# SSLS104 - Cylindrical hull pinch with diaphragm

**Summary:**

One treats in linear elasticity the case of a cylinder formed by two circular funds at the two ends and gripped with mid--length.

This makes it possible to treat the modes of deformation inextensionnels and a membrane behavior complexes due to the diaphragms.

The value tested is the arrow at the point of application of the force.

Three modelings: DKT, COQUE_3D QUAD9 and COQUE_3D TRIA7.

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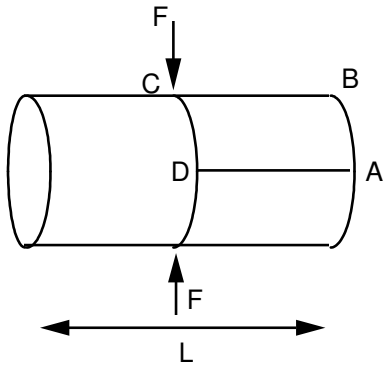
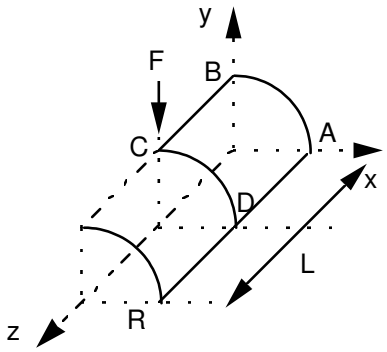
# 1 Problem of reference

## 1.1 Geometry




huitième de cylindre

| | |
|---|---|
| Longueur | L = 600 |
| Rayon | R = 300 |
| Epaisseur | t = 3 |

Coordinates of the points:

| | $A$ | $B$ | $C$ | $D$ |
|---|---|---|---|---|
| $x$ | 300. | 0. | 0. | 300. |
| $y$ | 0. | 300. | 300. | 0. |
| $z$ | 0. | 0. | 300. | 300. |

## 1.2 Material properties

$E = 3.10^6\ Pa$
$\nu = 0.3$
$A_{CIS} = 0.8333$

## 1.3 Boundary conditions and loadings

Rigid diaphragm at each end:

$u = v = 0\ ,\ \theta_z = 0$

Specific force in $C$ :

$F = 1.\ N$

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# 2 Reference solution

## 2.1 Method of calculating used for the reference solution

The parameters of with the dealt problem and the results of reference are explicitly given in the publication quoted below.

## 2.2 Results of reference

Displacement of the point $C$ according to $y$.

## 2.3 Bibliographical references

- Thomas J.R HUGHES, Ted BELYTSCHKO. Race notes for Recent advances in nonlinear finite element analysis. Volume III - p 238 and 239 (1990).

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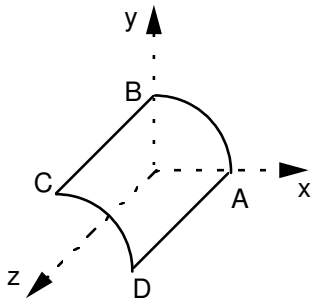
# 3 Modeling A

## 3.1 Characteristics of modeling

Element of hull DKT




Modeling of a eighth of plate

Cutting:

10 on $AD$ and $BC$
16 on $AB$ and $DC$ : 364 meshs TRIA3

Limiting conditions:

| | |
|---|---|
| in all the nodes of: | DDL_IMPO: |
| arc ( $AB$ ) | (GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0. ) |
| arc ( $CD$ ) | (GROUP_NO: CD DZ: 0. , DRX: 0. , DRY MARTINI: 0. ) |
| segment) $BC$ ( | (GROUP_NO: BCsansBC DX: 0. , DRY MARTINI: 0. , DRZ: 0. ) |
| segment) $AD$ ( | (GROUP_NO: ADsansAD DY: 0. , DRX: 0. , DRZ: 0. ) |
| in $C$ | (GROUP_NO: C DX: 0. , DRZ: 0. ) |
| in $D$ | (GROUP_NO: D DY: 0. , DRZ: 0. ) |

Loading:

with the node $C$ : (GROUP_NO: C FY: -0.25 )

Names of the nodes:

| | |
|---|---|
| Not $A$ | $N04$ |
| Not $B$ | $N02$ |
| Not $C$ | $N01$ |
| Not $D$ | $N03$ |

## 3.2 Characteristics of the grid

Many nodes: 209
Many meshs and types: 364 TRIA3

## 3.3 Values tested

| Identification | Reference |
|---|---|
| Not $C$ displacement $v$ | $-1.8248\ 10^{-5}$ |

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With 1,366 nodes: $-1.8511F$ in $C$.

