CURAN: BEAMS (HERMITIAN)	TEST 026	rev.1 21/10/13	version 10.70
VALIDATION, CROSS CHECKS, RELIABILITY, BENCHMARK	Tested by: Marco Croci – Checked by: Paolo Rugarli		
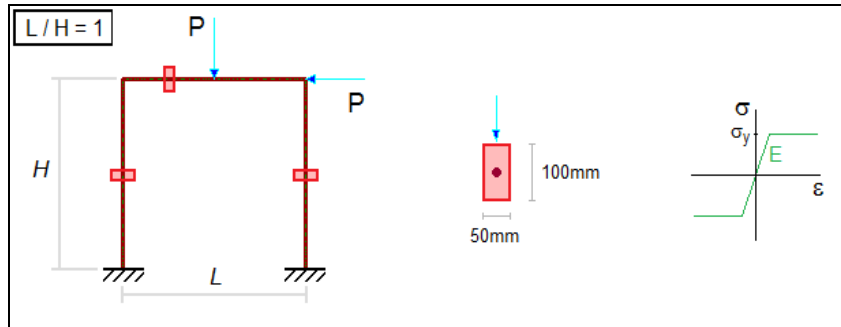
MODEL

MODELS NAME (see notes)	OUTPUT FILES (see notes)	ANALYSIS TYPE
curanBE_026_elem_xxxx.WSR	curanBE_026_elem_xxxx.cog	nonlinear static (Curan)

DATA

L [mm]	L/H	P [N]	E [N/mm^2]	σ_y [N/mm^2]	W_{pl} [mm^3]
3000	1	78333	210000	235	125000

THEORETICAL COMPUTATION

Material is elastic-perfectly plastic. For L/H=1, frame failure occurs when (see note below):

$$P_{lim} = 4M_{pl} / L$$

where $M_{pl} = W_{pl} * \sigma_y = 125000mm^3 * 235N/mm^2 = 2.938E+07Nmm$ It is

$$P_{lim} = 4 * 2.938E+07Nmm / 3000mm = 39167N < P$$

Since applied load P is greater than limit load P_{lim}, frame failure occurs. Load multiplier is:

$$P_{lim} / P = 39167N / 78333N = 0.5$$

CROSS-CHECK

| Value	Model	Number of beam elements	Theory	Sargon	% difference (S-T)/T*100
Load multiplier	curanBE_026_elem_0006	6	0.5	0.6304	26.1
Load multiplier	curanBE_026_elem_0012	12	0.5	0.5617	12.3
Load multiplier	curanBE_026_elem_0024	24	0.5	0.5276	5.5
Load multiplier	curanBE_026_elem_0048	48	0.5	0.5077	1.5
Load multiplier	curanBE_026_elem_0096	96	0.5	0.5067	1.3
Load multiplier	curanBE_026_elem_0192	192	0.5	0.4993	-0.1
Load multiplier	curanBE_026_elem_0384	384	0.5	0.4909	-1.8

NOTES
- 7 different models were created, with different meshes; precision of load multiplier computation depends on mesh refinement. Each model name ends with the number of elements (for example, *curanBE_026_elem_0006.WSR* has 6 elements; related output file is *curanBE_26_elem_0006.cog*).
- Theoretical multiplier is computed according to *Calcul Plastique des Constructions*, Ch. Massonnet, M. Save - Italian translation by AA.VV. from Istituto di Scienza e Tecnica delle Costruzioni del Politecnico di Milano, Clup Milano, 1982.
- Applied force is computed in order to get a theoretical load multiplier exactly equal to 0.5.
- Analysis parameters: Lobatto's points: 5. Fibers number: 1000.
- Shear area: not considered.
- Fibers stress in relevant sections of the last model are shown in the following page.

