Modeling of Bearings in Structural Systems for Bridges

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Summary

This paper deals with the representation of laminated rubber bearings in structural systems of bridges. First the main properties of rubber bearings, including the load-deflection-behavior and the moment-rotation-behavior, are presented. These are obtained from experiments and from numerical calculations. Since the properties are in general nonlinear, a series of idealizations are used and explained.
From these properties linearizations are derived, that are commonly used in an analysis of a bridge structure.
For the use with finite- element analysis of structural systems, then a special finite element is introduced, which is able to map some nonlinear characteristics of a real rubber bearing and can handle the interaction between horizontal, vertical and rotational loads. In addition, geometrical nonlinear effects will be taken into account.
The paper closes with an example of a calculation of a bridge structure using the different concepts and representations of the bearings in the structural model. The differences in internal forces and displacements are shown.

Keywords: bridges; structural systems; overall system; deformation bearings; finite element representation; second order theory; system stability;

1. Introduction

Almost every time the construction of bridges is the result of the solution of the challenge to find a structure that will perform its required function and present an acceptable appearance at the least cost. The design process must secure the safety and serviceability, taking into account the economy and appearance of the bridge. Several constraints exist regarding the design, for example requirements from location, soil, traffic route design, the kind and the amount of traffic and not at least environmental needs.

The structural analysis is a main part of bridge design. On the one hand the structure must be able to carry the loading required of it with the appropriate factor of safety. On the other hand the structural analysis should not lead to over dimensioned structures in order to reduce the costs.

Bridge Structures are in general 3-dimensional systems consisting, in the simplest cases, of a superstructure and a substructure that may include several parts (abutments, columns or piers). The substructure and the superstructure are in the most cases connected by structural bearings.

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