SDNS108 – Dynamic response of a reinforced concrete slab leaned on 4 with dimensions subjected to a concentrated loading

Summarized:

This test represents the computation of a reinforced concrete slab, in bending, subjected to a concentrated loading. It makes it possible to the model validate modelization `Q4GG` (thick shell) using total material `GLRC_DAMAGE` by comparing it with a similar computation with code EUROPLEXUS. The slab is simply leaned on the four with dimensions ones.

Two modelizations are carried out:

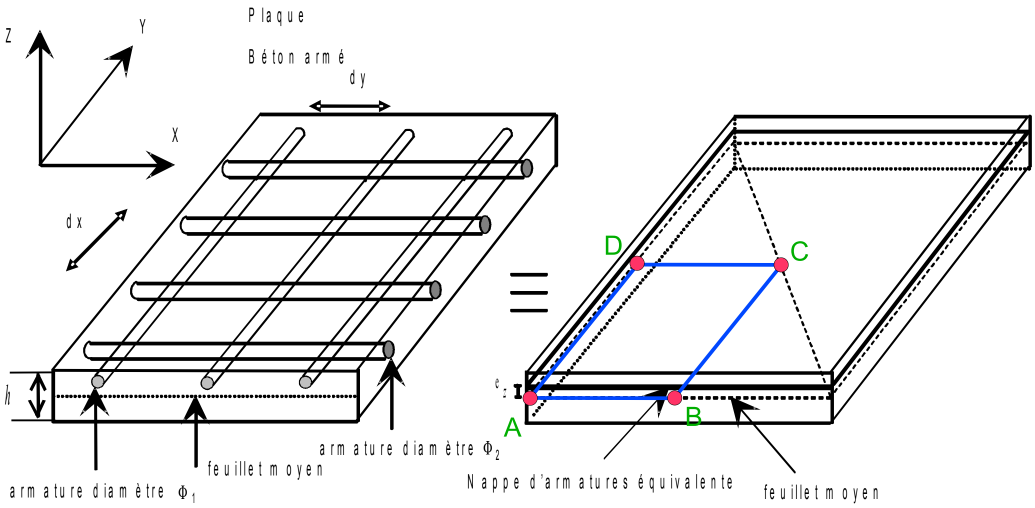
1) Modelization A makes it possible to test the model `Q4GG` with `QUAD4`,
2) Modelization B makes it possible to test the model `Q4GG` with `TRIA3`,
3) Modelization C makes it possible to the model test `Q4GG` with a plasticity criterion defined by the user.

1 Problem of reference

1.1 Geometry

Paves square, length $l=1.8\,m$, of thickness $h=0.12\,m$, out of simple bearing on four edges. The reinforcement of bending is parallel to edges; it is identical on each of the two sides and in each of the two meanings (dx , dy being spacings of irons in the directions x and y). The coating of the longitudinal irons closest to the sides is of $22\,mm$. The coating of irons compared to side edges of slab of $2\,cm$ is neglected. The table hereafter recapitulates the data of reinforcement. The geometrical percentage of steel μ is given for a face in a meaning.

Diameter of reinforcements	Spacing	Section steel/section of the concrete	outdistances grid/mean surface of slab
$\Phi=0{,}01\,\mathrm{m}$	$dx=dy=0{,}1\,\mathrm{m}$	$\mu=0{,}65$	$e_s=\pm 0{,}038\,\mathrm{m}$



One notes $a_x=\frac{A_x}{d_x}$ and $a_y=\frac{A_y}{d_y}$ rates of reinforcement (here: $a_x=a_y=7{,}854.10^{-4}\,\mathrm{m}$), A_x (A_y) being the area of the section of an iron bar in the direction $x(y)$; e_s is the distance from the three-dimensions functions at mean surface.

For reasons of symmetry one models a quarter $(ABCD)$ of slab.

