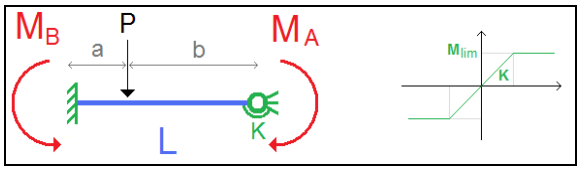
CURAN: BEAMS (HERMITIAN)	TEST 021	rev.1 21/10/13	version 10.70
VALIDATION, CROSS CHECKS, RELIABILITY, BENCHMARK	Tested by: Marco Croci - Checked by: Paolo Rugarli		



MODEL

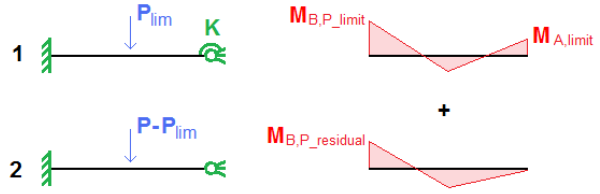
MODEL NAME	OUTPUT FILE	ANALYSIS TYPE
curanBE_021.WSR	curanBE_021.CS1.EEN	nonlinear static (Curan)

DATA

L [mm]	P [N]	a [mm]	b [mm]	E [N/mm^2]	I [mm^4]	K [Nmm/rad]	M_{limit} [Nmm]
1000	1000	500	500	210000	6.667E+03	4.200E+06	4.000E+04

THEORETICAL COMPUTATION

Beam material is linear elastic (fibers are not modeled).
It is possible to consider the sum of 2 schemes:
1) end **A** semirigid - end **B** fixed until M_A reaches the limit value.
2) end **A** hinge - end **B** fixed for the residual force $P_{residual}=P-P_{limit}$, where P_{limit} is the force giving $M_A=M_{limit}$.



To get moment values with P_{limit}, it is possible to compute the scheme (1) considering an indefinitely linear elastic spring and the full load P: the ratio between P_{limit} and P is equal to the ratio between M_{limit} and $M_{A,linear}$.

$$M_{A,linear}=\frac{rPL}{4-r}\frac{a}{L}\frac{b}{L}\left[3\left(1-\frac{a}{L}\right)\right] \qquad r=\frac{1}{1+\frac{3EI}{KL}}=0.5 \qquad P_{\text{limit}}=P\frac{M_{A,\text{limit}}}{M_{A,linear}}$$

$$M_{B,linear}=\frac{PL}{4-r}\frac{a}{L}\frac{b}{L}\left[2\left(1+\frac{a}{L}\right)-0.5\left(2-\frac{a}{L}\right)\right] \qquad M_{B,\text{P\_limit}}=M_{B,linear}\frac{P_{\text{limit}}}{P}$$

$$M_{B,residual}=\frac{3(P_{residual})L}{16} \qquad M_{B,total}=M_{B,P\_\text{limit}}+M_{B,residual}$$

CROSS-CHECK

End Moment	Theory [Nmm]	Sargon [Nmm]	% difference (S-T)/T*100
$M_A=M_{limit}$	4.000E+04	4.000E+04	0.0
$M_B=M_{B,total}$	1.675E+05	1.675E+05	0.0

NOTES
- force is parallel to web (strong axis bending).
- Formulae for M_A and M_B computation given in *Practical Analysis of Semi-Rigid Frame Design*, Editor: W F Chen, World Scientific Publishing.
- r_i=0: hinge; r_i=1: fixed.
- shear area: not considered. Beam elements number: 2