Influence of the bearing systems on the buckling behaviour of arch bridges

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Summary

This paper wants to draw the attention on the difference between neoprene and pot bearings. For this purpose, the same finite element model is once equipped with the model of a neoprene bearing and of a pot bearing. Since a transversally restrained neoprene bearing can still move a millimetre in that direction, these possible movements of the bearings are incorporated in the model. The main conclusion of the paper is that there is indeed a difference between the behaviour of the arch in both calculations. The arch supported by neoprene bearings buckles in the opposite direction of an arch supported by pot bearings. It can also be concluded that the model of the arch supported by bearings, modelled in detail has a bigger resistance towards buckling than an identical arch, without detailed modelling of the bearings. The buckling strength of an arch is furthermore greater than of a straight beam with the same section.

Keywords: tied-arch bridge, pot bearings, neoprene bearings, buckling behaviour, finite element modelling, contact problem

1. Introduction

Bearing systems are very seldom incorporated in the calculation methods for the determination of the out-of-plane buckling behaviour of steel tied-arch bridges during the design phase. Nevertheless, the choice of the type, location and size of the bearing systems and specifically the distribution of the bearing systems over the bridge, allowing for transversal and/or longitudinal movements of the bridge can have an important influence on the buckling mode and the critical buckling load. It is after all one of the only parts of the design which introduce asymmetry into the entire bridge concept. Another way to introduce asymmetry into a steel tied-arch bridge is the distribution of the wind bracings along the length of the arch. Possible geometrical imperfections and especially the presence of the second arch are other sources of asymmetrical behaviour. This factor will thus partly determine the buckling form and direction as well as the post-buckling behaviour of the concerned arch bridge.

In addition, this paper wants to report on the results of highly detailed finite element models (FEM) of a representative number of arch bridges. Two types of bearings were studied, the classical neoprene bearing system and the pot bearing system. The neoprene bearing systems are modelled completely, so the influence of the neoprene layers between the steel plates as well as the size and position of the ribs which partly restrict all movements of the bridge is incorporated. This is important since even in the direction where movement is nominally constricted, for this type of bearing system often a small gap exists in the bearing design between the upper and lower rib. Special contact elements are developed so the movement of the bearing system can be studied while the loads are increased linearly until buckling occurs. Analogous, a detailed finite element model was made, for the pot bearing systems.

https://doi.org/10.2749/weimar.2007.0279
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