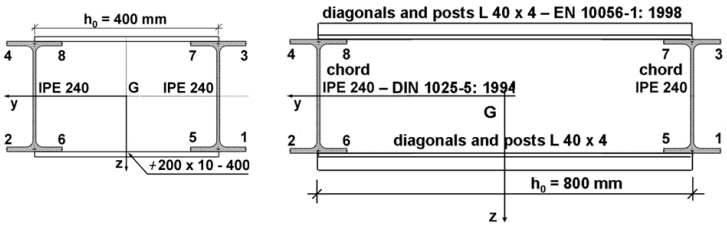
COMPUTATIONAL MECHANICS 2018
34th conference with international participation
Srní
October 31 - November 2, 2018

Analysis of metal built-up members

I. Baláž [a], Y. Koleková [b], L. Moroczová [b]

[a] *Department of Metal and Timber Structures, Faculty of Civil Engineering, Slovak University of Technology in Bratislava, Radlinského 11, 810 05 Bratislava, Slovak Republic*
[b] *Department of Structural Mechanics, Faculty of Civil Engineering, Slovak University of Technology in Bratislava, Radlinského 11, 810 05 Bratislava, Slovak Republic*

Battened built-up member. The analysis of the 2nd order with imperfection is used in calculations. The geometrical equivalent global initial sway imperfection is taken according to EN 1993-1-1. The column is made of steel S355. The yield strength f_y = 355 MPa, the safety factors γ_{M0} = 1.0, γ_{M1} = 1.0. The member cross-section is given in Fig. 1.



a) battened built-up member b) laced built-up member

Fig. 1. Cross-section of the built-up columns 2 IPE 240 – DIN 1025-5: 1994

The design values of the external actions applied at the column top with the length L = 7.2 m are given in Fig. 2 together with the obtained results of the analytical analysis. The horizontal force $H_{Ed,tot}$ consists of two parts: the external force H_{Ed} = 22 kN and the replacement of the global initial sway imperfection by equivalent horizontal force $N_{Ed}\Phi$ = 850 kN / 268.328 = 3.205 kN.

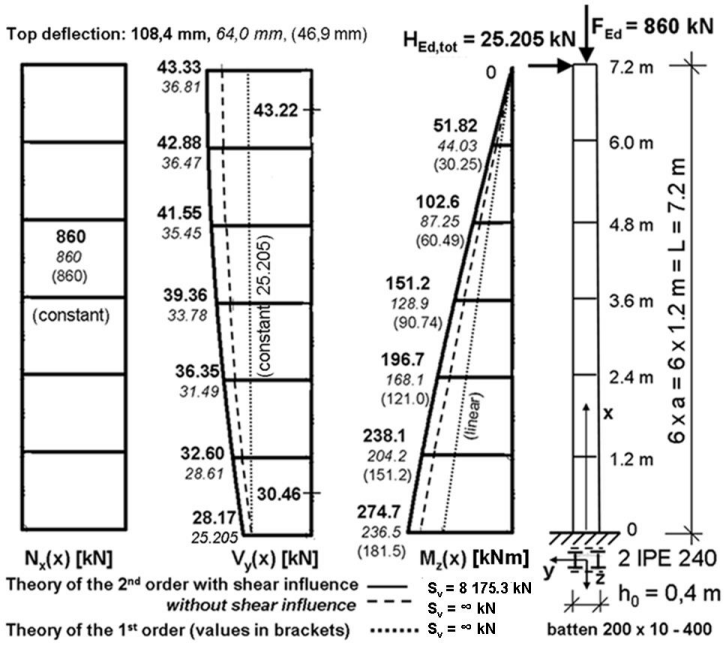


Fig. 2. Column geometry, actions and distributions of the internal forces $N_x(x)$, $V_y(x)$, $M_z(x)$

Laced built-up member. The cross-section is in Fig. 1 b). The design values of the external actions applied at the column top with the length L = 7.2 m are given in Fig. 3 together with the obtained results of the analytical analysis.

