SSLP100 - Stick in static substructure

Summary:

This CAS-test validates the static under-structuring, consistent in the condensation of the matrices of rigidity and the loadings.

One carries out the plane modeling of a structure having a linear behavior.

2 Modelings:

- Model a: “ordinary” plan: it is the reference solution.
- B: models with substructures.

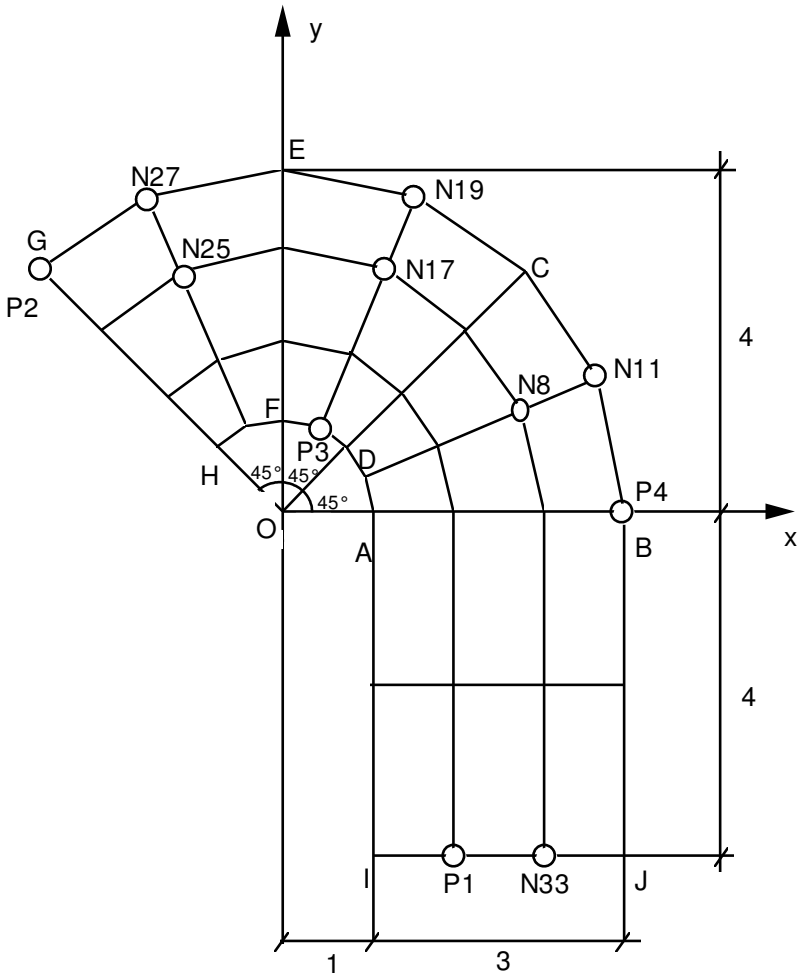
Interest:

- under-structuring on two levels,
- rotation of the macronutrients and the loadings (following or not),
- calculation of the fields inside the macronutrients.

The results of B are identical to those of A with 10^{-5} near.

1 Problem of reference

1.1 Geometry



1.2 Material properties

$E=15.\,Pa$

$\nu=0.3$

1.3 Boundary conditions and loadings

- $[GH]$: $u+v=0$; $N8$, $N17$ and $N25$: $u=v=0$; J : $u=2.0$
- loading case 1: pressure distributed on $ADFH$ $p=10.0$
- loading case 2: $N11$, $N19$, $N27$, $N33$, $P1$: $Fy=-20.0$

1.4 Initial conditions

Without object.

2 Reference solution

2.1 Method of calculating used for the reference solution

This problem does not have a reference solution.

Modeling A is used as reference for modeling B.

2.2 Results of reference

Displacements u and v at the points $P1$, $P2$, $P3$, $P4$.