1.2 Material properties

the mechanical properties of steels are the following ones:

Modulus Young E_a	Poisson's ratio	Yield stress to 0.2% σ_y	Slope of hardening
$210000\,MPa$	0,3	$500\,MPa$	$0.\,MPa$

Those of the concrete are the following ones:

Modulate of Youngformule E_b	Poisson's ratio	Strength in compression σ_c	Strength in tension σ_t
$35700\,MPa$	0,22	$52{,}5\,MPa$	$4{,}4\,MPa$

For the modelization C, one enters manually the moments limit plastic :

MP1X = 1200 Nm/m
MP1Y = 1200 Nm/m
MP2X = -1200 Nm/m
MP2Y = -1200 Nm/m

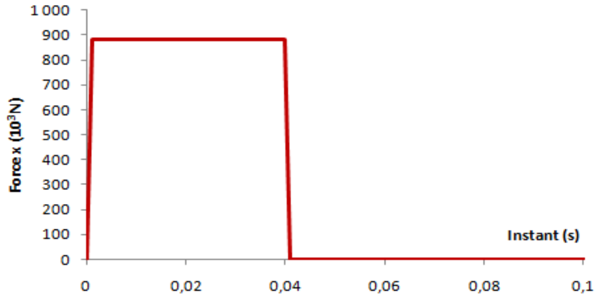
1.3 Boundary conditions and loadings

the boundary conditions are the following ones:

- Simply leaned on dimensioned AD and BC : $DZ=0$
- Symmetry on with dimensions ones
  - BC : $DX=DRY=0$
  - CD : $DY=DRX=0$

the evolution of the loading, applied to the center of the plate, is presented below.

Time (S)	$Fz(N)$
0.0.0. 0	
0.001	8.8E5
0.040	8.8E5
0.041	0.0.1.0.0 .0



1.4 Initial conditions

the plate is initially at rest in a virgin state.

2 Reference solution

2.1 Method of calculating used for the reference solution

the results of reference were got with Europlexus.

The meshes used by Europlexus and Code_Aster are the same ones.

2.2 Results of reference

the results of reference correspond to the following displacement Z of the point C located at the center of the plate. Appointed time corresponds to time when the displacement obtained with Europlexus is maximum. For the modelizations A and B, the values obtained by Europlexus are:

Time (s)	Quantity	Localization	Europlexus	
			Element	following (m)
$0{,}0093436$	Displacement Displacement Z	Centers plate	Q4GS	$-0.04890906\,\mathrm{m}$
$0{,}0091250$	following Displacement Z	Centers plate	T3GS	$-0.04574386\,\mathrm{m}$

For the modelization C, one has

Urgent (s)	Quantity	Localization	Europlexus	
			Element	Displacement (m)
$0{,}0096593$	following Displacement Z	Center of plate	Q4GS	$-0.05870762\,\mathrm{m}$

2.3 Uncertainty on the numerical

solution Solution.

2.4 Bibliographical references

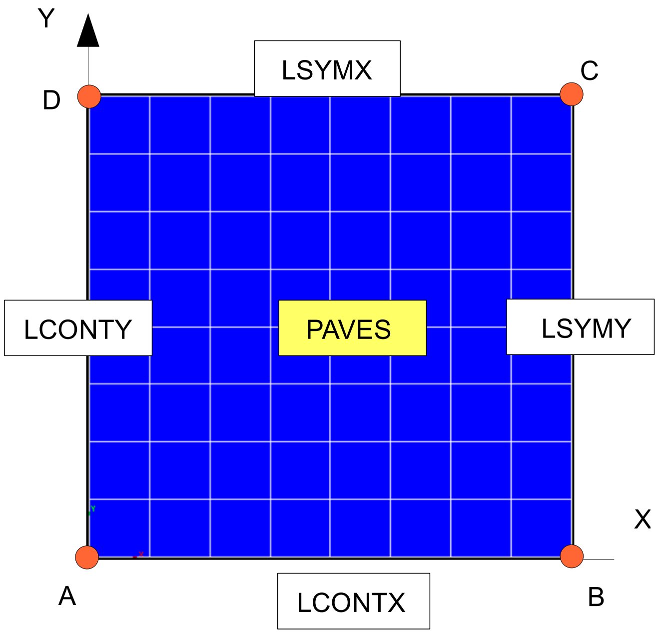
[1] [R3.07.09]: “Shell element thick T3G”