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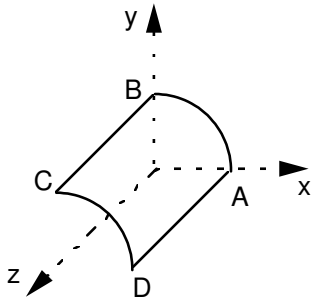
# 4 Modeling B

## 4.1 Characteristics of modeling

Element of hull 3D MEC3QU9H




Modeling of a eighth of plate

Cutting:

4 on $AD$ and $BC$
8 on $AB$ and $DC$ : 32 meshs QUAD9

Limiting conditions:

| | |
|---|---|
| in all the nodes of: | DDL_IMPO: |
| arc ( $AB$ ) | (GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0. ) |
| arc ( $CD$ ) | (GROUP_NO: CD DZ: 0. , DRX: 0. , DRY MARTINI: 0. ) |
| segment) $BC$ ( | (GROUP_NO: BCsansBC DX: 0. , DRY MARTINI: 0. , DRZ: 0. ) |
| segment) $AD$ ( | (GROUP_NO: ADsansAD DY: 0. , DRX: 0. , DRZ: 0. ) |
| in $C$ | (GROUP_NO: C DX: 0. , DRZ: 0. ) |
| in $D$ | (GROUP_NO: D DY: 0. , DRZ: 0. ) |

Loading:

with the node $C$ : (GROUP_NO: C FY: -0.25 )

Names of the nodes:

| | |
|---|---|
| Not $A$ | $N01$ |
| Not $B$ | $N02$ |
| Not $C$ | $N03$ |
| Not $D$ | $N04$ |

## 4.2 Characteristics of the grid

Many nodes: 121
Many meshs and types: 32 QUAD9

## 4.3 Values tested

| Identification | Reference |
|---|---|
| Not $C$ displacement $v$ | $-1.8248\ 10^{-5}$ |

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## 4.4 Remarks

For a grid of 60 meshs QUAD9 and 213 nodes (corresponding to cutting 6 on $AD$ and $BC$ and 10 on $AB$ and $DC$), displacement v at the point $C$ is worth – 1.8011 $10^{-5}$.

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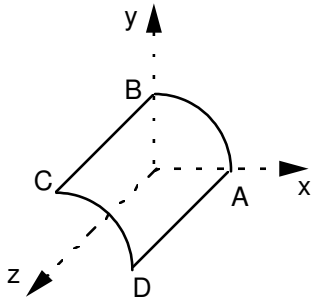
# 5 Modeling C

## 5.1 Characteristics of modeling

Element of hull MEC3TR7H




Modeling of a eighth of plate

Cutting:

10 on $AD$ and $BC$
18 on $AB$ and $DC$ : 360 meshs TRIA7

Limiting conditions:

| | |
|---|---|
| in all the nodes of: | DDL_IMPO: |
| arc ( $AB$ ) | (GROUP_NO: AB DX: 0. , DY: 0. , DRZ: 0. ) |
| arc ( $CD$ ) | (GROUP_NO: CD DZ: 0. , DRX: 0. , DRY MARTINI: 0. ) |
| segment) $BC$ ( | (GROUP_NO: BCsansBC DX: 0. , DRY MARTINI: 0. , DRZ: 0. ) |
| segment) $AD$ ( | (GROUP_NO: ADsansAD DY: 0. , DRX: 0. , DRZ: 0. ) |
| in $C$ | (GROUP_NO: C DX: 0. , DRZ: 0. ) |
| in $D$ | (GROUP_NO: D DY: 0. , DRZ: 0. ) |

Loading:

with the node $C$ : (GROUP_NO: C FY: -0.25 )

Names of the nodes:

| | |
|---|---|
| Not $A$ | $N01$ |
| Not $B$ | $N02$ |
| Not $C$ | $N03$ |
| Not $D$ | $N04$ |

## 5.2 Characteristics of the grid

Many nodes: 777
Many meshs and types: 360 TRIA7

## 5.3 Values tested

| Identification | Reference |
|---|---|
| Not $C$ displacement $v$ | $-1.8248\ 10^{-5}$ |

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## 5.4 Remarks

For a grid with 500 meshs TRIA7 and 1071 nodes (cutting 10 on $AD$ and $BC$, 25 on $AB$ and $DC$ ), a displacement is obtained $v$ at the point $C$ of – 1.7723 $10^{-5}$. The relative error on displacement $v$ in $C$ is then of 2.88%. The results with this element for light grids is thus not very good and improves relatively little with an increase amongst meshs.

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# 6 Summary of the results

With regard to the elements:

DKT:

The result is better with a finer grid (1366 nodes) which leads to an error < 1.5 %.

MEC3QU9H:

The result is acceptable with relatively few elements (compared with DKT). By increasing appreciably the number of elements (60 instead of 32), the error is < 1.3%.

MEC3TR7H:

Result little satisfying even with a fine grid leading to a great total number of nodes for MEC3TR7H (777 for MEC3TR7H to compare with 209 for DKT and 121 for MEC3QU9H). To arrive at an error lower than 2.9%, that requires one very a large number of nodes (1071). It seems recognized that this element is less good than MEC3QU9H.

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