2.3 Uncertainty on the solution

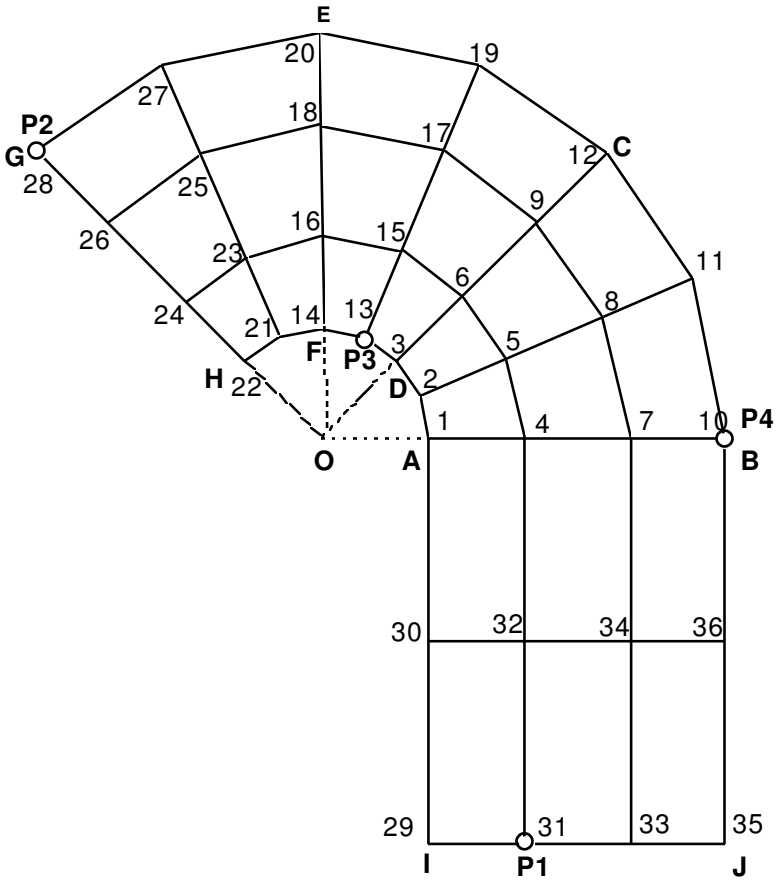
The solution of “reference” depends on the space discretization of the model; this is why the grid is drawn in [§1.1].

Modeling B must respect this grid to lead to the same results as A.

3 Modeling A

3.1 Characteristics of modeling

24 elements QUAD4, modeling: D_PLAN



3.2 Characteristics of the grid

Many nodes: 36.

Number of meshs and type: 24 QUAD4

3.3 Sizes tested and results

Identification		Reference
P1	*u*	1.88327
P1	*v*	$2.59224\ 10^{-2}$
P2	*u*	$-8.27372\ 10^{-2}$
P2	*v*	$8.27372\ 10^{-2}$
P3	*u*	$2.70375\ 10^{-1}$
P3	*v*	$5.69552\ 10^{-1}$
P4	*u*	$5.17703\ 10^{-1}$
P4	*v*	$5.43387\ 10^{-1}$
P1	*u*	1.71883

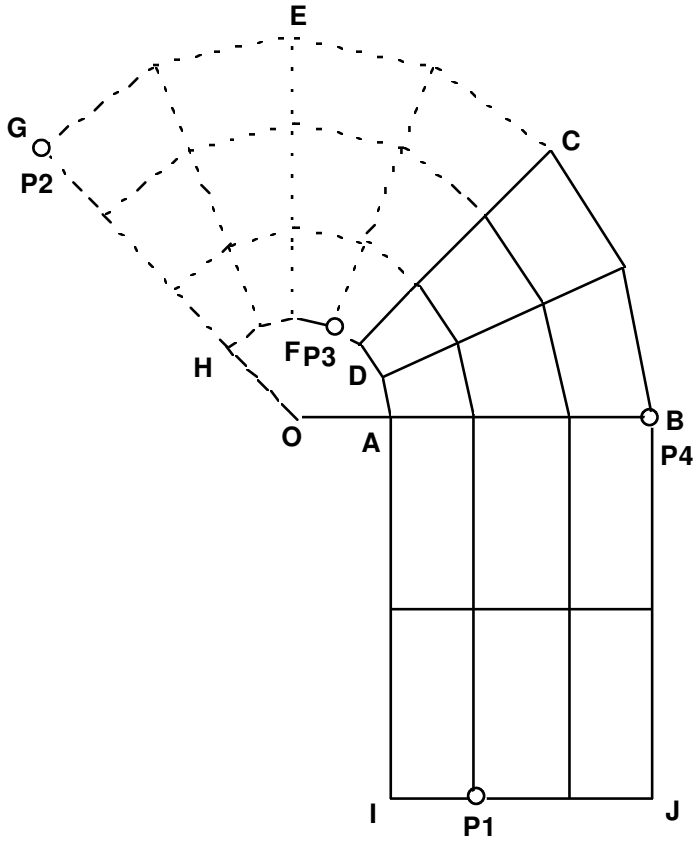
case of load n° 1

$P1$	v	– 6.04367	
$P2$	u	$-4.60196\ 10^{-2}$	case of
$P2$	v	$4.60196\ 10^{-2}$	load
$P3$	u	$2.26903\ 10^{-1}$	n° 2
$P3$	v	$-6.14296\ 10^{-1}$	
$P4$	u	$-9.57110\ 10^{-1}$	
$P4$	v	– 2.53878	

These results constitute the reference of modeling B.

