

## SSLP02 – Simple traction of a perforated plate

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### Summary:

The objective of C E test is to validate the calculation of the constraints in a perforated plate subjected to an effort of traction.

four modelings carried out are the following ones :

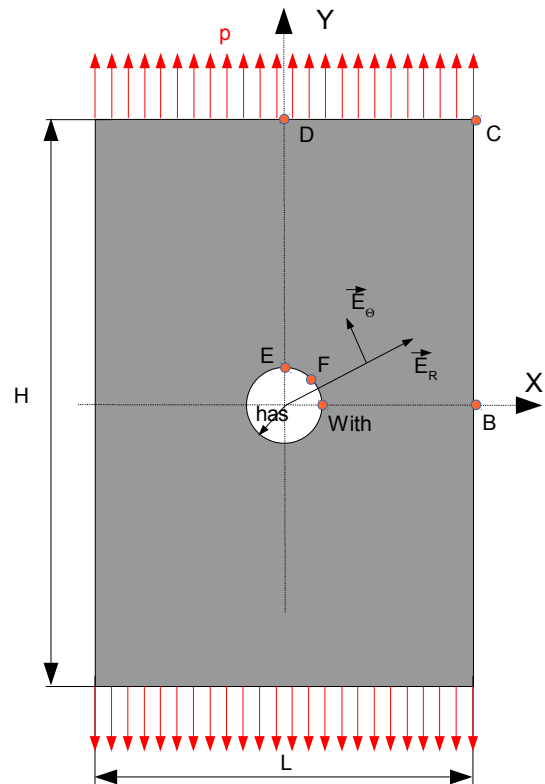
- Modeling *A* : linear grid with meshes QUAD4 ,
- Modeling *B* : quadratic grid with meshes QUAD8 ,
- Modeling *C* : grid linear with meshes TRIA3 ,
- Modeling *D* : quadratic grid with meshes TRIA6 .

## 1 Problem of reference

### 1.1 Geometry

- $L=200\text{ mm}$
- $h=300\text{ mm}$
- $a=10\text{ mm}$

Coordinates	$X$	$Y$
With	10.	0.
B	100.	0.
C	100.	150.
D	0.	150.
E	0.	10.
F	$10.\cos(\frac{\pi}{4})$	$10.\cos(\frac{\pi}{4})$



### 1.2 Properties of material

The material is elastic isotropic whose properties are:

- Young modulus  $E=3 \times 10^4\text{ MPa}$
- Poisson's ratio  $\nu = 0.25$

### 1.3 Boundary conditions and loadings

Imposed displacement:

- Dimensioned AB :  $DY=0$ .
- Dimensioned:  $DX=0$ .

Imposed pressure with dimensions CD :  $p=2.5\text{ N/mm}^2$

### 1.4 Initial conditions

None

## 2 Reference solution

### 2.1 Method of calculating

The result of reference was got analytically with the following assumptions :

- The plate is supposed of infinite size,
- Method of Muskhelishvili and Kolosov in polar coordinates.

$$\sigma_{rr} = \frac{P}{2} \left[ \left(1 - \frac{a^2}{r^2}\right) - \left(1 - \frac{4a^2}{r^2} + \frac{3a^4}{r^4}\right) \cos 2\theta \right]$$

$$\sigma_{\theta\theta} = \frac{P}{2} \left[ \left(1 + \frac{a^2}{r^2}\right) + \left(1 + \frac{3a^4}{r^4}\right) \cos 2\theta \right]$$

$$\sigma_{r\theta} = \frac{P}{2} \left(1 + \frac{2a^2}{r^2} - \frac{3a^4}{r^4}\right) \sin 2\theta$$

### 2.2 Sizes and results of reference

The selected results of reference relate to Lforced circumferential  $\sigma_{\theta\theta}$ .

