# SSLV114 - Movements of solid body 2D and 3D

**Summary:**

This test validates (in 2D and 3D) the keyword `LIAISON_SOLIDE` order `AFFE_CHAR_MECA`.

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

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

This equation is valid only in small displacements.

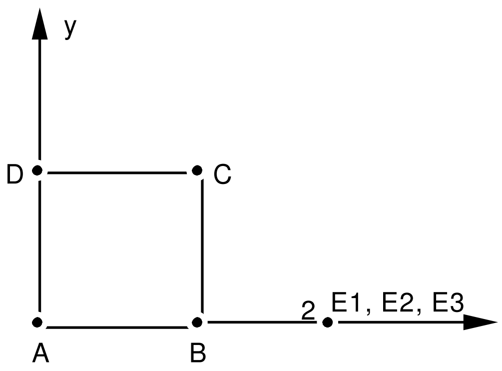
The problem tests the 2D and the 3D as well as the typical cases:

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

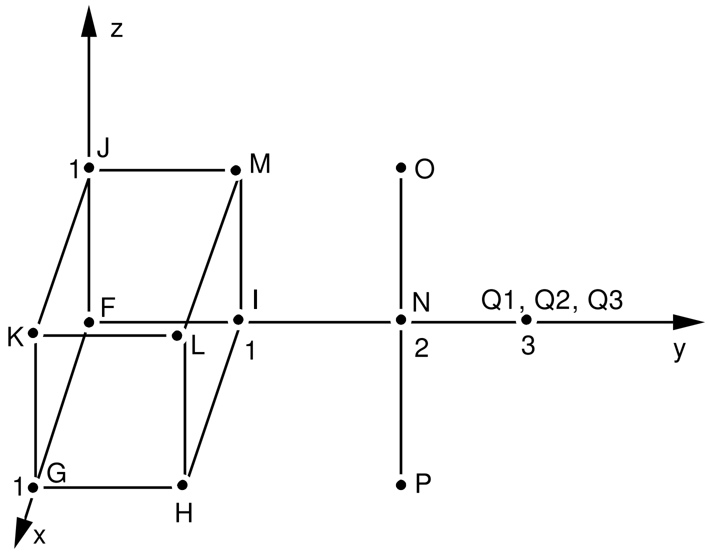
# 1 Problem of reference

## 1.1 Geometry

**Problème 2D**




**Problème 3D**




## 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 rigidity must be worthless.

## 1.3 Boundary conditions and loadings

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

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

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

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
$DX(A)=2.$ $DX(E1)=2.$
$DY(A)=3.$ $DY(E1)=3.$
$DY(B)=3.001$ (+ $DRZ(E1)=0.001$ for modeling 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 modeling B
$DRX(Q1)=0.001$
$DRY(Q1)=0.002$
$DRZ(Q1)=0.003$

# 2 Reference solution

## 2.1 Method of calculating used for the reference solution

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

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 Modeling A

## 3.1 Characteristics of modeling

The finite elements affected on the meshs of the grid are those of modelings `D_PLAN` and `3D`. The degrees of freedom carried by the nodes are thus:

$DX$ , $DY$ in 2D,

$DX$ , $DY$ , $DZ$ in 3D

## 3.2 Characteristics of the grid

Many nodes: 21

Many meshs 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 Modeling B

## 4.1 Characteristics of modeling

The finite elements affected on the meshs of the grid are those of modelings 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 grid

Many nodes: 21

Many meshs 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 ( $\varepsilon \leq 10^{-12}$ ).