



## Copenhagen Inner Harbour Bridge

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### Abstract

The new Inner Harbour Bridge in Copenhagen is innovative both in its method of opening and a number of its design features. The moving bridge comprises two steel box girders that retract by sliding between fixed concrete approach spans. The steel box girders are of a highly unusual form involving plan curvature, continually changing cross sections and a faceted – or triangulated – inner web. Furthermore, because of the support arrangement, the girders go from cantilevering to simply-supported conditions over the course of an opening cycle.

The dynamic response of the box girders, with 35 m cantilevering spans in the service condition, presented a challenge which was addressed in the design by a combination of rationalised design criteria and the application of a series of tuned mass dampers.

The project has been delayed for a variety of reasons, not least due to the original contractor going into liquidation part way through, and the fixed concrete spans were modified by adding a new composite top layer of reinforced concrete following the original casting.

This paper touches briefly on the unique form and opening mechanism of the bridge and then turns to the details of some of the novel structural aspects.

**Keywords:** Moving bridge; sliding bridge; dynamics; Copenhagen; box girder.

### 1 Introduction

The bridge is 250 m long and crosses the harbour at the heart of the city, surrounded by important historic buildings. The wide-open harbour context demands a design of subtlety and simple elegance, and calls for an urban bridge that creates a new public space from which to enjoy the harbour views. The design was the winning entry in an international design competition held by the City of Copenhagen in 2009, and is a deliberately understated response to the challenge of crossing the harbour at this point, avoiding masts, towers, arches or other overt structural forms, which would intrude and draw attention to themselves. Instead, the winning competition design was an exercise in simplicity and restraint, relying on an elegant form and fine detailing to create a delightful bridge of refinement and subtlety. Unfortunately some of

these fine details have been compromised by problems experienced on site during construction, but on the whole the result is an attractive new addition to Copenhagen's unique family of modern bridges.

### 2 Structural form and operation

The bridge – the first crossing to be encountered by vessels entering Copenhagen from the north – provides an important link between the heart of the city and the developing area to the east of the Inner Harbour. It has dramatically enhanced traffic routes for pedestrians and cyclists, who are now able to travel between the city centre and the Opera House to the north east with ease. The form of the bridge is understated and its low profile is respectful to the surrounding historic buildings and long views up, down and across the harbour – Figure 1 shows the bridge in elevation.