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## SSLP100 - Stick in static substructure

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### 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.

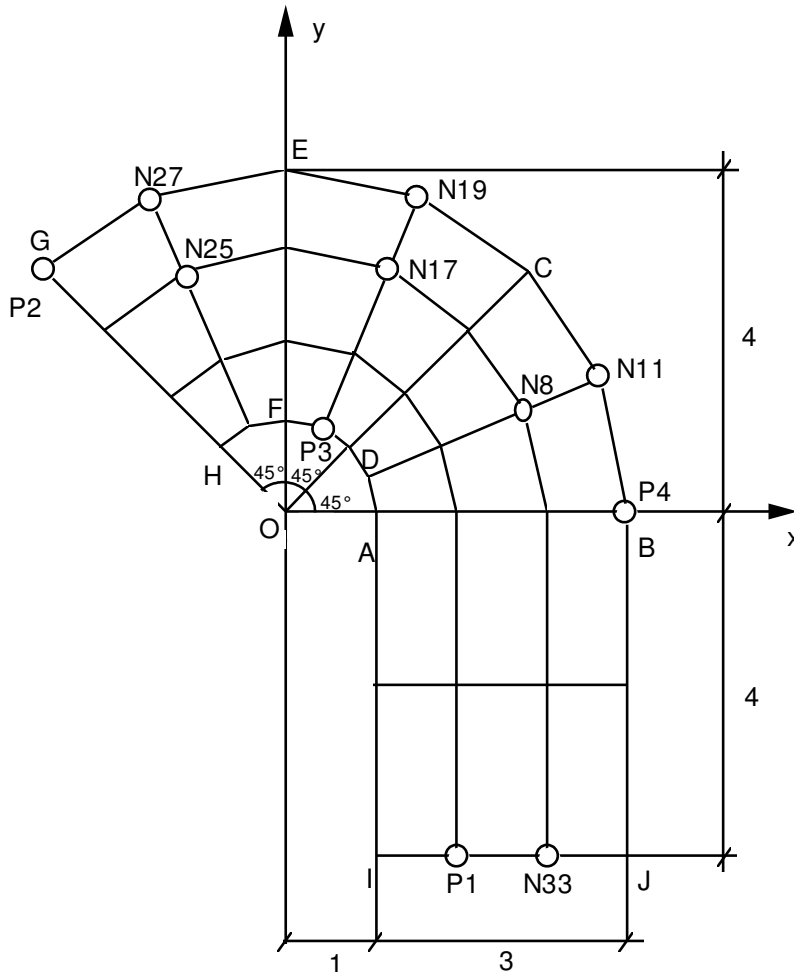
### Interest:

- 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:  $N11$  ,  $N19$  ,  $N27$  ,  $N33$  ,  $P1$  :  $F_y = -20.0$

### 1.4 Initial conditions

Without object.

## 2 Reference solution

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### 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

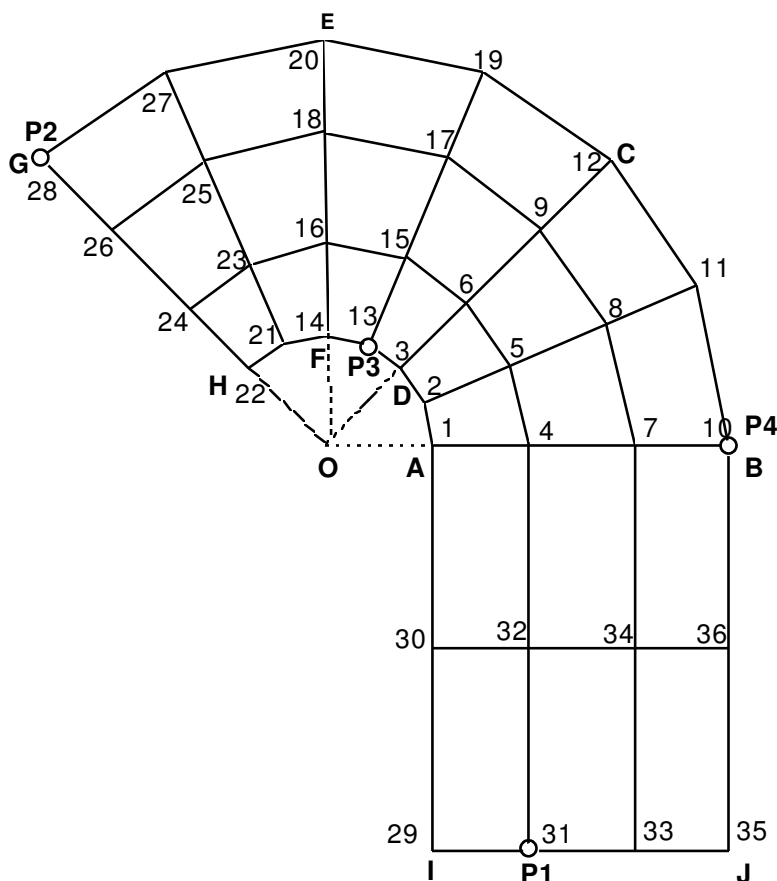
The solution of "reference" depends on the space discretization of the model; this is why the grid is drawn in [§1.1].

