IABSE Workshop Helsinki 2017
Ignorance, uncertainty and human errors in structural engineering
February 15-16, 2017, Helsinki, Finland

A simplified method for evaluation of robustness of bridges

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Abstract

Many theoretical methods for assessing robustness introduced so far, due to their complexity, appear to be almost impossible to use in practical design. Therefore, the present study proposes a simplified method for evaluation of the robustness of bridges.

In the proposed methods two strategies for providing robustness are utilised: increasing local resistance in order to prevent the key element from failing; increasing damage tolerance by providing redundancy in order to recompense failure of the element. Accordingly, two separate approaches for evaluating bridge robustness are introduced. Both of them are based on a rating system, where each evaluated component is assigned with a partial factor, which value can vary from 0 to 10. Next, in each approach, all points from partial factors are summed up. The robustness of the bridge can be evaluated by comparing the final value with possible minimum and maximum values.

The proposed evaluation method has been implemented in a case study: 118,8 m long four spans prestressed concrete girder overpass. The method appears to be promising in estimating the robustness level in considered bridges. Furthermore, it can provide assistance in identification of the components of the bridge that contribute to its local resistance and redundancy level.

Keywords: bridges, robustness, redundancy, local resistance

1 Introduction

In the past, many of bridges have failed. After investigating the collapses, engineers have been gaining more knowledge about the behaviour of bridge structures. Mistakes made in the past can be prevented. For instance, Tacoma Narrow Bridge's aerodynamic instability mechanism that led to large-scale oscillations in torsional mode can nowadays be foreseen and avoided. By investigating the bridge collapses that have happened, it can be also noticed that providing additional load bearing capacity for structural elements, does not necessarily solve all the problems. Therefore, increased number of studies has been carried out in order to find different methods for enhancing structural safety. Many of different approaches have been introduced so far. One of them is to ensure sufficient robustness of the structure.

Furthermore, almost each of the present standards, specifications or design guidelines recommends, or even demands, from an engineer to ensure sufficient robustness of designed structure. However, many theoretical methods for robustness evaluation proposed so far, due to their complexity, appears to be almost impossible to use in practical design. Therefore, a simplified method is proposed.

https://doi.org/10.2749/helsinki.2017.126
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