SSLV114 - Motions of solid body 2D and 3D

Summarized:

This test of the command validates (in 2D and 3D) `key word` LIAISON_SOLIDE `AFFE_CHAR_MECA`.

This key word is used to rigidify a set of nodes by linear relations expressing that displacements of the “rigidified” nodes are dependant between them by the equation:

$$U(M)=U(A)+\Omega(A)\wedge AM$$

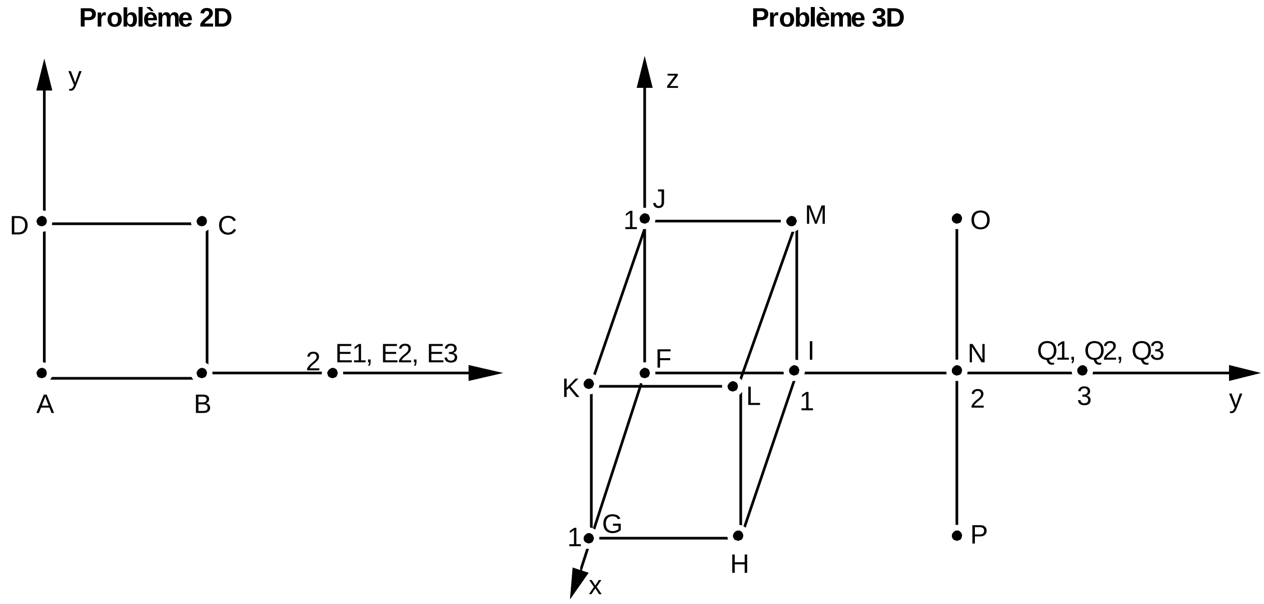
This equation is valid only in small displacements.

The problem tests 2D and 3D as well as the cas particuliers:

- geometrically confused nodes (2D and 3D),
- aligned nodes (in 3D).

1 Problem of reference

1.1 Geometry



1.2 Material properties

$E=0$

$\nu=0$

the finite elements present in this problem are only used to define the degrees of freedom carried by the nodes. Their stiffness must be null.

1.3 Boundary conditions and loadings

In this problem, one defines “solid” nodes groups:

- in 2D:
  - A, B, C, D
  - $E1, E2, E3$
- in 3D:
  - F, G, H, I, J, K, L, M
  - O, N, P
  - $Q1, Q2, Q3$

For each one of these nodes groups, one imposes partial displacements so that the “solids” move while respecting:

In 2D: $$\begin{cases} translation : T(A)=T(E1)=\begin{pmatrix} 2. \\ 3. \end{pmatrix} \\ rotation : \theta(A)=\theta(E1)=0.01 \end{cases}$$

