SDLS111 - Under-structuring dynamic: triangular plate

Summary:

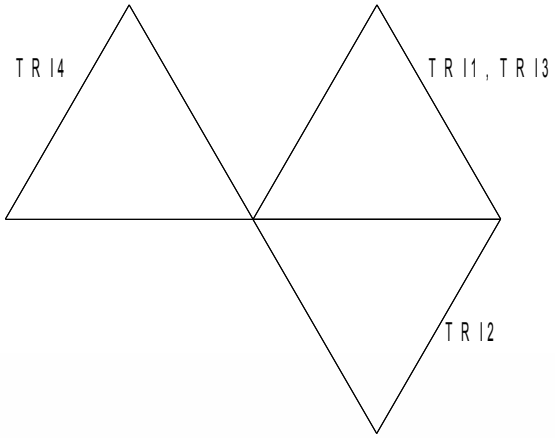
The objective of this case test is to validate the classical under-structuring with interfaces of the type CRAIG-BAMPTON in the case of a triangular plate.

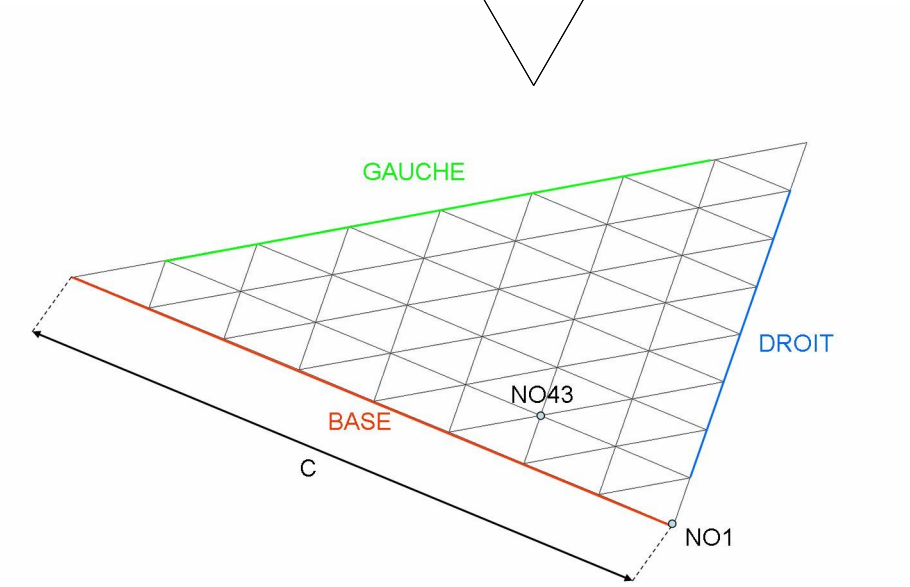
The case test is composed of a modeling DKT triangular plate

1 Problem of reference

1.1 Geometry

Geometry of the four substructures ($TRI1$, $TRI2$, $TRI3$, $TRI4$):





Grid of the substructures

Geometry of the triangle (m) :

$C=1$
thickness: $e=0.01$

Coordinates of the nodes:

$NO1=(1.0,0.0)$
$NO43=(0.687,0.108)$

Group of meshs:

$BASE$: together nodes forming the base of the triangle
$GAUCHE$: together nodes forming the right side of the triangle
$DROITE$: together nodes forming the left side of the triangle
$TOUT$: together nodes forming the triangle

1.2 Elastic properties of materials

- Young modulus: $E = 2.1\text{E}11\ Pa$
- Poisson's ratio: $\nu = 0.3$
- voluminal density: $\rho = 7800.0\ kg.m^{-3}$

1.3 Boundary conditions and loadings

- Substructure: *TRI1* :
  - Imposed displacements:
    - *TOUT* : $DRZ = 0.0$
    - *BASE* : $DX = DY = DZ = DRX = DRY = 0.0$
  - Interfaces:
    - *BASE* : type: CRAIGB , mask: *DRZ*

