decivil universidade de aveiro departamento de engenharia civil

EN 1993-1-2: LATERAL-TORSIONAL BUCKLING RESISTANCE MOMENT OF STAINLESS STEEL BEAMS IN CASE OF FIRE

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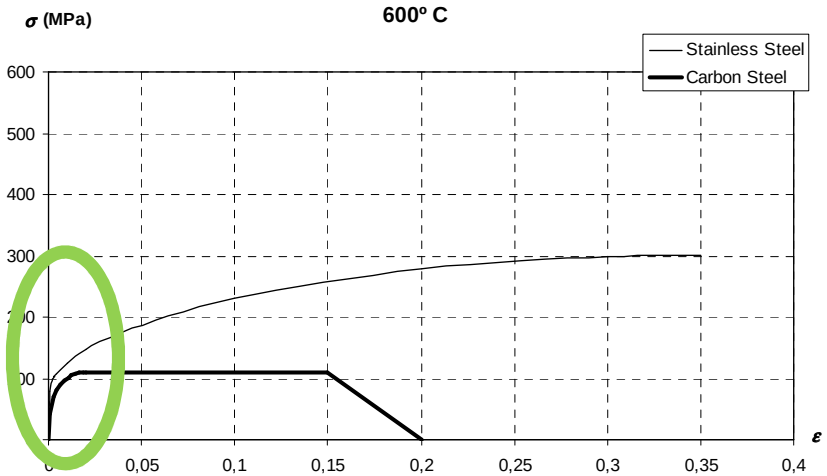
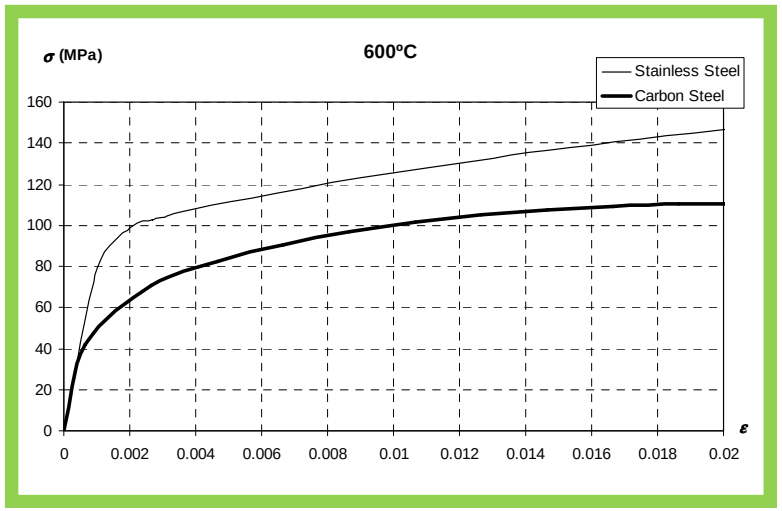
LABEST - Universidade de Aveiro

Carbon Steel vs Stainless steel at hight temperature

Eurocode 3 states that stainless steel structural members, subjected to high temperatures, must be designed with the same expressions used for carbon steel members. However, as these two materials have different constitutive laws, it should be expected that different formulae for the calculation of member stability should be used.

