STABILITY OF A STEEL WELDED GIRDER WITH BENDING AND SHEAR FORCES INCLUDED

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1. INTRODUCTION AND PROBLEM FORMULATION

The stability of the elements of a steel welded girder subjected by bending and shear forces is considered (Figure 1).

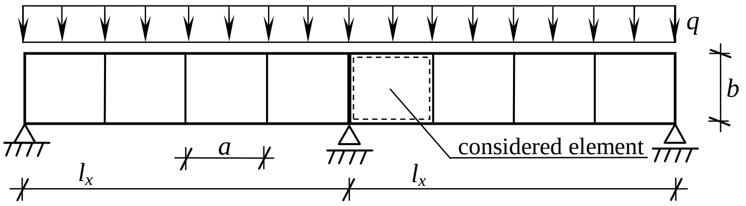

Fig. 1. Steel girder with vertical stiffeners

The correct determination of the critical load is essential in the design process. This issue was investigated and solved in analytical terms by Timoshenko [1]. The Finite Element Method (FEM) is applied to numerical investigation of the stability of the steel welded girder with the bending and the shear forces included. Suitable numerical algorithms of FEM were presented e.g. by Rakowski and Kacprzyk [2]. Others e.g. Shi [3], Chinnaboon, Chucheepsakul and Katsikadelis [4] have used the Boundary Element Method (BEM) to solve the buckling problem of thin plates of any shape including the plates with holes.

2. NUMERICAL EXAMPLES

The element of the steel welded girder is considered and modeled as the rectangular simply-supported plate of dimensions $a = b = 2.0$ m, subjected by N_x and N_{xy} in-plane forces with linear and constant distributions respectively (Figure 2). The material properties are $E = 205$ GPa, $v = 0.3$ and the plate thickness is $h = 0.015$ m. The ABAQUS computational program was used in the analysis. The plate domain is divided into 1600 elements of the S4R and the S8R types and the finite element mesh is regular. The critical loading N_{cr} is expressed using the non-dimensional term $\tilde{N}_{\mathrm{cr}} = N_{\mathrm{cr}} \cdot a \cdot b / D$, where D is the plate stiffness. The results of calculation are presented in Table 1. Additionally, the stability problem of the plate subjected only by N_{xy} in-plane forces was solved as the simple benchmark test (Table 2). The FEM results was compared with the analytical and the BEM solution according conception presented in [5].

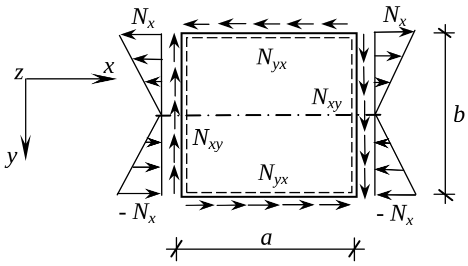

Fig. 2. Considered element of steel welded girder

Table 1. Critical loading value $\tilde{N}_{cr}$. Assumed the comparative compressing loading: $\tilde{N}_x$

$\tilde{N}_{xy}/\tilde{N}_x$	0.0	0.025	0.05	0.1	0.15
FEM (S4R)	251.837	250.498	247.032	236.685	224.229
FEM (S8R)	250.069	248.705	245.227	235.037	222.884

Table 2. Critical loading value $\tilde{N}_{cr}$

Loading: N_{xy}	FEM (S4R)	FEM (S8R)	BEM [5]	Analytical [1]
$\tilde{N}_{xy} = \tilde{N}_{cr}$	92.066	91.454	93.051	92.182

3. SUMMARY

The impact of tangential in-plane loading cannot be avoided. Detailed analysis of the critical load is important in the case of complex structures, included welded girders with stiffeners or holes. This will allow to estimate the maximum value of external loading q.

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