$$\sigma_{\theta\theta}(a, \theta) = P(1 + 2 \cos 2\theta)$$

Not	Size	Value (N/mm <sup>2</sup> )
A (a, 0)	$\sigma_{\theta\theta}$	7.5
F (a, $\frac{\pi}{4}$ )	$\sigma_{\theta\theta}$	2.5
E (a, $\frac{\pi}{2}$ )	$\sigma_{\theta\theta}$	-2.5

### 2.3 Uncertainties on the solution

Solution semi-analytical

### 2.4 Bibliographical references

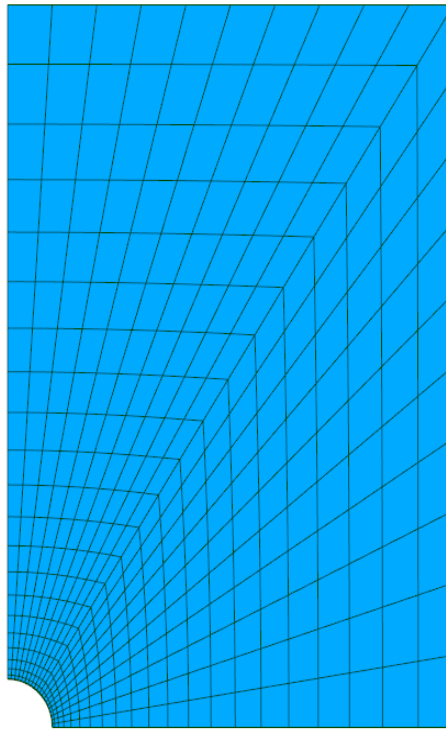
- [1] Guide VPCS - Edition 1990.

## 3 Modeling A

### 3.1 Characteristics of modeling

A modeling is used C\_PLAN.

### 3.2 Characteristics of the grid



- Many nodes: 4 83
- Many meshes:
  - QUAD4 : 4 4 0
  - S E G 2 : 1 0 6

### 3.3 Sizes tested and results

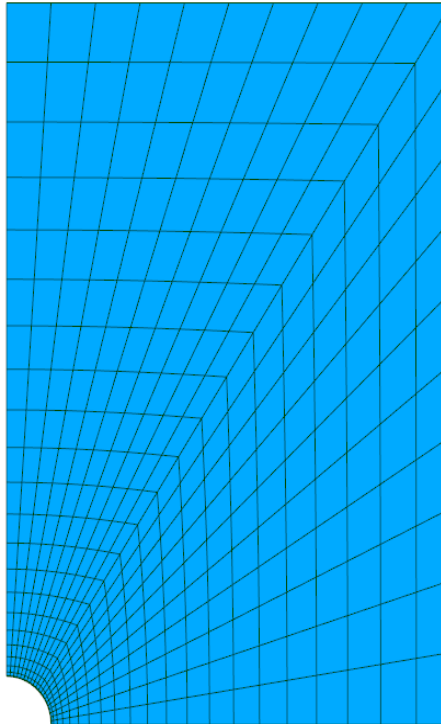
Identification		Type of reference	Value of reference	Tolerance (%)
Not	Size			
<i>A</i>	$\sigma_{\theta\theta}$	'ANALYTICAL'	7.5	1.5
<i>F</i>	$\sigma_{\theta\theta}$	'ANALYTICAL'	2.5	2.6
<i>E</i>	$\sigma_{\theta\theta}$	'ANALYTICAL'	-2.5	0.9

## 4 Modeling B

### 4.1 Characteristics of modeling

A modeling is used C\_PLAN.

