Flange Buckling Behavior of Stainless Steel Girders with Trapezoidally Corrugated Webs

A parametric numerical study

Background and Aim

The replacement of a flat web with a corrugated one in steel girders is a way of increasing the shear buckling capacity, without the need of additional vertical stiffeners. But, except for that, the corrugation of the web changes the bending behavior, more specifically the normal stress buckling behavior of the flange plate. Numerous investigations have been conducted on this subject for trapezoidally corrugated web I-girders in carbon steel, with the one by Jáger et al. [1] being the most extensive one, comprising both experimental and numerical investigations. But, no design models for trapezoidally corrugated web I-girders in stainless steel are available.

The current study aims at investigating the normal stress flange buckling of trapezoidally corrugated web I-girders in stainless steel in terms of the elastic buckling coefficient and required reduction factor.

Method and Results

The analyses are performed in the analysis software ABAQUS. The results of the parametric numerical studies are compared to the existing models for carbon steel girders suggested by Eurocode 3 (EN1993-1-5) [2], the DASt Richtlinie 015 [3] and Jáger et al. [1] In case these prove to be inaccurate, a design model is developed. In total, **450** girders with varying geometries are analyzed.

The results of the comparisons generally show that the method of approximating the buckling coefficient and required reduction factor developed by Jáger et al. [1] is an improvement compared to Eurocode 3 [2]. The DASt Richtlinie 015 [3] leads to the most inaccurate approximations of the reduction factor. In general, all models show insufficient accuracy in the prediction of the buckling coefficient and reduction factor.

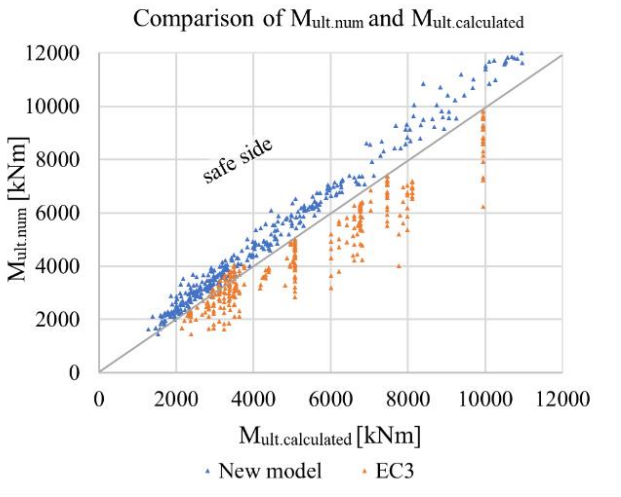

Figure 1: A comparison in estimation accuracy of ultimate moment capacities, M_{ult}, according to the developed model and Eurocode 3.

Conclusions

The suggested buckling curve of Eurocode 3 [2], originally developed for flat web girders, has a too high relative slenderness limit of $\overline{\lambda_p} = 0.748$, which, according to the obtained results, should be $\overline{\lambda_p} = 0.4$. This is the main reason behind the Eurocode model resulting in over-estimations for almost all analysed girders. The improvement in the accuracy of estimations demonstrated by the design models of Jáger et al. [1] are concluded to be the result of considering several parameters related to corrugation geometry. This insight is applied in the development of a new model to approximate the buckling coefficient, consequently used as input parameter in the expression of the relative slenderness ratio $\overline{\lambda_p}$. A buckling curve is then designed as a function of this parameter. The accuracy of the developed model is demonstrated in Figure 1.

References

[1] Dunai, L., Jáger, B., Kövesdi, B. (2017): Flange buckling behavior of girders with corrugated web Part II: Numerical study and design method development. *Thin-Walled Structures*, Vol. 118, 2017, pp. 238-252.

[2] CEN (2019). *Eurocode 3: Final draft of the EN1993-1-5*. Brussels.

[3] DASt-Richtlinie 015 (1990): *Träger mit schlanken Stegen* (Girders with slender webs). Stahlbau-Verlagsgesellshaft, Köln, 1990.