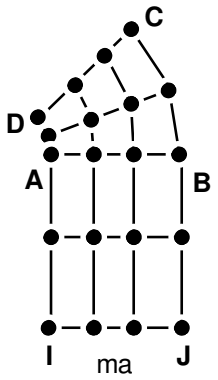
4 Modeling B

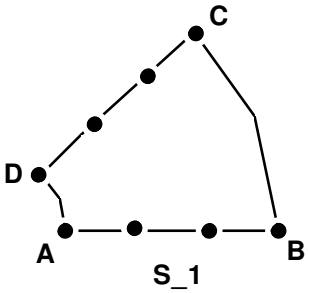
4.1 Characteristics of modeling



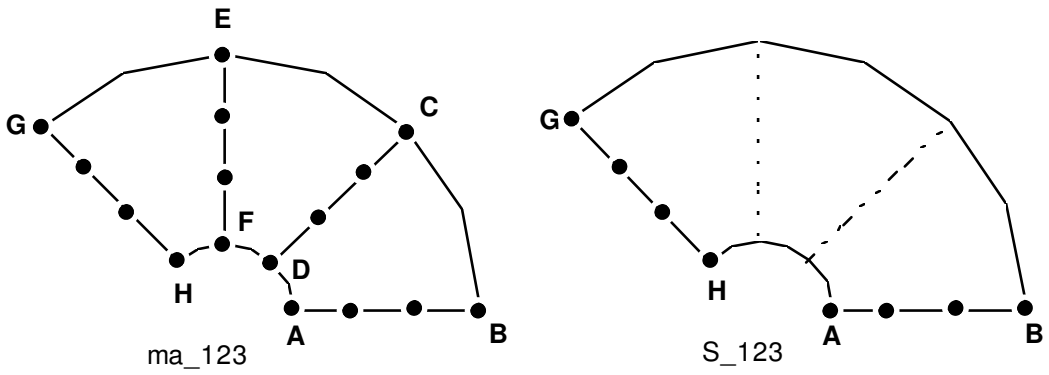
Initial grid ma (level -2 under-structuring) contains only the 12 QUAD4 of $IJBA$ and $ABCD$.

macr_elem_stat (S_1) is defined starting from the elements of $ABCD$. It macr_elem_stat is condensed on the nodes of AB and CD (level -2).





Grid ma_123 of level -1 is defined while making turn twice S_1 to represent the crown $ABCEGHFDA$.

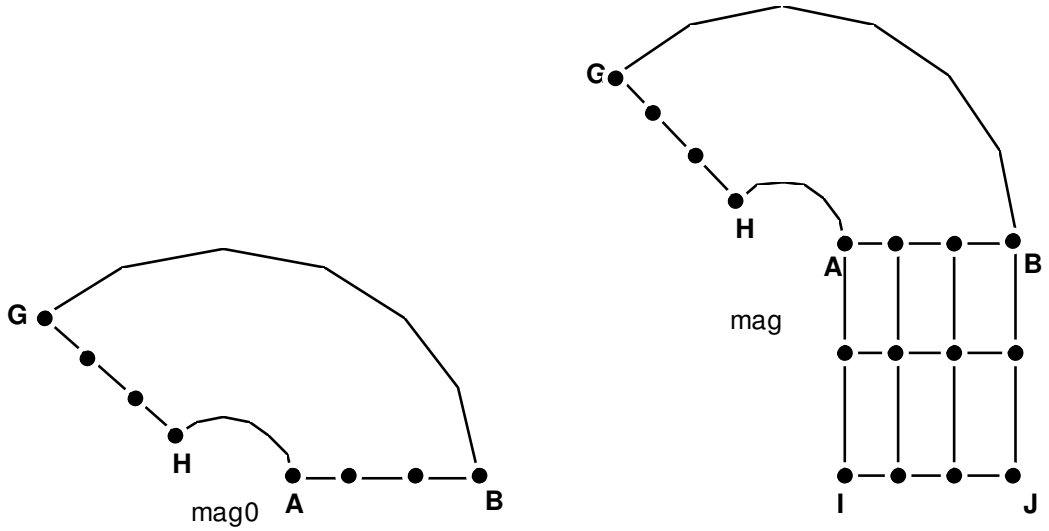


macr_elem_stat S_123 is defined starting from the substructures $ABCD$, $DCEF$ and $FEGH$. It macr_elem_stat is condensed on the nodes of AB and GH.

Grid $mag0$ is defined by macr_elem_stat S_123.

Final grid mag (level 0) is defined by the grid $mag0$ that one assembles (ASSE_MAILLAGE) with the initial grid ma to recover the meshs of $IJBA$.

The resolution is then made on this final grid, then one calculates displacements inside macr_elem_stat using the operator DEPL_INTERNE.



4.2 Characteristics of the grid

Many nodes: 20.

Many meshs and types: 12 QUAD4

4.3 Sizes tested and results

Identification	Reference
$P1 \quad u$	1.88327
$P1 \quad v$	$2.59224\ 10^{-2}$
$P2 \quad u$	$-8.27372\ 10^{-2}$

P2	v	8.27372 10−2
P3	u	2.70375 10−1
P3	v	5.69552 10−1
P4	u	5.17703 10−1
P4	v	5.43387 10−1
P1	u	1.71883
P1	v	– 6.04367
P2	u	– 4.60196 10−2
P2	v	4.60196 10−2
P3	u	2.26903 10−1
P3	v	– 6.14296 10−1
P4	u	– 9.57110 10−1
P4	v	– 2.53878

5 Summary of the results

Precision of the got results (error $\leq 10^{-5}$) is natural because the static under-structuring is an “exact” method (in infinite digital precision).