Structural Reliability Assessment for existing composite bridges without design documents

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Summary

In order to achieve a fast and reliable determination of the load-bearing capacity of existing bridges while in missions abroad, a system to classify bridges was developed. Generally, no building documents are available in such a case. The assessment system works on two different levels of accuracy: a quick assessment (Level 1) only with geometric input values, and a structural analysis (Level 2) which requires additional material properties. If the generated military load class from the quick assessment is insufficient, a more accurate classification based on structural analysis is carried out.

Keywords: Reliability, existing bridges, load-bearing capacity, composite bridges, Military Load Class, Assessment, design documents

1. Methods for the Assessment

1.1 Quick assessment of existing bridges without design documents (Level 1)

The quick estimation method must have the following properties according to [1]:

- small number of necessary input
- input data easy to measure
- short time of calculation
- short time period to get results by use of the quick estimation method.

The calculation of permitted bending M_Q concept based on the relation between the bending moment of the superstructure caused by the construction dead load M_{KG} and the bending moment caused by the live load M_Q.

$$\alpha = \frac{M_{KG}}{(M_{KG}+M_Q)} \tag{1}$$

The permitted bending moment can be described by the function:

$$M_Q = M_{KG} * \left(\frac{1}{\alpha} - 1\right) \tag{2}$$

For the calculation of the value α, the static documents of many existing reference bridges have been evaluated in our own calculations to determine M_{KG} and M_Q. The safety margin for M_Q is illustrated in the full paper. In [2], diagrams for concrete bridges with spans up to 40 m are presented. Here composite bridges will be treated.

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The fixed value α for composite bridges can be extracted from the following diagrams:

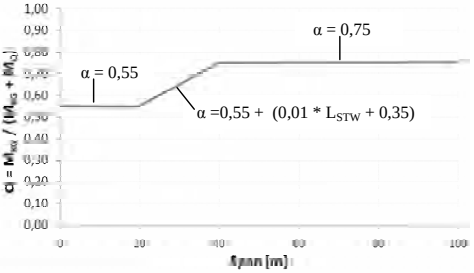

Fig. 1: relation value α for open rib systems

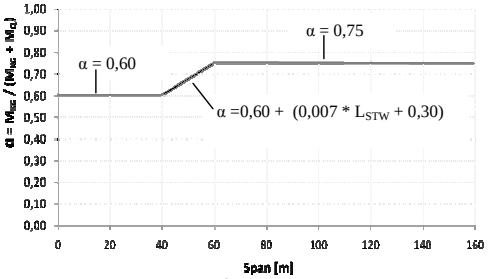

Fig. 2: relation value α for closed rib system

1.2 Structural analysis (Level 2)

For a bridge exploration in the context of military operations there is usually no structural engineer on site. Moreover, there is normally no time for a detailed calculation. For this, the computer program BRASSCO (Bridge Assessment Code) [1] has been developed. The special feature is the graphical user interface which leads the user step by step through the input. To avoid typing errors, there is a graphical representation of the system, where unusual proportions usually quickly attract attention. Additionally a database system has been developed to complete non-available values and to check the values for plausibility. The generated system is loaded by the traffic loads from the STANAG 2021. After calculation, the permissible bridge class is shown. Based on measurement errors and lack of knowledge about the actual construction of the bridge, it is necessary to review the computer model and the calculated results. This is done with a monitoring, by which the actual system is validated. The deformations and vibrations are measured and compared with the results from the calculation.

2. Praxis Field test – Mission in Kosovo

The developed technology for the structural reliability assessment for existing bridges without design documents has been approved as helpful; first of all with bridges in the home country and then, in October 2005, during a first manageability proof of the overall system in a mission in Kosovo.

The team of experts consisted partly of members of the School of Engineers (BUZ) and partly of members of the developing team from the University of the German Armed Forces Munich. The purpose of the manageability proof was the use of the overall system under realistic operation conditions. The bearing capacity of the structures was determined during or immediately after inspection. The collected data was tested with the decentralized Pocket PCs, as well as directly on the laptop. The input logic and the menu guidance proved to be very field friendly. In the last two years, the system has been developed further and additional tests have been done, using our own test bridge with 30 m span.

References

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