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 meshes and type: 24 QUAD4

### 3.3 Sizes tested and results

Identification	Reference	
P1 u	1.88327	case of load n° 1
P1 v	2.59224 10 <sup>-2</sup>	
P2 u	- 8.27372 10 <sup>-2</sup>	
P2 v	8.27372 10 <sup>-2</sup>	
P3 u	2.70375 10 <sup>-1</sup>	
P3 v	5.69552 10 <sup>-1</sup>	
P4 u	5.17703 10 <sup>-1</sup>	
P4 v	5.43387 10 <sup>-1</sup>	
P1 u	1.71883	

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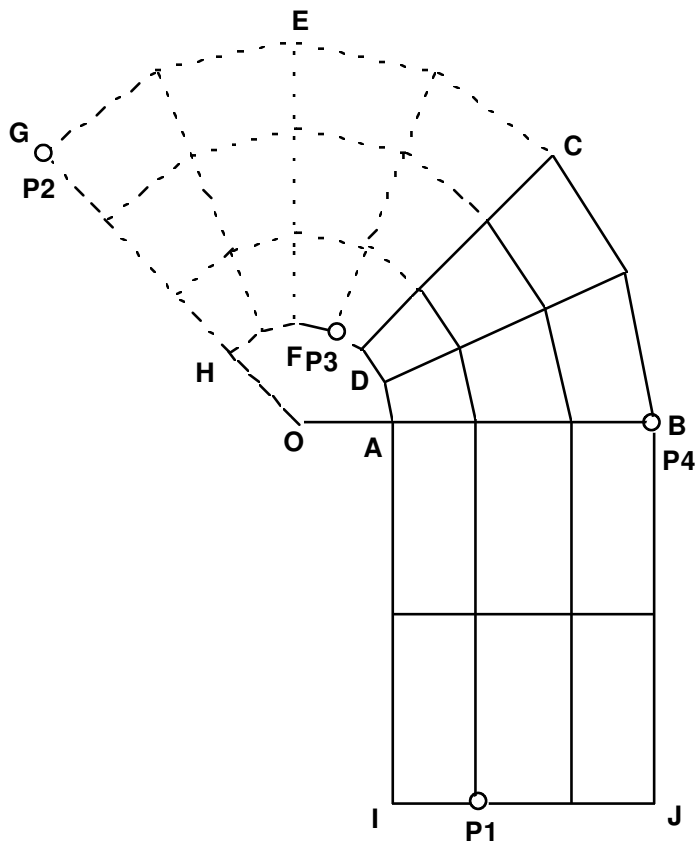
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<i>P1</i>	<i>v</i>	− 6.04367	
<i>P2</i>	<i>u</i>	− 4.60196 10 <sup>−2</sup>	case of
<i>P2</i>	<i>v</i>	4.60196 10 <sup>−2</sup>	load
<i>P3</i>	<i>u</i>	2.26903 10 <sup>−1</sup>	n° 2
<i>P3</i>	<i>v</i>	− 6.14296 10 <sup>−1</sup>	
<i>P4</i>	<i>u</i>	− 9.57110 10 <sup>−1</sup>	
<i>P4</i>	<i>v</i>	− 2.53878	

These results constitute the reference of modeling B.

