SSNL111 - Three thermoelastoplastic bars perfect Von Mises

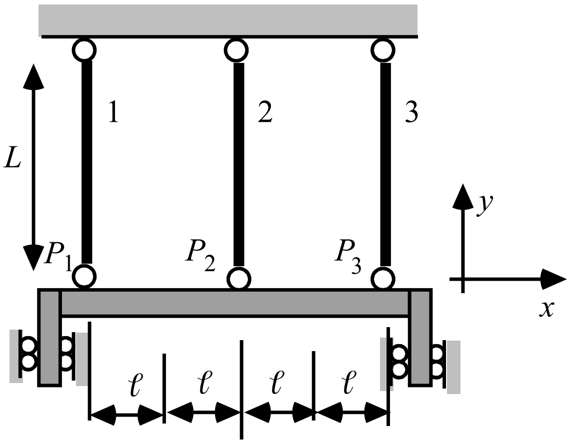
Abstract:

This quasi-static test enters the frame of the elastoplastic validation of the behavior models.
Three perfect, parallel thermoelastoplastic bars, rotulées on a rigid support at an end and rotulées on a rigid bar with the other, undergo an external thermal loading.

This application, where all the fields are uniform in each bar makes it possible to validate 2 numerical types of modelizations: massive finite elements ($2D$ plane stresses), plates and bars.

1 Problem of reference

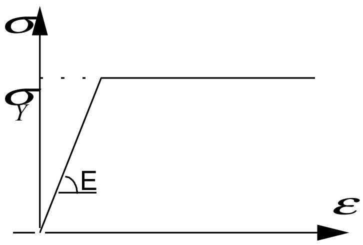
1.1 Geometry



the three bars have the same length $L=1\text{m}$, and are spaced of $l=1\text{m}$.

1.2 Material properties

thermoelastoplastic Constitutive law perfect standard, with criterion of Von Mises. Plastic strains are null in an initial state.



E = 200000 MPa
ν= 0.3
σ_Y = 200 MPa
α= 0.00001

1.3 Boundary conditions and loadings

the three bars have a following displacement blocked Oy at the points higher ends, where they are articulated, and they are attached at the lower points $P_{1,} P_{2,} P_3$, which one can represent by a rigid frame compels to move vertically, length $4l$ on which the three bars are pin-jointed. The bars are free of mechanical force.

The way of loading is described by the change of the temperature, uniform in each bar ($T^{max}=330°C$):

2 Reference solution

2.1 Method of calculating used for the reference solution

to refer to the document [bib1] which provides the thermoelastoplastic solution.

2.2 Results of reference

Modelization A
σ_{yy} in $P1$ $P2$ $P3$.

Modelization B
constant normal N Force on each bar (value identical to σ_{yy} , because one took a section equalizes to 1).

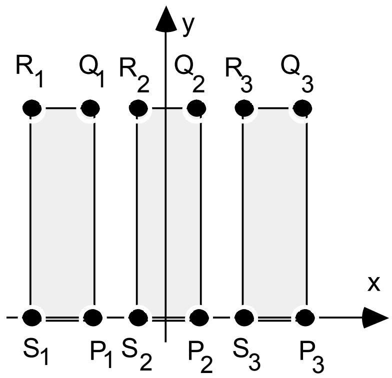
2.3 Bibliographical references

• S. ANDRIEUX: Thermoelastoplastic TD 1 Three bars perfect Von Mises. In “Initiation with thermoplasticity in the Code_Aster”, HI-74/96/November 13th, 1996 (manual of reference of the course).

3 Modelization A

3.1 Characteristic of the modelization

Elements $2D$ (`QUAD4`). Modelization `C_PLAN`.



3.2 Characteristics of the mesh

Many nodes: 12.
Number of meshes and types: 3 `QUAD4`.

3.3 Quantities tested and results

Identification	Times	Node	Reference	*Aster*	Variation %
σ_{yy}	1	*P1*	– 200	– 200.00000	0.100
σ_{yy}		*P2*		100.00000	0.100
σ_{yy}		*P3*		100.00000	0
σ_{yy}	2	*P1*	– 200	– 200.00036	1.8 E-4
σ_{yy}		*P2*	100	100.00017	1.7 E-4
σ_{yy}		*P3*	100	100.00017	1.7 E-4
σ_{yy}	3	*P1*	20	19.99978	– 1.1 E-3
σ_{yy}		*P2*	– 120	– 119.99989	– 0.8 E-4
σ_{yy}		*P3*	100	100.00010	1 E-4
σ_{yy}	4.200	*P1*		200.00060	3 E-4
σ_{yy}		*P2*	– 100	– 100.00008	0.8 E-4
σ_{yy}		*P3*	– 100	– 100.00008	0.8 E-4
σ_{yy}	5.200	*P1*		200.00002	0.1 E-4
σ_{yy}		*P2*	– 100	– 100.00011	1.1 E-4
σ_{yy}		*P3*	– 100	– 100.00011	1.1 E-4

4 Modelization B

4.1 Characteristic of the modelization

3 elements $1D$ (SEG2). Modelization BARS

4.2 Characteristic of the mesh

6 nodes.
3 meshes SEG2

4.3 Quantities tested and results

Identification	Times	Bar N °	Reference	*Aster*	Variation $\%$
normal force N	1	1	– 200	– 200	0
normal force N		2.100.100			0
normal force N		3.100.100			0
normal force N	2	1	– 200	– 200	0
normal force N		2.100.100			0
normal force N		3.100.100			0
normal force N	3	1	20	20	0
normal force N		2	– 120	– 120	0
normal force N		3.100.100			0
normal force N	4	1.200.200			0
normal force N		2	– 100	– 100	0
normal force N		3	– 100	– 100	0
normal force N	5	1.200.200			0
normal force N		2	– 100	– 100	0
normal force N		3	– 100	– 100	0

5 Summary of the results

the results provided by *Code_Aster* are in excel agreement with the analytical solution.