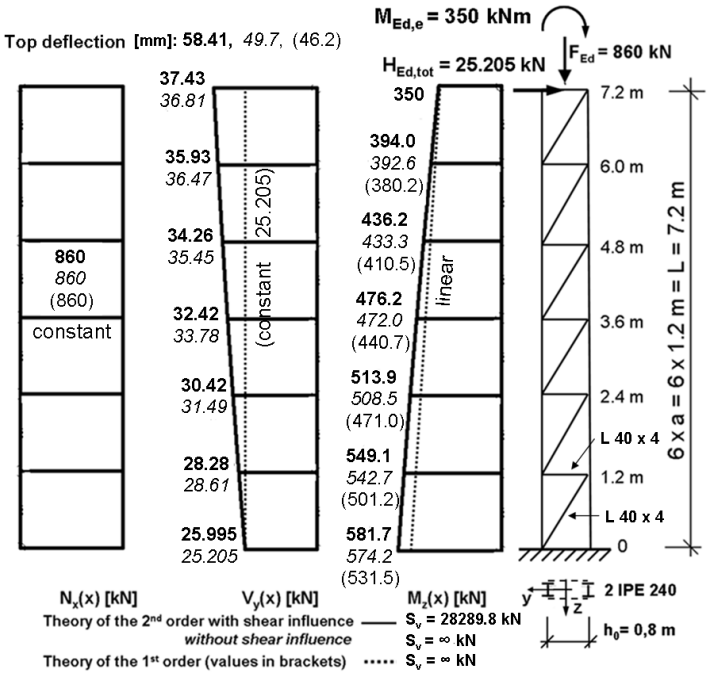


Fig. 3. Column geometry, actions and distributions of the internal forces $N_x(x)$, $V_y(x)$, $M_z(x)$

Conclusions. The most important parameters of the member are: the shear parameter γ, the member parameter ε, the parameter α_{cr} and amplification factor k_{II} ($M_{II} = k_{II} M_I$), see Table 1.

Table 1. Shear parameter γ, member parameter ε, α_c and amplification factor k_{II}. Index V indicates shear effects

Member parameters	Battened built-up member	Laced built-up member
$\gamma = \left[1/\left(1 - N_{Ed}/S_V\right)\right]^{0.5}$	1.118 (1.0 without shear influence)	1.031 (1.0 without shear influence)
$\varepsilon = L\left[\gamma N_{Ed}/\left(EI_{eff}\right)\right]^{0.5}$	0.863	0.418
$\alpha_{cr,V} = N_{cr,V}/N_{Ed}$	3.702 (for $N_{cr,V}$); 2.664 (for $N_{.cr}$)	14.542 (for $N_{cr,V}$); 10.084 (for $N_{.cr}$)
$k_{II,V} \approx \alpha_{cr,V}/\left(\alpha_{cr,V} - 1\right)$	1.370 (for $N_{cr,V}$); 1.601 (for $N_{.cr}$)	1.074 (for $N_{cr,V}$); 1.110 (for $N_{.cr}$)
by calculation: $k_{II,V} = M_{II,V}/M_I$	274.7 / 181.5 = 1.513	581.7 / 531.5 = 1.094

Notes: These parameters give to the designer information about built-up members without doing calculations similar to those in Figs. 2 and 3. More details including analytical solutions and Eurocode EN 1993-1-1 verification conditions may be found in [2, 3]. The comparisons of the results of the analytical solutions given in Figs. 2 and 3 with the results of the computer program IQ 100 [4] shown zero differences. The calculations according to the former Czechoslovak standard STN 73 1401: 1968 are in [1].

Acknowledgements

Project No. 1/0603/17 was supported by the Slovak Grant Agency VEGA.

References

[1] Balaz, I., Agocs, Z., Metal Structures, Part I., ES STU Bratislav, Bratislav, 1994. (in Slovak).
[2] Balaz, I., Kolekova, Y., Moroczova, L., Battened built-up member under compression and bending with one end fixed and the other end free, Proceedings of the 3rd International Conference on ESaT, Tatranské Matliare, 2018, pp. 12-14.
[3] Balaz, I., Kolekova, Y., Moroczova, L., Behaviour of steel laced built-up column, ESaT, Ibidem, 2018.
[4] Rubin, H., Aminbaghai, M., Weier, H., IQ 100, Vollversion Feb. 2010, TU Wien.