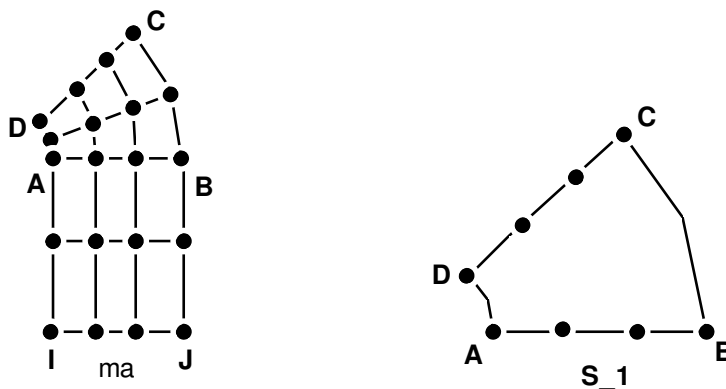
## 4 Modeling B

### 4.1 Characteristics of modeling

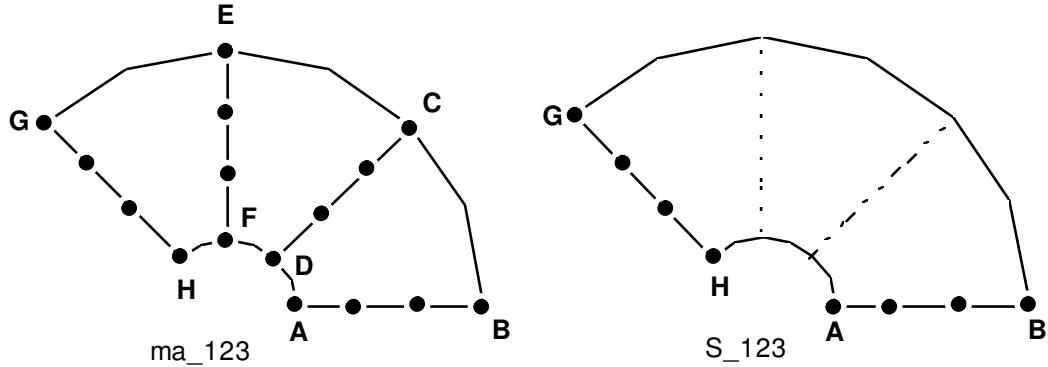


Initial grid *ma* (level  $-2$  under-structuring) contains only the 12 QUAD4 of *IJBA* and *ABCD*.

*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*.

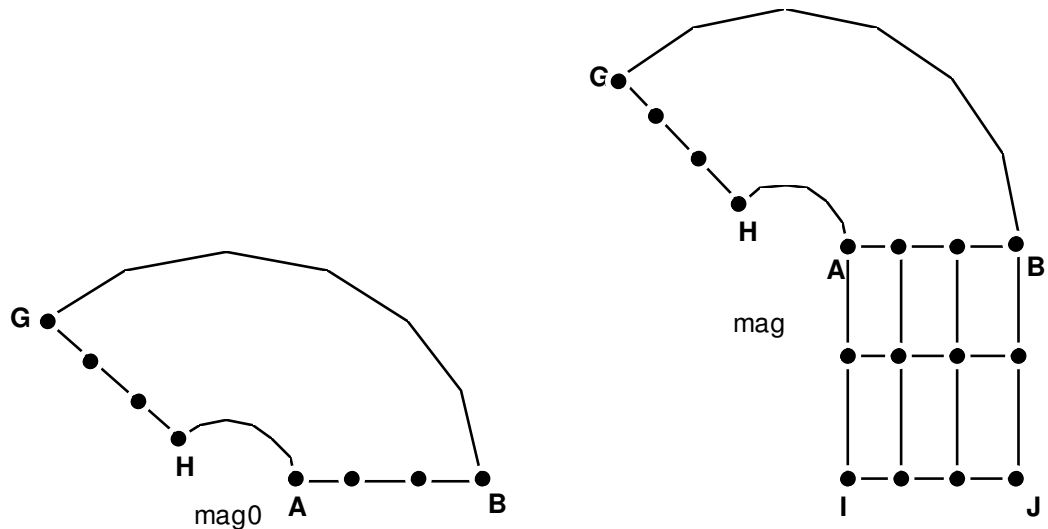


*macr\_elem\_stat* *S\_123* is defined starting from the substructures *ABCD*, *DCEF* and *FEGH*. It *macr\_elem\_stat* is condensed on the nodes of *AB* and *GH*.

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 meshes 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 meshes and types: 12 QUAD4

## 4.3 Sizes tested and results

Identification	Reference
<i>P1</i> <i>u</i>	1.88327
<i>P1</i> <i>v</i>	$2.59224 \cdot 10^{-2}$
<i>P2</i> <i>u</i>	$-8.27372 \cdot 10^{-2}$

<i>P2</i>	<i>v</i>	8.27372 10 <sup>-2</sup>
<i>P3</i>	<i>u</i>	2.70375 10 <sup>-1</sup>
<i>P3</i>	<i>v</i>	5.69552 10 <sup>-1</sup>
<i>P4</i>	<i>u</i>	5.17703 10 <sup>-1</sup>
<i>P4</i>	<i>v</i>	5.43387 10 <sup>-1</sup>
<i>P1</i>	<i>u</i>	1.71883
<i>P1</i>	<i>v</i>	- 6.04367
<i>P2</i>	<i>u</i>	- 4.60196 10 <sup>-2</sup>
<i>P2</i>	<i>v</i>	4.60196 10 <sup>-2</sup>
<i>P3</i>	<i>u</i>	2.26903 10 <sup>-1</sup>
<i>P3</i>	<i>v</i>	- 6.14296 10 <sup>-1</sup>
<i>P4</i>	<i>u</i>	- 9.57110 10 <sup>-1</sup>
<i>P4</i>	<i>v</i>	- 2.53878

## 5 Summary of the results

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