In 3D:

$$\begin{cases} translation \quad : \quad T(F)=T(N)=T(Q1)=\begin{pmatrix}2.\\3.\\4.\end{pmatrix} \\ rotation \quad : \quad \theta(F)=\theta(N)=\theta(Q1)=\begin{pmatrix}0.001\\0.002\\0.003\end{pmatrix} \end{cases}$$

Selected displacements forced to lead to required displacements "solid" are:

2D

$DX(A)=2.$ $\quad DX(E1)=2.$
$DY(A)=3.$ $\quad DY(E1)=3.$
$DY(B)=3.001$ $\quad$ (+ $DRZ(E1)=0.001$ for the modelization B)

3D

$DX(F,N,Q1)=2.$
$DY(F,N,Q1)=3.$
$DZ(F,N,Q1)=4.$

$DY(J,O)=2.002$
$DY(J,O)=2.999$

$DX(I)=1.997$

+ $DRZ(N)=0.003$ for the modelization B
$DRX(Q1)=0.001$
$DRY(Q1)=0.002$
$DRZ(Q1)=0.003$

2 Reference solution

2.1 Méthode de calcul used for the reference solution

the motion of "solids" being imposed, the reference solution (in displacement) is imposed motion.

The reference solution is thus exact (in small rotations).

2.2 Results of reference

In 2D: $U(C)=\begin{pmatrix}1.999\\3.001\end{pmatrix}$ $U(E2)=\begin{pmatrix}2.\\3.\end{pmatrix}$

In 3D: $U(L)=\begin{pmatrix}1.999\\3.002\\3.999\end{pmatrix}$ $U(P)=\begin{pmatrix}1.998\\3.001\\4.000\end{pmatrix}$ $U(Q3)=\begin{pmatrix}2.\\3.\\4.\end{pmatrix}$

2.3 Uncertainty on the solution

exact Solution.

3 Modelization A

3.1 Characteristic of the modelization

the finite elements assigned on meshes the mesh are those of modelizations D_PLAN and 3D. The degrees of freedom carried by the nodes are thus:

DX , DY in 2D

DX DY , DZ 3D

3.2 Characteristic of the mesh

Many nodes: 21

Number of meshes and types: 1 QUAD4, 1 HEXA8, 8 SEG2

3.3 Values tested

	Identification	Reference
	$DX(C)$	1.999
	$DY(C)$	3.001
2D	$DX(E2)$	2.000
	$DY(E2)$	3.000
	$DX(L)$	1.999
3D	$DY(L)$	3.002
	$DZ(L)$	3.999
	$DX(P)$	1.998
	$DY(P)$	3.001
	$DZ(P)$	4.000
	$DX(Q3)$	2.000
	$DY(Q3)$	3.000
	$DZ(Q3)$	4.000

4 Modelization B

4.1 Characteristic of the modelization

the finite elements assigned on meshes the mesh are those of modelizations D_PLAN, COQUE_C_PLAN, 3D and POU_D_E.

- the nodes 2D carry the degrees of freedom DX, DY (+ DRZ for B and $E1$),
- the nodes 3D carry the degrees of freedom DX DY, DZ (+ DRX DRY, DRZ for I, N and $Q1$).

4.2 Characteristics of the mesh

Many nodes: 21

Number of meshes and types: 1 QUAD4, 1 HEXA8, 10 SEG2

4.3 Values tested

	Identification	Reference
	$DX(C)$	1.999
	$DY(C)$	3.001
2D	$DX(E2)$	2.000
	$DY(E2)$	3.000
	$DX(L)$	1.999
3D	$DY(L)$	3.002
	$DZ(L)$	3.999
	$DX(P)$	1.998
	$DY(P)$	3.001
	$DZ(P)$	4.000
	$DX(Q3)$	2.000
	$DY(Q3)$	3.000
	$DZ(Q3)$	4.000

5 Summary of the results

the results are excellent ($\varepsilon \leq 10^{-12}$).