[2] [U2.02.01]: “ Note of use of the voluminal elements plates, shells and shells SHB ”

3 Modelization A

3.1 Characteristic of the modelization

Modelization Q4GG



3.2 Characteristic of the mesh

Many nodes: 81
Number of meshes and type: 64 QUAD4

3.3 Quantities tested and results

Time (S)	COMPONENT	QUANTITY	GROUP_NO	Standard of Reference	Reference	Tolerance (%)
0,0093436	DEPL	DZ	Point_C	"SOURCE_EXTERNE"	-0.04890906 m	5.0

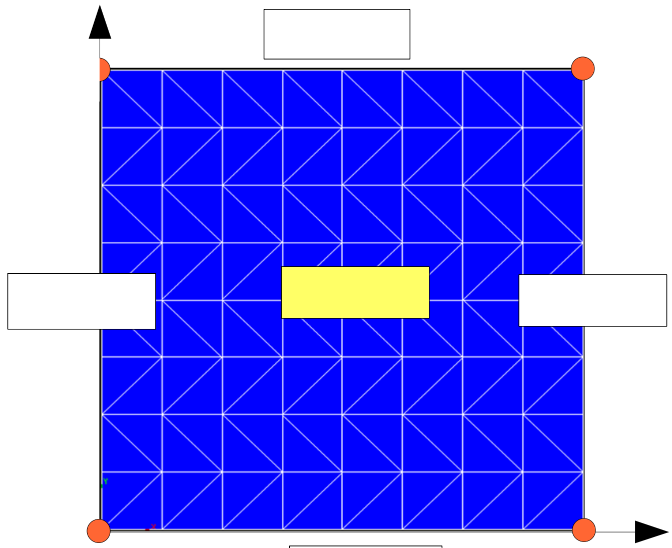
3.4 Remarks

computations were carried out with a diagram of temporal integration explicit of centered differences type finished.

4 Modelization B

4.1 Characteristic of the modelization

Q4GG



4.2 Characteristic of the mesh

Many nodes: 91

Number of meshes and type: 128 TRIA3

4.3 Quantities tested and results

Time (S)	*COMPONENT*	*QUANTITY*	*GROUP_NO*	*Standard of Reference*	*Reference*	*Tolerance (%)*
0,0091250	DEPL	DZ	Point_C	"SOURCE_EXTERNE"	-0.04574386 m	1.5

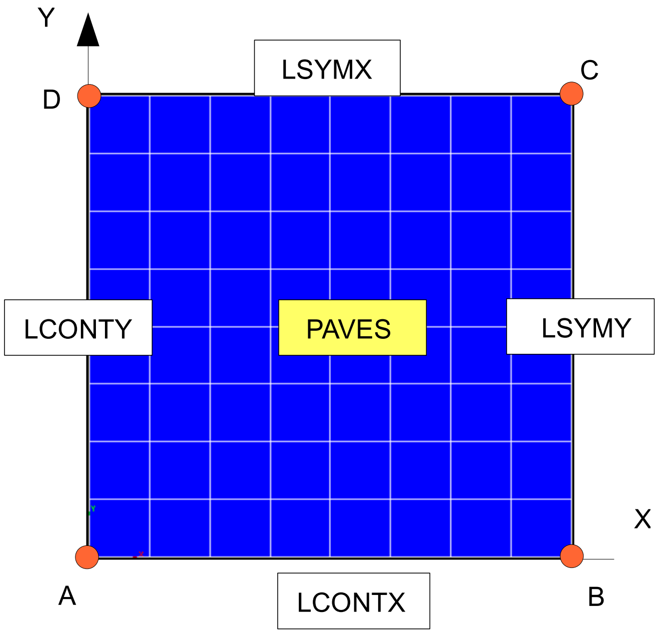
4.4 Remarks

computations were carried out with a diagram of temporal integration explicit of centered differences type finished.

