

**Zeitschrift:** IABSE reports = Rapports AIPC = IVBH Berichte  
**Band:** 82 (1999)

**Artikel:** Design of girder and cables for train loads  
**Autor:** Bitsch, Niels / Hauge, Lars  
**DOI:** <https://doi.org/10.5169/seals-62149>

#### **Nutzungsbedingungen**

Die ETH-Bibliothek ist die Anbieterin der digitalisierten Zeitschriften auf E-Periodica. Sie besitzt keine Urheberrechte an den Zeitschriften und ist nicht verantwortlich für deren Inhalte. Die Rechte liegen in der Regel bei den Herausgebern beziehungsweise den externen Rechteinhabern. Das Veröffentlichen von Bildern in Print- und Online-Publikationen sowie auf Social Media-Kanälen oder Webseiten ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. [Mehr erfahren](#)

#### **Conditions d'utilisation**

L'ETH Library est le fournisseur des revues numérisées. Elle ne détient aucun droit d'auteur sur les revues et n'est pas responsable de leur contenu. En règle générale, les droits sont détenus par les éditeurs ou les détenteurs de droits externes. La reproduction d'images dans des publications imprimées ou en ligne ainsi que sur des canaux de médias sociaux ou des sites web n'est autorisée qu'avec l'accord préalable des détenteurs des droits. [En savoir plus](#)

#### **Terms of use**

The ETH Library is the provider of the digitised journals. It does not own any copyrights to the journals and is not responsible for their content. The rights usually lie with the publishers or the external rights holders. Publishing images in print and online publications, as well as on social media channels or websites, is only permitted with the prior consent of the rights holders. [Find out more](#)

**Download PDF:** 07.02.2026

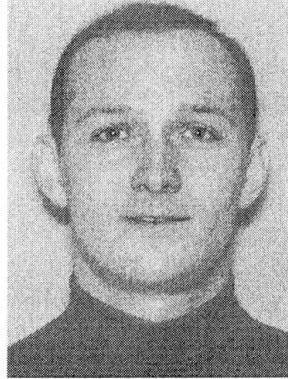
**ETH-Bibliothek Zürich, E-Periodica, <https://www.e-periodica.ch>**



## Design of Girder and Cables for Train Loads

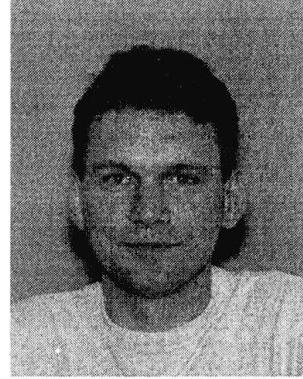
**Niels BITSCH**  
MSc Civil Engineer  
COWI  
Lyngby, Denmark

Niels Bitsch, born 1958, received his civil engineering degree from the Technical University of Denmark, year 1984. Has in the past 10 years been working with the bridges of the two major links in Denmark, the Great Belt Link and the Öresund Link



**Lars HAUGE**  
MSc Civil Engineer  
COWI  
Lyngby, Denmark

Mr. Lars Hauge born 1962, received his civil engineering degree from the Technical University of Denmark, year 1986. Has through his work with some of the world's largest bridges obtained considerable expertise in design of cable stayed and suspension bridges.



### Abstract

#### The Cable Stayed Bridge of the Öresund Link

The High Bridge of the Öresund Link is a Cable Stayed Bridge with a Main Span of 490 m and two side spans of 160m and 141m respectively. The Pylons, with two single towers each, are constructed in reinforced concrete and the Bridge girder is a two level composite girder. The two level composite girder comprises a main carrying steel truss and a upper roadway deck slab in concrete.

The Cable Stays are arranged as a harp system with 10 Cable Stays in each cable fan. The Cable Stay inclination with horizontal is 30° Deg, and the distance between the anchorages on the Girder are 20 m. For anchorage of the Cable Stays in the Pylon, a cast-in steel box has been designed. See Figure 1.

