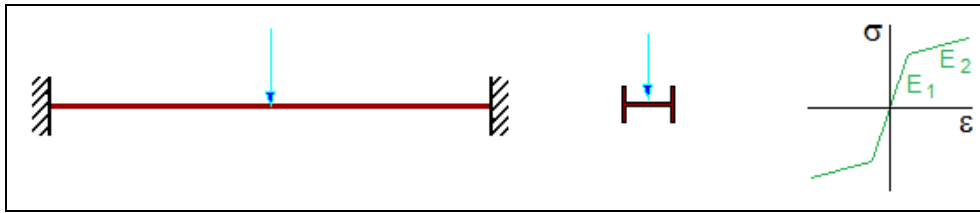


CURAN: BEAMS (HERMITIAN)	TEST 020	rev.1 21/10/13	version 10.70
VALIDATION, CROSS CHECKS, RELIABILITY, BENCHMARK	Tested by: Marco Croci - Checked by: Paolo Rugarli		



MODEL		
MODEL NAME	OUTPUT FILE	ANALYSIS TYPE
curanBE 020.WSR	curanBE 020.CS1.EEN	nonlinear static (Curan)

DATA						
L [mm]	P [N]	E ₁ [N/mm ²]	E ₂ [N/mm ²]	σ _y [N/mm ²]	I [mm ⁴]	W _{p1} [mm ³]
5000	500000	210000	208000	235	1.336E+07	207000

THEORETICAL COMPUTATION

Maximum bending moment is $M_{max}=PL/8=3.125E+08\text{Nmm}$.

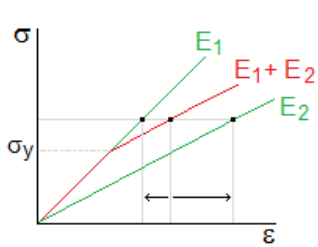
Since σ_y is exceeded*, it is not simple to compute beam displacements. We know that the displacement computed considering bilinear constitutive law (E_1+E_2) must be greater than the displacement computed considering a linear law with $E=E_1$ but smaller than the displacement computed considering a linear law with $E=E_2$ (see image).

Midspan displacement are computed as follows; the displacement computed by Sargon ($\delta_{E_1+E_2}$) must be inside that range: $\delta_{E_1} < \delta_{E_1+E_2} < \delta_{E_2}$.

$$\delta_{E_i} = \frac{PL^3}{192E_i I} \rightarrow \delta_{E_1} = 11.61 \text{ and } \delta_{E_2} = 11.72$$

In order to have a very small range, the difference between E_1 and E_2 is equal to 1% only. For $E_1=E_2$, it would be $\delta_{E_1}=\delta_{E_1+E_2}=\delta_{E_2}$.

(*) $P(\sigma_y)=8M_{p1}/L < P$, with $M_{p1}=W_{p1} \cdot \sigma_y$ (see test 011 for comparison)



CROSS-CHECK

Value	Theory	Sargon	% difference (S-T)/T*100
M_{max} [Nmm]	3.125E+08	3.125E+08	0.0

Displacement check	
$\delta_{E_1} < \delta_{E_1+E_2} < \delta_{E_2} \rightarrow 11.61 < 11.71 < 11.72$	CHECKED

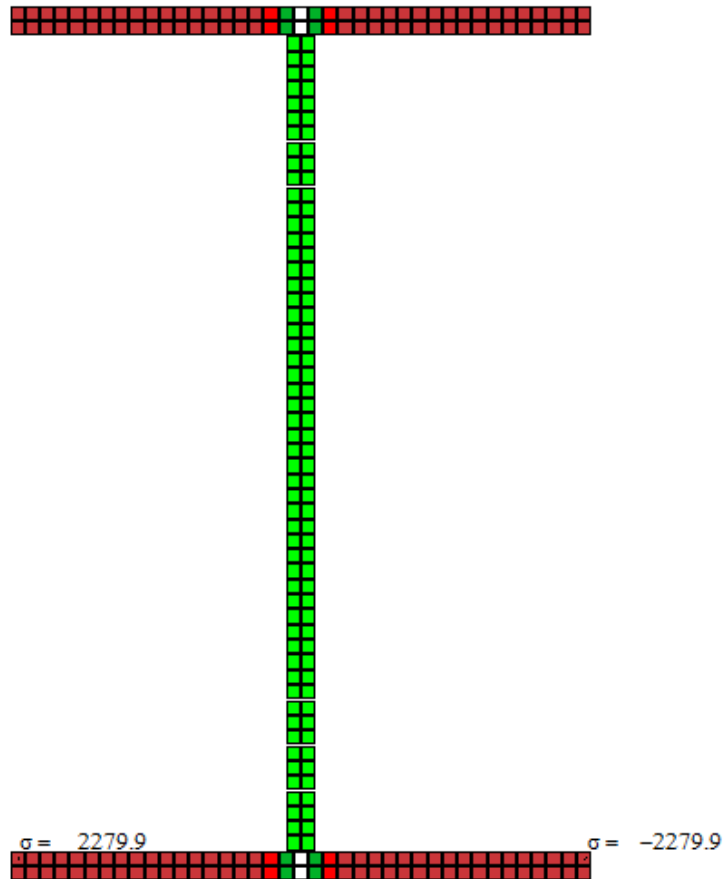
NOTES

- force is parallel to flanges (weak axis bending).
- shear area: not considered.
- Analysis parameters: Lobatto's points: 5. Fibers number: 250
- Beam elements number: 2

NONLINEAR FIBER MODEL ANALYSIS RESULTS - NORMAL STRESS

Beam #1 Lobatto's section #1 (csi = -1.000) Lcase = 1 / 1

Sigma, max= 2279.9 N/mm²; Sigma, min= -2279.9 N/mm²;



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