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Numerical Investigation of the Influence on Buckling Behaviour Due to Different Launching Bearings

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Abstract : In general, today, two types of launching bearings are used in the construction of large steel and steel concrete composite bridges. These are sliding rockers and systems with hydraulic bearings. The advantages and disadvantages of the respective systems are under discussion. During incremental launching, the center of the webs of the superstructure is not perfectly in line with the center of the launching bearings due to unavoidable tolerances, which may have an influence on the buckling behavior of the web plates. These imperfections are not considered in the current design against plate buckling, according to DIN EN 1993-1-5. It is therefore investigated whether the design rules have to take into account any eccentricities which occur during incremental launching and also if this depends on the respective launching bearing. Therefore, at the Technical University Munich, large-scale buckling tests were carried out on longitudinally stiffened plates under biaxial stresses with the two different types of launching bearings and eccentric load introduction. Based on the experimental results, a numerical model was validated. Currently, we are evaluating different parameters for both types of launching bearings, such as load introduction length, load eccentricity, the distance between longitudinal stiffeners, the position of the rotation point of the spherical bearing, which are used within the hydraulic bearings, web, and flange thickness and imperfections. The imperfection depends on the geometry of the buckling field and whether local or global buckling occurs. This and also the size of the meshing is taken into account in the numerical calculations of the parametric study. As a geometric imperfection, the scaled first buckling mode is applied. A bilinear material curve is used so that a GMNIA analysis is performed to determine the load capacity. Stresses and displacements are evaluated in different directions, and specific stress ratios are determined at the critical points of the plate at the time of the converging load step. To evaluate the load introduction of the transverse load, the transverse stress concentration is plotted on a defined longitudinal section on the web. In the same way, the rotation of the flange is evaluated in order to show the influence of the different degrees of freedom of the launching bearings under eccentric load introduction and to be able to make an assessment for the case, which is relevant in practice. The input and the output are automatized and depend on the given parameters. Thus we are able to adapt our model to different geometric dimensions and load conditions. The programming is done with the help of APDL and a Python code. This allows us to evaluate and compare more parameters faster. Input and output errors are also avoided. It is, therefore, possible to evaluate a large spectrum of parameters in a short time, which allows a practical evaluation of different parameters for buckling behavior. This paper presents the results of the tests as well as the validation and parameterization of the numerical model and shows the first influences on the buckling behavior under eccentric and multi-axial load introduction.

Keywords : buckling behavior, eccentric load introduction, incremental launching, large scale buckling tests, multi axial stress states, parametric numerical modelling
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