



## Loads caused by earthquakes and ship impact - experiences from current projects

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## Abstract

In the past, static evaluation of solid bridges considered the effects of ship impact in approximation approaches including static dummy loads; earthquake load conditions were taken into account as an exception only. With the implementation of a new generation of standards, the DIN technical reports based on the European set of regulations, loads caused by earthquakes and ship impact have become much more important. Practical implementation of the effects of the new standards is demonstrated using several recent examples.

## 1. Introduction

To account for the non-static impacts, such as moving loads from road or railroad traffic, the calculation of bridges in Germany is traditionally based on statistic dummy loads that, in the case of ship impact, are evaluated in consideration of the possible threat scenarios. Despite the low speed of ships, the threat potential is by all means high. This is documented by an outline of serious accidents in [7], which have increased significantly in numbers since 1950, just as emphatically as by description of the renovation of a bridge over the Danube [1] that suffered massive damage from an impact of a pushed convoy. On the other hand, the possibility of ship impact is rather unlikely, the effects depending on a great variety of parameters.

During the past years, earthquake load cases have not been very important in the structural dimensioning of bridges in Germany. Normative regulations for bridges did not exist, in cases where bridges were planned in high-risk earthquake zones, regulations from structural engineering and the technical literature applied alternatively.

## 2. Theoretical Principles

### 2.1 Ship Impact

Ship impact load cases are very complex pushing actions where a ship with its high weight and high overall stiffness crashes into a stiff pier made of masonry, concrete or reinforced concrete, or comparably soft control facilities or sheet pile wall constructions. This issue has been examined in detail, especially by the German Federal Institute for Hydraulic Engineering. [2] shows the concept of a realistic approach to the determination of shock loads based on a probabilistic security concept. In [3] the main focus is on the significance of the subsoil under ship impact. Hence the basic parameters for a both safe and economical consideration of ship impact have been provided. This concept has also been incorporated in the effective standards regime. [6], [5].