

## SSLL112 - Circular vault under uniform pressure

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### Summary:

This test makes it possible to check the internal efforts of the elements `POU_D_T` for the modeling of a circular vault.

It in particular makes it possible to realize of refinement necessary to get correct results on the components `VY` and `VZ` field of effort.

## 1 Problem of reference

### 1.1 Geometry

#### 1.1.1 Circular vault

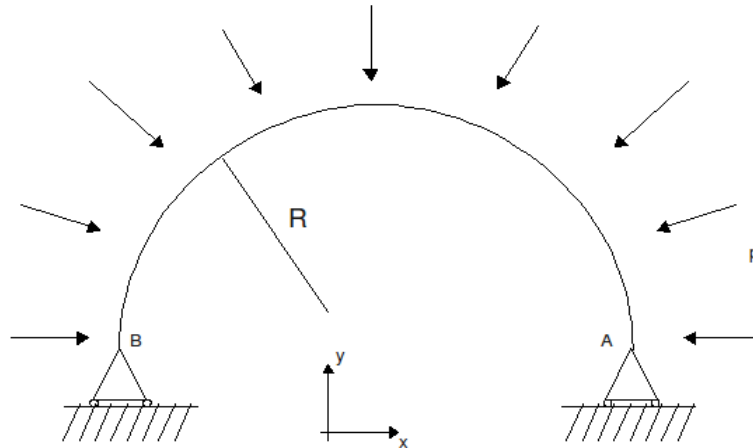


Figure 1.1.1-a : Circular vault.

Ray:  $R=1\text{ m}$

### 1.2 Properties of materials

Young modulus:  $E=2.10^{11}\text{ Pa}$

Poisson's ratio:  $\nu=0.3$

### 1.3 Boundary conditions and loading

Boundary condition:

$DX = DY = DZ = DRX = 0$  on the point  $A$

$DY = DZ = 0$  on the point  $B$

Loading: Force distributed

$p=100\text{ N/m}$  on  $AB$

## 2 Reference solutions

### 2.1 Method of calculating used for the reference solutions

The beam of the figure [Figure 1.1.1-a] checks the equilibrium equations (problem plan).

$$V_y = \frac{dN}{d\theta}, \quad N + \frac{dV_y}{d\theta} = -pR, \quad \frac{dM}{d\theta} + RV_y = 0$$

(  $p$  : normal constant loading divided into any point of the beam).

$N(\theta)$ ,  $V_y(\theta)$ ,  $M_z(\theta)$  indicate the efforts (normal, cutting-edge and moment bending) in a point of the vault expressed in the local reference mark.

Their integration with the limiting conditions:

$$V_y(0) = 0, \quad M_z(0) = 0$$

give:

$$V_y(\theta) = 0, \quad M(\theta) = 0, \quad N(\theta) = -pR$$

### 2.2 Results of reference

Interior efforts for  $\theta = 0^\circ, 6^\circ, 42^\circ$  and  $60^\circ$ .

### 2.3 Uncertainty on the solution

Analytical solution.

### 2.4 Bibliographical references

- [1] Report n° 2314/A of the Institute Aerotechnics "Proposal and realization for new cases tests missing with the validation of the beams ASTER"

## 3 Modeling A

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### 3.1 Characteristics of modeling

The model is composed of 450 elements beam rights of Timoshenko.

### 3.2 Characteristics of the grid

It consists of 450 elements `POU_D_T`.

### 3.3 Sizes tested and results

Type of effort	Reference	Precision (%)
$V_y(0^\circ)$	0.0000	0.4 (absolute)
$V_y(6^\circ)$	0.0000	0.01 (absolute)
$N(60^\circ)$	- 1.000E+02	0,100 (relative)
$MFZ(42^\circ)$	0.0000	0.01 (absolute)

### 3.4 Variation of the refinement of the grid

Initially, the grid of this test comprised 30 meshes modelled in `POU_C_T`. With this refinement the results with elements `POU_D_T` are very good except for  $V_y(0^\circ)$  :

Type of effort	Reference	Variation (%)
$V_y(0^\circ)$	0.0000	5.23 (absolute)
$V_y(6^\circ)$	0.0000	1E-11 (absolute)
$N(60^\circ)$	- 1.000E+02	1,3E-3 (relative)
$MFZ(42^\circ)$	0.0000	1E-12 (absolute)

With 450 meshes, one obtains only one variation of 0.34 on  $V_y(0^\circ)$  .

## 4 Summary of the results

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The normal effort in the vault (only effort not no one) is calculated with a good precision ( 0,1% ) for adopted modeling. It is noticed however that the value of  $V_y(0^\circ)$  remain isolated reference in spite of important refinement.