- Substructure: *TRI2* :
  - Nautical angles (α, β, γ) : $(0.0, 0.0, 180.0)$
  - Imposed displacements:
    - *TOUT* : $DRZ = 0.0$
    - *BASE* : $DX = DY = DZ = DRX = DRY = 0.0$
    - *DROITE* : $DX = DY = DZ = DRX = DRY = 0.0$
    - *GAUCHE* : $DX = DY = DZ = DRX = DRY = 0.0$
  - Interfaces:
    - *BASE* : type: CRAIGB , mask: *DRZ*
    - *GAUCHE* : type: CRAIGB , mask: *DRZ*
    - *DROITE* : type: CRAIGB , mask: *DRZ*

- Substructure : *TRI3* :
  - Imposed displacements:
    - *TOUT* : $DRZ = 0.0$
    - *BASE* : $DX = DY = DZ = DRX = DRY = 0.0$
    - *DROITE* : $DX = DY = DZ = DRX = DRY = 0.0$
  - Interfaces:
    - *DROITE* : type: CRAIGB , mask: *DRZ*

- Substructure: *TRI4* :
  - Nautical angles (α, β, γ) : $(0.0, 180.0, 0.0)$
  - Imposed displacements:
    - *TOUT* : $DRZ = 0.0$
    - *BASE* : $DX = DY = DZ = DRX = DRY = 0.0$
    - *DROITE* : $DX = DY = DZ = DRX = DRY = 0.0$
  - Interfaces:
    - *DROITE* : type: CRAIGB , mask: *DRZ*

2 Reference solution

2.1 Calculation of reference

Déroulement case test:

- Calculation of the clean modes of each triangle
  - $TRI1$ AND $TRI2$, research of the clean modes for $f \in [10,3000]$
  - $TRI3$ AND $TRI4$, research of 25 first clean modes
- Definition and calculation of the static modal base of each triangle
- Creation of a static model generalized by coupling of the bases
- Calculation and restitution, on the physical basis, of the modes of the total structure
  - Test of displacements
  - Test of the Eigen frequencies

2.2 Sizes and results of reference

- $FREQ$: frequency
- DZ : following displacement Z

Test of the results restored on the physical basis:

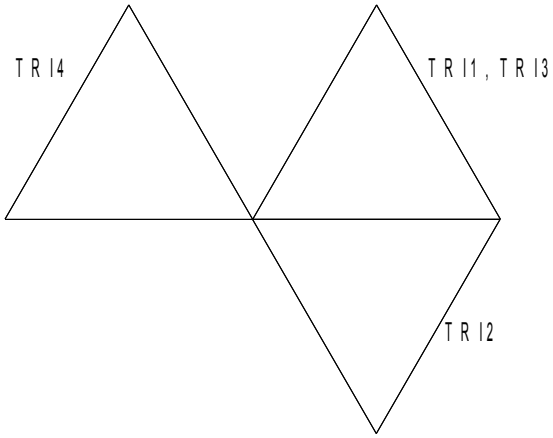
	Component	Reference (m)
Displacement of the node $NO1$	DZ	0.454388
Displacement of the node $NO43$	DZ	0.60375

Test of values of the Eigen frequencies:

Component	N° mode	Reference (Hz)
FREQ	1	5.5
	2	21.66
	3	23.64
	4	55.63
	5	56.97

3 Modeling A

3.1 Characteristics of modeling



Modeling DKT :

Many nodes	45		
Many meshs	64	That is to say:	
		TRI3	64

3.2 Sizes tested and result

Node	Component	Reference	Tolerance (%)
NO1	*DZ*	0.454388 (*m*)	0.1
NO43	*DZ*	0.60375 (*m*)	0.1

Component	N° mode	Reference (*Hz*)	Tolerance (%)
FREQ	1	430.852	1.3
	2	707.717	1.3
	3	808.549	1.3
	4	930.199	1.3
	5	1193.94	1.3

4 Summary of the results

The got results are satisfactory.