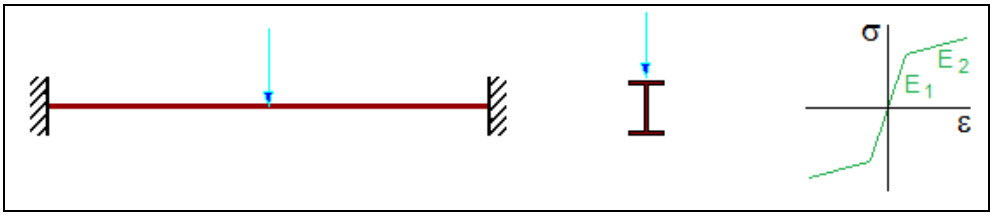
CURAN: BEAMS (HERMITIAN)	TEST 019	rev.1 21/10/13	version 10.70
VALIDATION, CROSS CHECKS, RELIABILITY, BENCHMARK	Tested by: Marco Croci - Checked by: Paolo Rugarli		



MODEL		
MODEL NAME	OUTPUT FILE	ANALYSIS TYPE
curanBE_019.WSR	curanBE_019.CS1.EEN	nonlinear static (Curan)

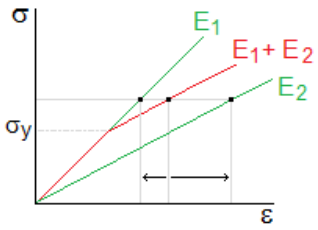
DATA

L [mm]	P [N]	E_1 [N/mm²]	E_2 [N/mm²]	σ_y [N/mm²]	I [mm⁴]	W_{pl} [mm³]
5000	500000	210000	208000	235	1.024E+08	776000

THEORETICAL COMPUTATION

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

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 (δ_{E1+E2}) must be inside that range: $\delta_{E1}<\delta_{E1+E2}<\delta_{E2}$.

$$\delta_{Ei}=\frac{PL^3}{192E_iI} \quad \rightarrow \quad \delta_{E1}=15.13 \quad \text{and} \quad \delta_{E2}=15.28$$

In order to have a very small range, the difference between E_1 and E_2 is equal to 1% only. For E1=E2, it would be $\delta_{E1}=\delta_{E1+E2}=\delta_{E2}$.

(*) $P(\sigma_y)=8M_{pl}/L$ < P, with $M_{pl}=W_{pl}*\sigma_y$ (see test 005 for comparison)

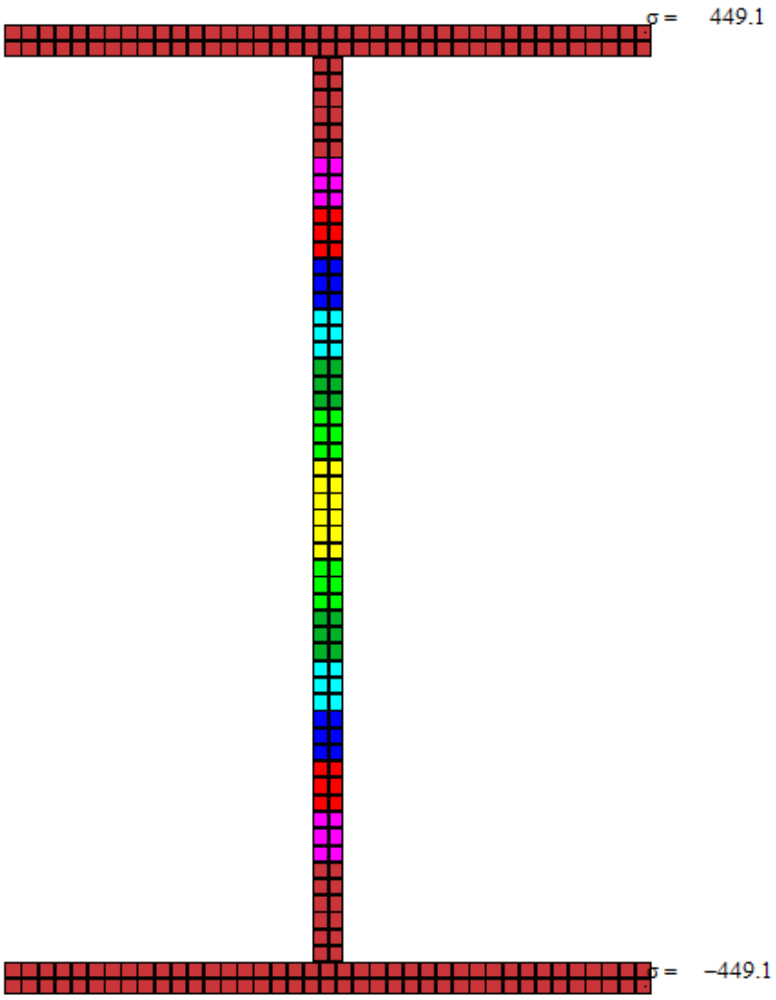
CROSS-CHECK

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

Displacement check	
$\delta_{E1}<\delta_{E1+E2}<\delta_{E2}$	$\rightarrow$ 15.13<15.17<15.28 CHECKED

NOTES
- force is parallel to web (strong 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= 449.1 N/mm²; Sigma, min= -449.1 N/mm²;



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