1

NONLINEAR FIBER MODEL ANALYSIS RESULTS - NORMAL STRESS
Beam #1 Lobatto's section #1 (csi = -1.000) Lcase = 1 / 1
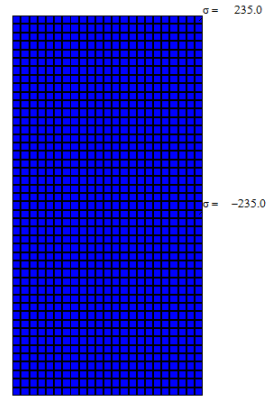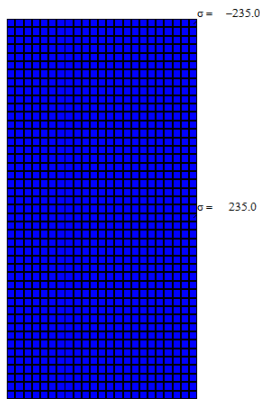Sigma, max=   235.0 N/mm²; Sigma, min= -235.0 N/mm²;
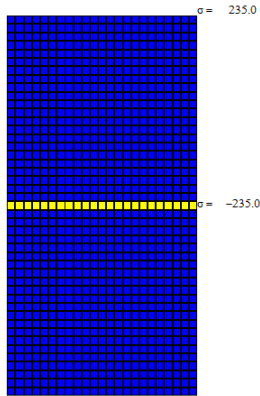
σ =   235.0

σ = −235.0

2

NONLINEAR FIBER MODEL ANALYSIS RESULTS - NORMAL STRESS
Beam #3 Lobatto's section #1 (csi = -1.000) Lcase = 1 / 1
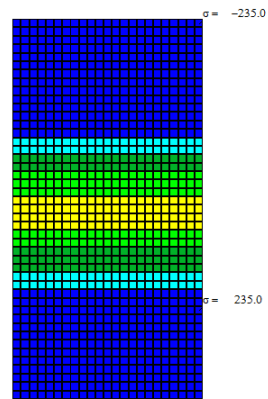Sigma, max=   235.0 N/mm²; Sigma, min= -235.0 N/mm²;

σ =   235.0

σ = −235.0

3

NONLINEAR FIBER MODEL ANALYSIS RESULTS - NORMAL STRESS
Beam #384 Lobatto's section #5 (csi = 1.000) Lcase = 1 / 1
Sigma, max=   235.0 N/mm²; Sigma, min= -235.0 N/mm²;

σ = −235.0

σ =   235.0

4

NONLINEAR FIBER MODEL ANALYSIS RESULTS - NORMAL STRESS
Beam #2 Lobatto's section #2 (csi = -0.655) Lcase = 1 / 1
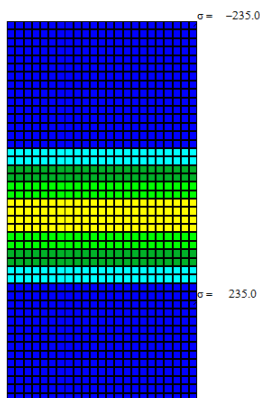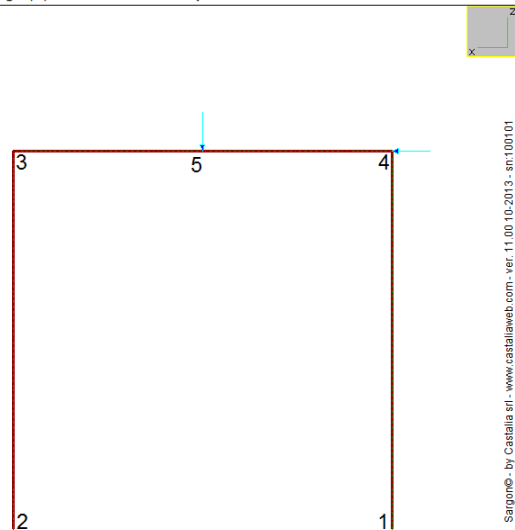Sigma, max=   235.0 N/mm²; Sigma, min= -235.0 N/mm²;

σ = −235.0

σ =   235.0

5

NONLINEAR FIBER MODEL ANALYSIS RESULTS - NORMAL STRESS
Beam #4 Lobatto's section #1 (csi = -1.000) Lcase = 1 / 1
Sigma, max=   235.0 N/mm²; Sigma, min= -235.0 N/mm²;

σ = −235.0

σ =   235.0

3   5   4

2   1