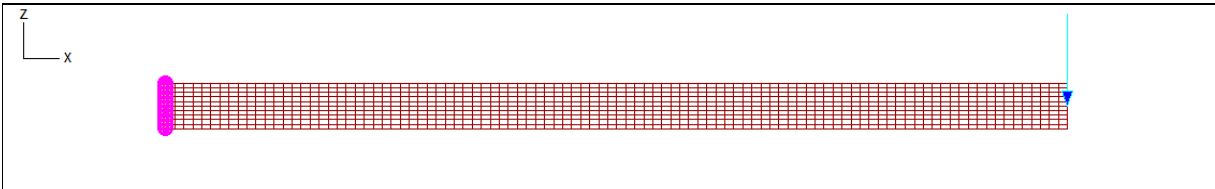


<b>Validation of Sargon Nonlinear solver (CURAN, version 9.60)</b>			
<b>TEST MB004</b>	<b>VALIDATION, CROSS CHECKS, RELIABILITY, BENCHMARK</b>	<b>Marco Croci</b>	<b>25/11/2010</b>



<b>Test description</b>	
Constitutive law of membranes material: linear elastic. Solution should coincide with a linear elastic solution.	
Theoretical check and cross-check with Sargon linear solver (CLEVER)	
Test model: <b>curanMB_003.WSR</b>	Target model: <b>C003MB_CLEVER.WSR</b>

<b>Material properties</b>		
Name	ν	E
S235LE	0,3	210000N/mm <sup>2</sup>

<b>Model data</b>
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<b>Beam</b>			<b>Constraints</b>		<b>Load (z direction)</b>	
LENGTH	HEIGHT	THICKNESS	LEFT	RIGHT	APPLICATION POINT	FORCE
10000mm	500mm	100mm	Fixed	Free	Right end	-100000N

Membrane elements	Type	Thickness	d.o.f.
1000 (10x100)	QM6WI	100mm	2200

<b>CROSS CHECK</b>
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Displacement in the middle of the beam is  $\delta = FL^3/3EI + L\chi T/2GA$  where  $\chi$  is shear factor and T is internal shear force

<b>Load case</b>	<b>Value</b>	<b>Unit</b>	<b>CURAN</b>	<b>TARGET</b>	<b>KIND</b>	<b>% diff.</b>
1	Node 24 displacement (z)	mm	-1,525E+02	-1,527E+02	theoretical	-0,12
1	$\sigma_{vm}$ element 830, node 848	N/mm <sup>2</sup>	1,031E+02	1,031E+02	cross-check	0,00
1	$\sigma_x$ element 830, node 848	N/mm <sup>2</sup>	1,030E+02	1,030E+02	cross-check	0,00

$$\% \text{ difference} = (\text{CURAN} - \text{TARGET}) / \text{TARGET} * 100$$

Precision of limit multiplier for the analysis: 0.005  
 QM6WI: 4 nodes incompatible element with Wilson-Ibrahimbegovic modification