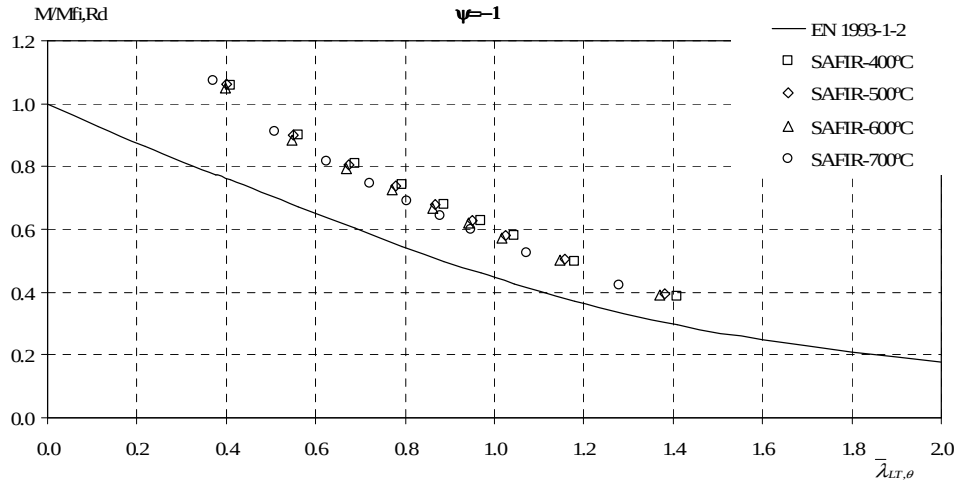


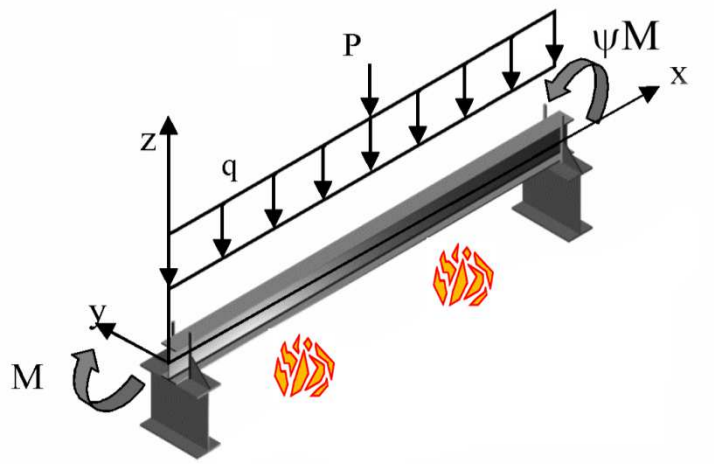


Stainless steel 1.4301 vs Carbon steel S235

Unrestrained beams at high temperatures

EC3 (EN 1993-1-2) Needs improvement





$$M_{b,fi,t,Rd} = \chi_{LT,fi} W_{pl,y} k_{y,\theta} f_y / \gamma_{M,fi}$$

$$\chi_{LT,fi} = \frac{1}{\phi_{LT,\theta,com} + \sqrt{\phi^2_{LT,\theta,com} - \bar{\lambda}^2_{LT,\theta,com}}} \quad \text{with} \quad \chi_{LT,fi} \le 1$$

$$\phi_{LT,\theta,com} = \frac{1}{2}\left(1 + \alpha\bar{\lambda}_{LT,\theta,com} + \bar{\lambda}^2_{LT,\theta,com}\right) \qquad \alpha = 0.65\sqrt{235/f_y}$$

Unrestrained beams at high temperatures

"Full" proposal

$$M_{b,fi,t,Rd} = \chi_{LT,fi,\mathrm{mod}} W_{pl,y} k_{y,\theta} \, f_y / \gamma_{M,fi}$$

$$\chi_{LT,fi,\mathrm{mod}} = \frac{\chi_{LT,fi}}{f} \quad \text{but} \quad \chi_{LT,fi,\mathrm{mod}} \le 1$$

$$f = 1 - 0.65(1 - k_c)$$

$$\chi_{LT,fi} = \frac{1}{\phi_{LT,\theta,com} + \sqrt{\phi^2_{LT,\theta,com} - \bar{\lambda}^2_{LT,\theta,com}}} \quad \text{with} \quad \chi_{LT,fi} \le 1$$

