Adjusted Design Concept for Integral Concrete bridges

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Abstract

In current days the description of the load displacement correlation of the ground normally takes place by indicating a scope (upper and lower boundary value) of the ground stiffness (refer to Eurocode 7). From the geotechnical standpoint it makes sense because the local geological conditions could be covered. For the structural analysis, application of a scope of the ground stiffness brings a strong rise of computational efforts due to the fact that any change of the foundation stiffness leads to a new static system.

With the goal to adjust this procedure to a user-friendly, faultless and economical method an adjusted design concept for integral bridges was developed at the Technische Universität München, Germany. In this article the authors show the problems, explain methods of resolution and illustrate the first results of numerical analysis of different bridge structures by implementation of the new adjusted design concept.

Keywords: Adjusted Design Concept, Integral Concrete Bridge, soil-structure interaction, upper/lower boundary value

https://doi.org/10.2749/222137809796078784

Summary

Integral bridges – i.e. bridges without joints and bearings – are standard for concrete bridges with few and short spans. For medium spans, they can be an interesting and economical alternative to conventional bearing bridges. The omission of bearings and expansion joints mainly reduces maintenance costs but may also improve driving comfort and appearance.

Due to the high grade of statical indeterminacy the design of an integral bridge – a clamped frame – requires the consideration of temperature influence (restraint effects) unlike a conventional bridge with bearings. Furthermore the uncertainty of geological conditions requires the consideration of the soil-structure interaction. For that upper and lower limit values are generally used as soil coefficients (description of the load displacement correlation of the ground) based on currently applicable codes (refer to Eurocode 7). They are varied and combined in such ways as to determine the most adverse effects for the structure.

From the geotechnical standpoint the description of the ground characteristics by indicating a scope of the ground stiffness makes sense because the local geological conditions (e. g. different soil layers, natural variance of the ground characteristics, inaccuracies during construction) could be covered.

For the structural analysis, application of a scope of the ground stiffness brings a strong rise of computational efforts due to the fact that any change of the foundation stiffness leads to a new static system. For design and verification the unfavourable system combination from a multitude of system combinations governs.

With the goal to adjust this procedure to a user-friendly, faultless and economical method an adjusted design concept for integral bridges was developed at the Technische Universität München, Germany. Bases on a spring-supported structural system, the adjusted design concept uses additional base point displacements that model the soil uncertainties in the structural analysis.

In this article the authors show the problems, explain methods of resolution and illustrate the first results of numerical analysis of different bridge structures by implementation of the new adjusted design concept. Using comprehensive comparative calculations, a regression model was deduced with a high quality (correlation of the prediction accuracy). For a specific construction project the additional base point displacements can thus be determined without having to evaluate numerous system combinations allowing for a more economic, practical and safe design procedure for integral concrete bridges.