### 4.2 Characteristics of the grid



- Many nodes: 1 405
- Many meshes:
  - QUAD 8 : 4 40
  - S E G 3 : 1 0 6

### 4.3 Sizes tested and results

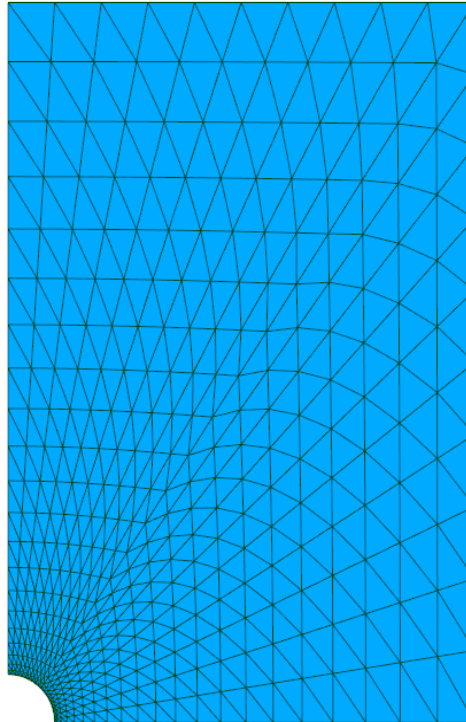
Identification		Type of reference	Value of reference	Tolerance (%)
Not	Size			
$A$	$\sigma_{\theta\theta}$	'ANALYTICAL'	7.5	2.0
$F$	$\sigma_{\theta\theta}$	'ANALYTICAL'	2.5	4.5
$E$	$\sigma_{\theta\theta}$	'ANALYTICAL'	-2.5	0.5

## 5 Modeling C

### 5.1 Characteristics of modeling

A modeling is used C\_PLAN.

### 5.2 Characteristics of the grid



- Many nodes: 4 83
- Many meshes:
  - TRIA3 : 880
  - SEG2 : 1 0 6

### 5.3 Sizes tested and results

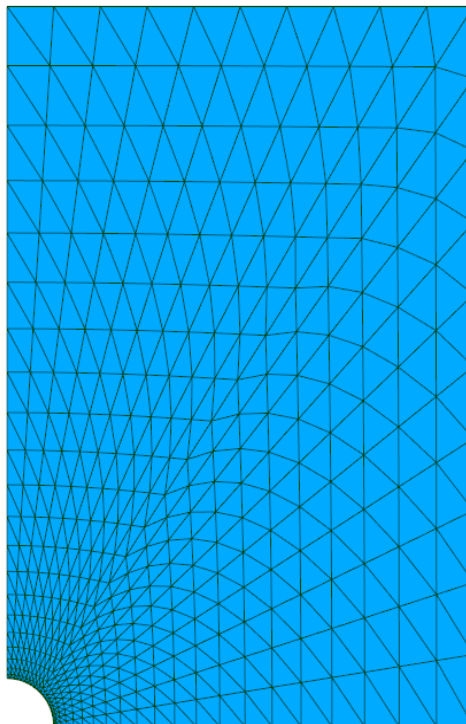
Identification		Type of reference	Value of reference	Tolerance (%)
Not	Size			
<i>A</i>	$\sigma_{\theta\theta}$	'ANALYTICAL'	7.5	2.0
<i>F</i>	$\sigma_{\theta\theta}$	'ANALYTICAL'	2.5	2.0
<i>E</i>	$\sigma_{\theta\theta}$	'ANALYTICAL'	-2.5	3.6

## 6 Modeling D

### 6.1 Characteristics of modeling

A modeling is used C\_PLAN.

### 6.2 Characteristics of the grid



- Many nodes: 1 845
- Many meshes:
  - TRIA6 : 8 80
  - SEG3 : 1 0 6

### 6.3 Sizes tested and results

Identification		Type of reference	Value of reference	Tolerance (%)
Not	Size			
$A$	$\sigma_{\theta\theta}$	'ANALYTICAL'	7.5	1.5
$F$	$\sigma_{\theta\theta}$	'ANALYTICAL'	2.5	4.5
$E$	$\sigma_{\theta\theta}$	'ANALYTICAL'	-2.5	0.25

## 7 Summary of the results

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The got results are satisfactory, L 'maximum change at the point E ( $\theta=90^\circ$ ) is of 4, 5 % and of 2. 0 % at the point with ( $\theta=0^\circ$ ) .