SSNL107 - Plate clamped subjected to a bending by beams in contact with Summarized free

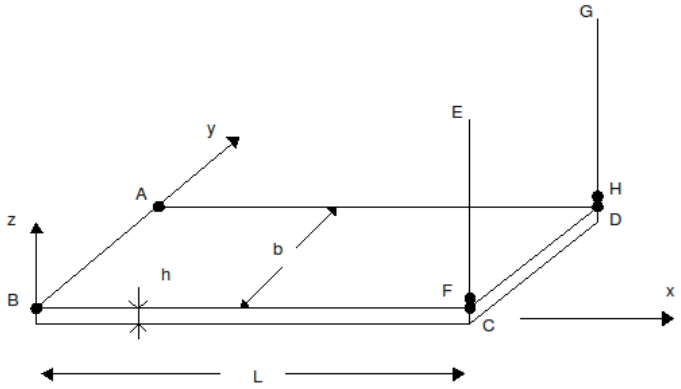
edge:
This test validates the unilateral contact between beam elements POU_D_E (straight beam of Eulerian) and shell elements DKQ.

The main features are:
- linear behavior,
- analyzes elastic,
- unilateral contact,
- 2 modelizations: elements POU_D_E and DKQ by means of CONTACT in AFFE_CHAR_MECA and AFFE_CHAR_MECA_F.

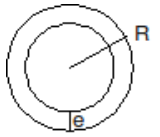
The reference solution is analytical and the got results are of good quality.

1 Problem of reference

1.1 Geometry



EF Plates	ABCD	
	length of	$L=10\text{mm}$
	width of	$B=1\text{mm}$
thickness 2 beams and GH		$H=0.1\text{mm}$
	length	$I=1\text{mm}$
	Of section circulars	$R=2.10-3$, $e=2.10-4$



1.2 Material properties

linear Elasticity: $E=2\,10^5\,MPa$, $\nu=0.3$
Identical for the plate and the two beams.

1.3 Boundary conditions and loadings

Fixed support on AB : $DX=DY=DZ=DRX=DRY=DRZ=0$
Displacement imposed in E and G : $DZ=-0.2\,mm$
Unilateral contact enters F and C enters H and D

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the Analytical reference solution

the plate undergoes a pure bending. The solution is of the type “” poutre' “:

$$V=DZ(C)=DZ(D)=\frac{PL^3}{3\mathrm{E.I}_y} \qquad \text{with } I_y=\frac{bh^3}{12}$$

the deflection V and the load P are unknown.
The two beams are in pure compression:

$$-P=2.\frac{ES}{L}(V-U) \qquad \text{with } U=DZ(E)=DZ(G)$$

One can thus find P and V from these two equations. One obtains:

$$P=\frac{6E\ S\ I\ U}{2\mathrm{SL}^3+3\mathrm{I}_y l}$$

$$V=\frac{2\mathrm{SL}^3\ U}{2\mathrm{SL}^3+3\mathrm{I}_y l}$$

2.2 Results of reference

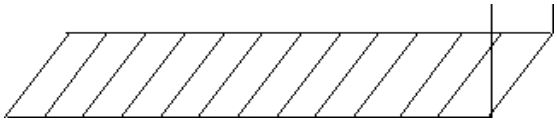
$V=-0.19005\ \ mm$
$P=-9.5025\ \ 10^{-3}\ \ N$

2.3 Uncertainty on the solution

Null. Analytical solution.

3 Modelization B

3.1 Characteristic of the modelization



20 shell elements DKQ
2 beam elements POU_D_E

There exists a clearance ($0.2\,mm$) between the points H and D in the mesh.
One introduces a fictitious clearance ($0.2\,mm$) between the points F and C by the key word DIST_ESCL of DEFI_CONTACT with FORMULATION=' DISCRETE".
The contact is treated between meshes the POI1 thanks to key word ESCL_FIXE of DEFI_CONTACT.

3.2 Characteristics of the mesh

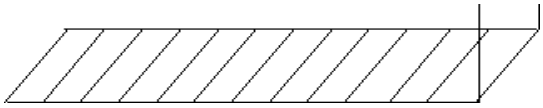
Many nodes: 46
Number of meshes and types: 20 QUAD4, 2 SEG2

3.3 Quantities tested and results

Identification			Reference	% tolerance
C	*DZ*	*N46*	– 0.19005	0.03
D	*DZ*	*N45*	– 0.19005	0.03
EF	*N*	*M22*	– 4.75126 10^{-3}	0.58
GH	*N*	*M21*	– 4.75126 10-3	0.58

4 Modelization C

4.1 Characteristic of the modelization



20 shell elements DKQ
2 beam elements POU_D_E

There exists a clearance ($0.2\,mm$) between the points H and D in the mesh.
One introduces a fictitious clearance between the points F and C by the key word DIST_ESCL of DEFI_CONTACT. This clearance is declared like a function of time, of constant value equalizes with $0.2\,mm$.
This problem is solved in FORMULATION=' DISCRETE'.

4.2 Characteristics of the mesh

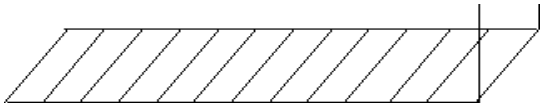
Many nodes: 46
Number of meshes and types: 20 QUAD4, 2 SEG2

4.3 Quantities tested and results

Identification			Reference	% tolerance
C	*DZ*	*N46*	– 0.19005	0.10
D	*DZ*	*N45*	– 0.19005	0.10
EF	*N*	*M22*	– 4.75126 10^{-3}	1.00
GH	*N*	*M21*	– 4.75126 10-3	1.00

5 Modelization D

5.1 Characteristic of the modelization



20 shell elements DKQ
2 beam elements POU_D_E

There exists a clearance ($0.2\,mm$) between the points H and D in the mesh.
One introduces a fictitious clearance between the points F and C by the key word DIST_ESCL of DEFI_CONTACT. This clearance is declared like a constant equalizes with $0.2\,mm$.
This problem is solved by algorithm GCP in FORMULATION=' DISCRETE'.

5.2 Characteristics of the mesh

Many nodes: 46
Number of meshes and types: 20 QUAD4, 2 SEG2

5.3 Quantities tested and results

Identification			Reference	% tolerance
C	*DZ*	*N46*	– 0.19005	0.10
D	*DZ*	*N45*	– 0.19005	0.10
EF	*N*	*M22*	– 4.75126 10^{-3}	1.00
GH	*N*	*M21*	– 4.75126 10-3	1.00

6 Summary of the results

the results are very close to the analytical solution (0.58%). They are not exact because they depend on the smoothness of the mesh of the plate.

The results show the good performance of the contact unilateral between the beams and the plate.