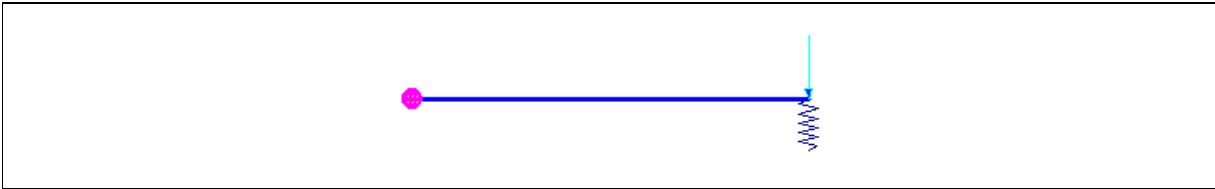


**Validation of Sargon Nonlinear solver (CURAN, version 9.70)**

**TEST SP004**

**VALIDATION, RELIABILITY, BENCHMARK**

**Marco Croci Rev.1-09/03/2011**



**Test description**

A spring has been added under the free end of a cantilever. The spring has a gap so that it starts to react after a displacement equal to 10mm. Since in this test the spring is infinitely rigid, once it reacts it prevents further displacements of beam end.

Test model: **curanSP\_004.WSR**

**Springs properties**

$k_1$ [N/mm]	$D_y$ [mm]	$(k_2)$ [N/mm]	$(D_u)$ [mm]	Gap [mm]	Law
$\infty$	$\infty$	/	/	$\pm 10$	symmetric

**Beam properties**

Length	Shape	Material
3000mm	IPE300 $J=83561000\text{mm}^4$	S235 $E=210000\text{N/mm}^2$ $\nu=0,3$

**Loads and constraints**

Left end	Right end	Force
Fixed	Spring	$F = -50000\text{N}$

**CHECK**

Without the spring, the displacement of the simple cantilever would be equal to  $FL^3/(3EJ)=-25,64\text{mm}$  and maximum bending moment would be equal to  $F*L=1,5*10^8\text{Nmm}$ . Since the infinitely rigid spring limits the displacement to  $-10\text{mm}$ , computed moment should be equal to  $1,5*10^8\text{Nmm}*10\text{mm}/25,64\text{mm}=5,85*10^7$ .

Load case	Value	Unit	CURAN	THEORETICAL	% diff.
1	Node 8 displacement (z)	mm	$-1,000\text{E}+01$	$-1,000\text{E}+01$	0,00
1	Beam #1 max bending moment	Nmm	$5,849\text{E}+07$	$5,850\text{E}+07$	-0,02

% difference = (CURAN - THEORETICAL) / THEORETICAL \* 100

Precision of limit multiplier for the analysis: 0.005