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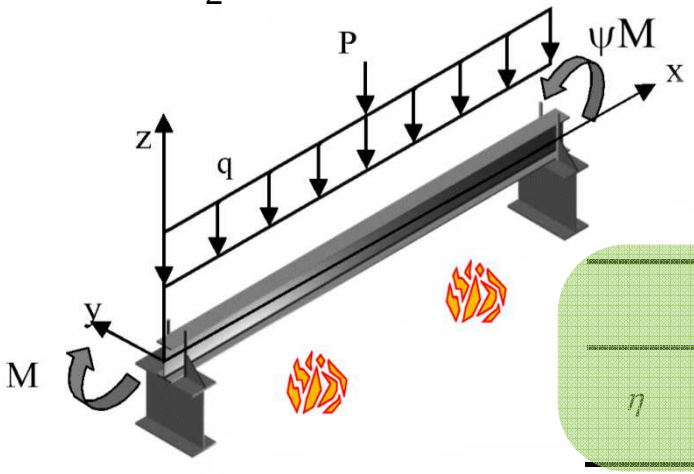
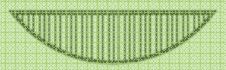
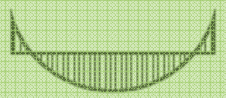
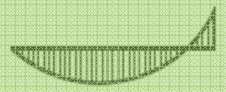
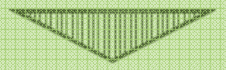
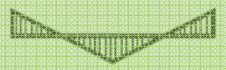


$$\alpha = \eta\sqrt{\frac{235}{f_y}}\sqrt{\frac{E}{210000}}\sqrt{\frac{k_{E,\theta}}{k_{y,\theta}}}$$

	1.4301; 1.4401; 1.4404; 1.4571	1.4462 and 1.4003
η	$0.22\left(\frac{h}{b}\right) + 0.38$	$0.16\left(\frac{h}{b}\right) + 0.34$

Moment distribution	k_c
M ψM  $-1 \le \psi \le 1$	$\frac{1}{1.33 - 0.33\psi}$ but $k_c \le 1$
	0.94
	0.90
	0.91
	0.86
	0.77
	0.82

Simplified proposal

$$\alpha = 0.9\sqrt{235 / f_y}$$

Unrestrained beams at high temperatures
The effect of factor f

The factor f

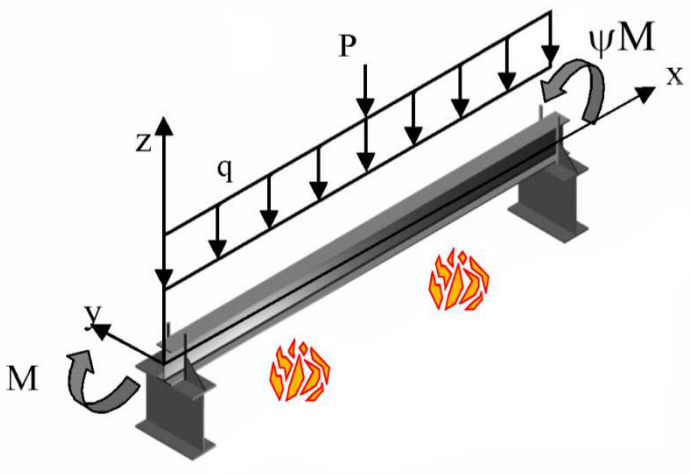
$$M_{b,fi,t,Rd} = \chi_{LT,fi,\mathrm{mod}} W_{pl,y} k_{y,\theta} \, f_y / \gamma_{M,fi}$$