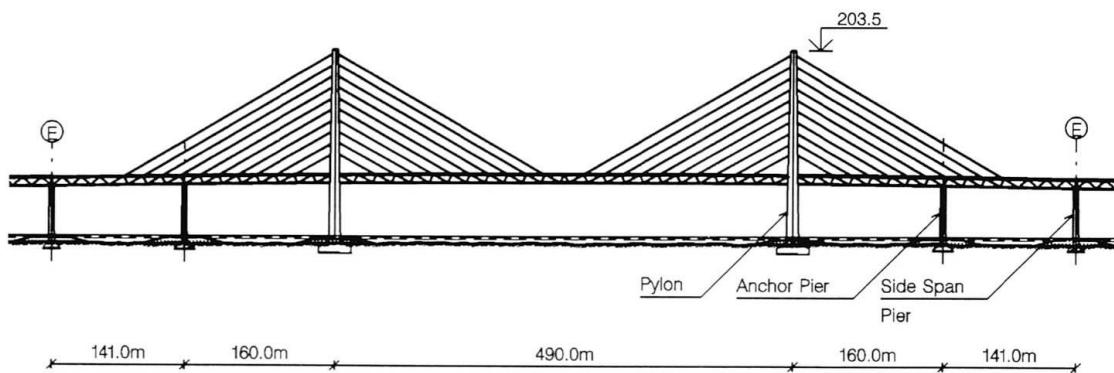


Figure 1 : Öresund Link, Cable Stayed Bridge. Side view.

The structural design was based on the Eurocodes with an associated Project Application Document and a Design Requirement document. The Design Requirement document supplemented and took precedence over the other two documents, with specific loads and other requirements covering topics which are not considered in the Eurocodes.

During detailed design computer models was established in order to perform the general verification of the Bridge, but also to perform the rather complex analyses related to the Train loads such as :

- Comfort analyses
- Dynamic Actions
- Fatigue analyses

Other complex effects with considerable design impact, but without connection to the Train loads, such as shrinkage and creep effects, shear lag and cable stay rupture, was also analysed.

### Comfort Analysis

The vertical accelerations within a passenger coach was evaluated for a train with a speed of 200 km/hour, in order to verify that the comfort criteria's was fulfilled. A maximum vertical acceleration of  $0,5 \text{ m/sec}^2$  (peak value), was found during passage of an expansion joint. Compared to the max. acceptable vertical peak acceleration of  $2,0 \text{ m/sec}^2$ , the girder is found to be well within the acceptable limits. Figure 2 gives body accelerations for one of the analysed passenger trains crossing the bridge.

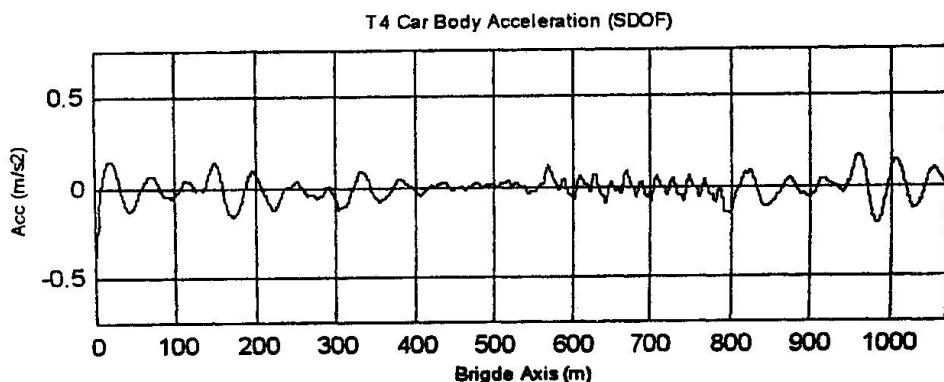


Figure 2 : Acceleration results for a passenger train crossing

### Dynamic Actions

Dynamic effects from crossing of a train, was included in the design of both Girder and Cables, by introduction of a dynamic load factor. Analyses was carried out in order to determine the dynamic load factor of the global actions. The general result of the analyses, was a dynamic load factor depending on both the type of bridge element analysed, but also the element position in the bridge.

The dynamic load factors for crossing of a UIC train, was found to be in the range of 1.02 to 1.05 for the Girder, and 1.01 to 1.06 for the cable stays considering tension and 1.30 for detensioning.

Dynamic load factors was determined separately for "fatigue" trains. Here the global dynamic load factors was found to be in the range of 1.02 to 1.40 for the girder structure, and 1.02 to 1.30 in the cable stays considering tension and 1.02 to 3.60 for detensioning.

### Fatigue Analysis

The Railway Tracks are supported on the lower bridge deck, a closed steel box with orthotropic deck panels, supported by transverse bulkheads with maximum 3,00 m spacing. General stress and plate buckling analyses has been performed for the steel panels and transverse bulkheads, but the major work has been related to the fatigue verification. Combination of fatigue contributions from both wind, roadway traffic and trains was made, with however the fatigue contribution from the trains as dominating. In order to perform the rather detailed fatigue verification, based on a great number of stress information's, a special computer programme was developed.