, to ensure an acceptable low frequency of collisions with serious structural consequences, consideration of relevant collision forces have to be performed in the design of the exposed parts of the bridge. The investigation made for the new Sidney Lanier Bridge both covers fully exposed piers, and piers protected by artificial islands of the penetration type (steep slope, coarse friction material).

Design requirements to the pier structure and protection islands have been determined on basis of a comprehensive ship collision risk analysis, such that the same residual risk of serious collisions is obtained for both alternatives. Hence, selection of the most feasible alternative can be based on other qualities such as construction cost and time, environmental implications, aesthetics, etc.

Essentially the risk analysis comprise an estimation of frequencies of collision to the piers, and evaluation of the structural consequences of these collisions. With reference to selected critical consequences and an associated target risk level, relevant design scenarios can then be selected.

2. Ship Collision Frequency

The navigational difficulties in passage of the existing and the new bridge are associated with a significant cross current at the bridge location, and a 50 degree turn only 450m upstream from the bridge. Recognising these specific conditions, a model for estimation of the frequency of ship collisions have been established according to the principles given in [1]. The model utilise information on traffic volume and composition, bridge geometry, navigational procedures and difficulties, river bed topology, tidal range, visibility etc. Collision frequency estimates are calculated for a range of vessel sizes, and when combined with a ranking according to the associated collision consequences, these results provide a rational basis for selection of design vessels and scenarios to include in the design verification.

3. Structural Consequences

In assessing the consequences to the bridge structures in a ship collision, all collisions are for simplicity assumed to be ideal head-on-bow (HOB) collision. However, the two alternatives considered - with and without protective islands - calls for very different mechanical modelling.

For unprotected piers the calculation of the potential collision forces is based on an available empirical relation for the maximal force developed in HOB collisions into a rigid wall [2]. This relation incorporates the vessel size and collision energy, and is convenient and relevant to adopt both in ranking of the collision frequency contributions for different vessel sizes, and for determination of design forces for the selected design vessels and design scenarios.

For the protected pier, the consequence assessment concern both the penetration of the vessel bow into the island, and the forces transmitted through the core of the island to pier. Regarding penetration large vessels in ballast will be critical, whereas transmission of large forces is associated with large, fully loaded vessels. Lacking established relations for these quantities, the ranking of frequency contributions from the risk assessment, is based on an empirical collision force index which combines collision energy and vessel draught, and refers to results of model tests made for the penetration islands on the Sunshine Skyway Bridge. The more recent experience gained in development of the protection islands to the Great Belt East Bridge piers is not applicable since these islands are of the shallow friction type.

Once design vessels have been selected, more detailed numerical computer simulations are performed to provide specific estimates for vessel penetration and transmitted loads. On basis of these numerical simulations appropriate design loads can be selected.

4. References

[1] *Ship Collision with Bridges, The Interaction between Vessel Traffic and Bridge Structures*, Ole Damgaard Larsen, Struct. Eng. Doc. - 4, IABSE/ AIPC/IVHB, 1993

[2] *Ship Impacts, Bow Collisions*, P. T. Pedersen et al, Third International Symposium on Structural Crashworthiness and Failure, University of Liverpool, U.K. April 1993