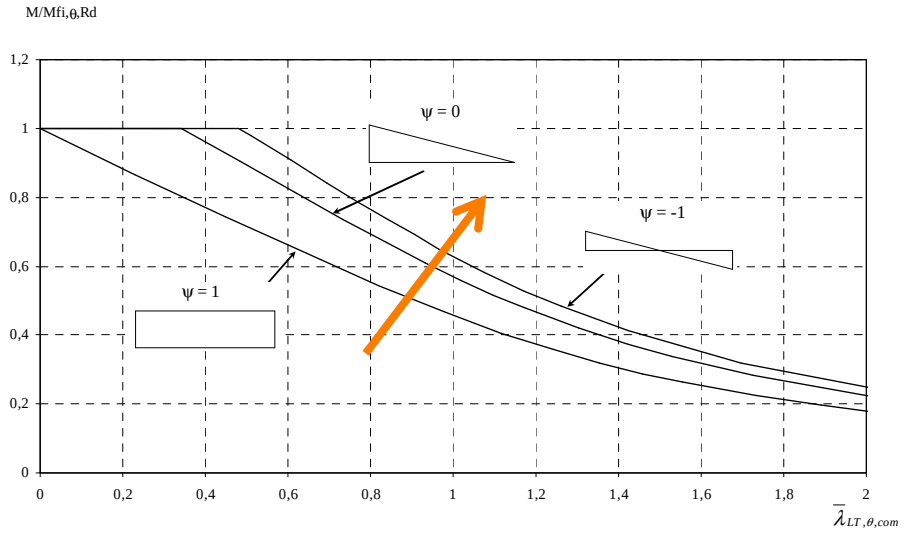
$$\chi_{LT,fi,\mathrm{mod}} = \frac{\chi_{LT,fi}}{f} \quad \text{but} \quad \chi_{LT,fi,\mathrm{mod}} \le 1$$

$$f = 1 - 0.65(1 - k_c)$$

$$\chi_{LT,fi} = \frac{1}{\phi_{LT,\theta,com} + \sqrt{\phi^2_{LT,\theta,com} - \overline{\lambda}^2_{LT,\theta,com}}} \quad \text{with} \quad \chi_{LT,fi} \le 1$$

$$\phi_{LT,\theta,com} = \frac{1}{2}\left(1 + \alpha\overline{\lambda}_{LT,\theta,com} + \overline{\lambda}^2_{LT,\theta,com}\right)$$

