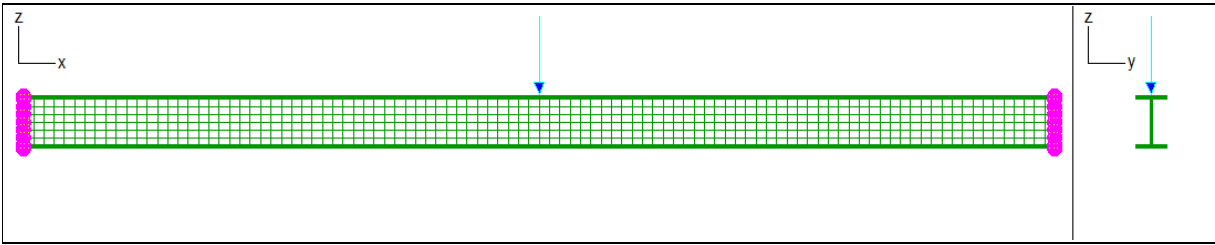


|  |   |                    |                   |
|--|---|--------------------|-------------------|
| <b>Validation of Sargon Nonlinear solver (CURAN, version 9.60)</b> |   |                    |                   |
| <b>TEST SO019</b>  | <b>VALIDATION, CROSS CHECKS, RELIABILITY, BENCHMARK</b> | <b>Marco Croci</b> | <b>02/12/2010</b> |

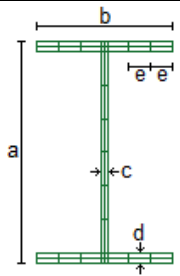


| Test description   |  |
|--|--|
| Constitutive law of membranes material: linear elastic. Solution should coincide with a linear elastic solution. |  |
| Theoretical check and cross-check with Sargon linear solver (CLEVER)   |  |
| Test model: <b>curanso_019.WSR</b>   | Target model: <b>C019SO_CLEVER.WSR</b> |

| Material properties |       |                         |
|---------------------|-------|-------------------------|
| Name                | $\nu$ | E                       |
| S235LE              | 0,3   | 210000N/mm <sup>2</sup> |

| Model data |
|------------|
|------------|

| Beam           |             | Constraints |       | Load (z direction) |          |
|----------------|-------------|-------------|-------|--------------------|----------|
| LENGTH         | SHAPE SIZES | LEFT        | RIGHT | APPLICATION P.     | FORCE    |
| 10000mm        | See image   | Fixed       | Fixed | Middle point       | -100000N |
| a              | b           | c           | d     | e                  |          |
| 500mm          | 300mm       | 14,5mm      | 28mm  | 50mm               |          |
| Solid elements |             | Type        |       | d.o.f.             |          |
| 4400           |             | BRICK8SRI   |       | 20493              |          |



| CROSS CHECK |
|-------------|
|-------------|

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

| Load case | Value                               | Unit              | CURAN      | TARGET     | KIND        | % diff. |
|-----------|-------------------------------------|-------------------|------------|------------|-------------|---------|
| 1         | Node 1638 displacement (z)          | mm                | -2,799E+00 | -2,806E+00 | theoretical | -0,24   |
| 1         | $\sigma_x$ element 2952, node 4052  | N/mm <sup>2</sup> | 2,844E+01  | 2,844E+01  | cross-check | 0,00    |
| 1         | $\tau_{zx}$ element 2952, node 4052 | N/mm <sup>2</sup> | 5,136E-02  | 5,136E-02  | cross-check | 0,00    |

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

Precision of limit multiplier for the analysis: 0.005  
 BRICK8SRI: trilinear isoparametric element with reduced integration