5 Modelization C

5.1 Characteristic of the modelization

Modelization Q4GG



5.2 Characteristic of the mesh

Many nodes: 81
Number of meshes and type: 64 QUAD4

5.3 Quantities tested and results

Time (S)	COMPONENT	QUANTITY	GROUP_NO	Standard of Reference	Reference	Tolerance (%)
0,0096593	DEPL	DZ	Point_C	"SOURCE_EXTERNE"	−0.05870762 m	20.0

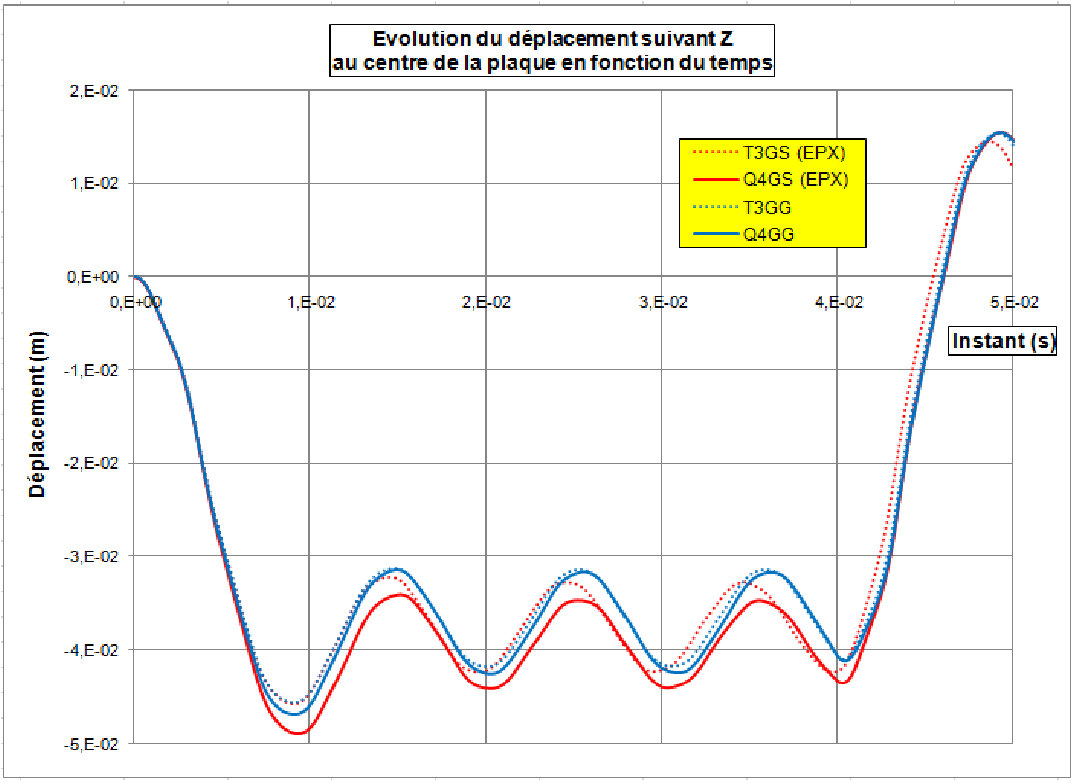
5.4 Remarks

computations were carried out with a diagram of temporal integration explicit of centered differences type finished.

6 Summary of the results

the got results are satisfactory for the modelizations A and B.

On the figure below, we traced the evolution of displacement in the center of the plate according to time. This response is compared with that obtained with Europlexus (EPX).



The results got for the modelization C show an important variation on the amplitudes between the results got with Europlexus and Code_Aster. The limit use of manually defined plastic moments must be made with precaution.