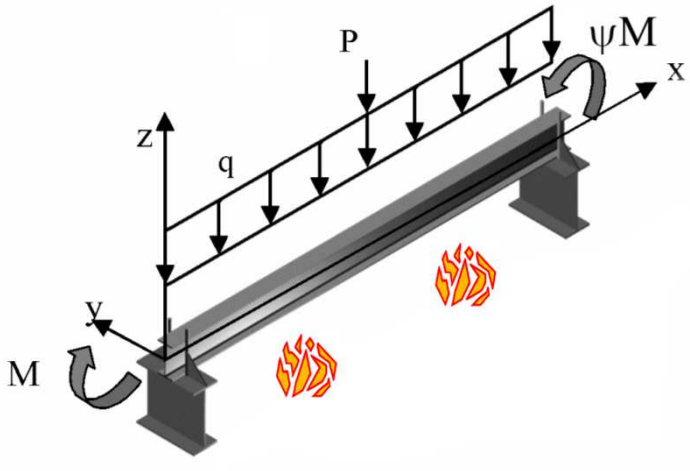


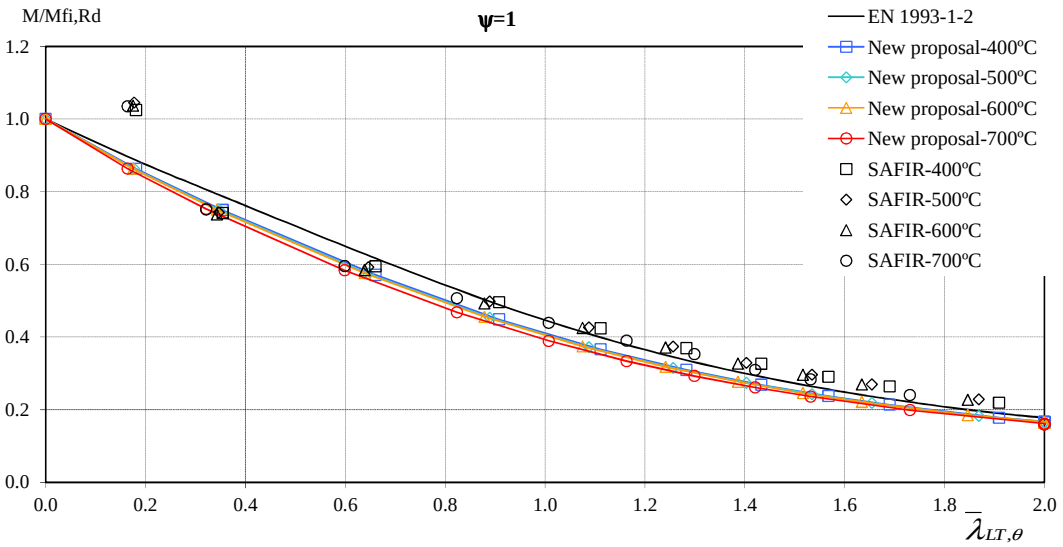


Unrestrained beams at high temperatures

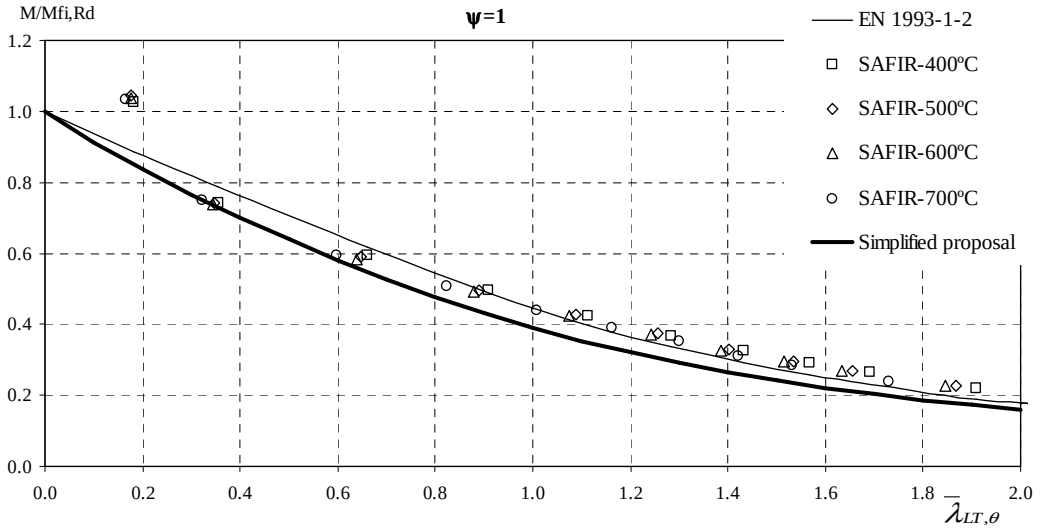
“Full” proposal

IPE220
1.4301





Simplified proposal



Unrestrained beams at high temperatures

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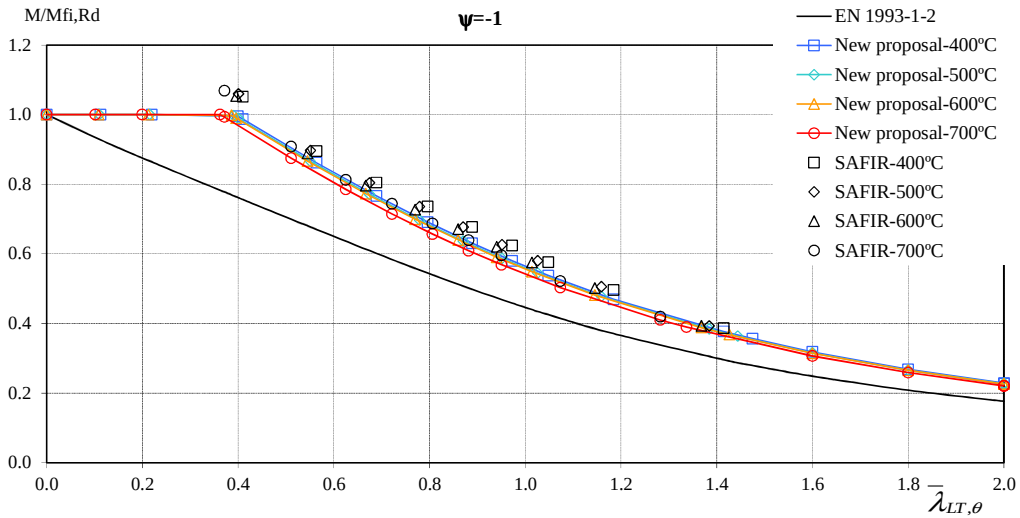
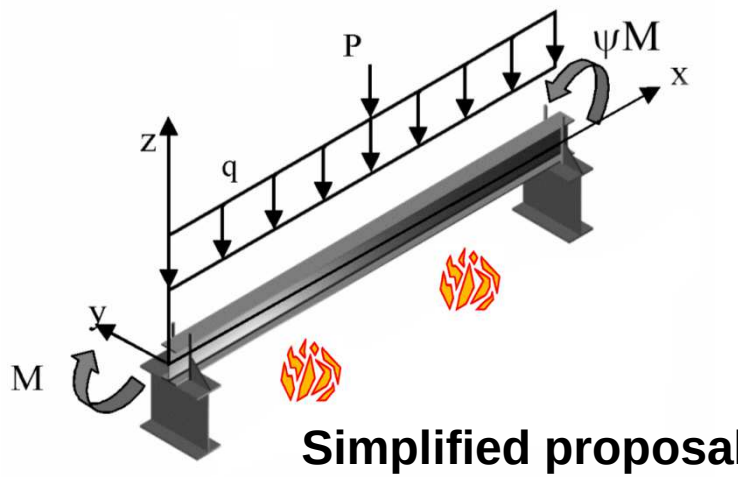
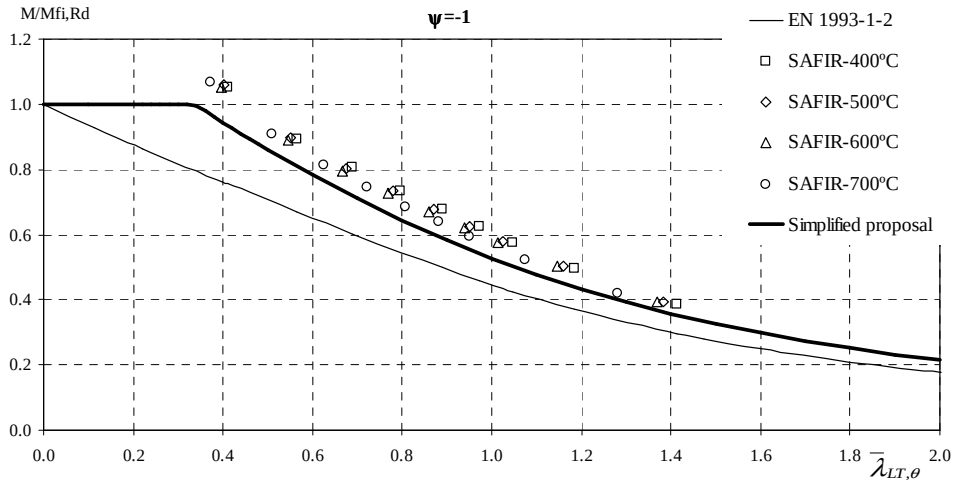




Simplified proposal



References:

VILA REAL, P.; LOPES, N.; SIMÕES DA SILVA, L.; FRANSSEN, J.-M. *"Lateral-torsional buckling of Stainless steel I-beams in case of fire"*, Journal of Constructional Steel Research, ELSEVIER, ISSN 0143-974X, volume 64/11, pp 1302-1309, November of **2008**.

LOPES, N.; VILA REAL, P.; SIMÕES DA SILVA, L.; FRANSSEN, J.-M. "Lateral-torsional buckling on carbon steel and stainless steel beams with lateral loads plus end moments in case of fire", proceedings of the 6th International Conference on Structures in Fire SiF'10, pp. 67-74, ISBN 978-1-60595-027-3, East Lansing, United States of America, 2 to 4 of June of **2010**.

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Thank you for your attention

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