PLEXU03 – Validation of the cables of prestressed in Summarized

CALC_EUROPLEXUS:

The purpose of this test is validating the sequence of a computation of setting in tension of cables of prestressed in Code_Aster with a fast computation of dynamics in Europlexus via the macro-command of Code_Aster CALC_EUROPLEXUS .

More precisely, it validates the following points in CALC_EUROPLEXUS :

- the use of the elements BARS
- the taking into account of the kinematic relations resulting from DEFI_CABLE_BP
- modelization Q4GG with a mesh group containing of the triangles and of the quadrangles
- the taking into account of an initial state (displacements and stresses)
- the computation of the stresses starting from the initial trip made by Europlexus
- the use of the key word BALANCES ETAT_INIT

The modelization B is also used to validate the computation of option FORC_NODA in DEFORMATION = "PETIT_REAC" for the elements BARS and in DEFORMATION = "GROT_GDEP" for elements Q4GG from Europlexus.

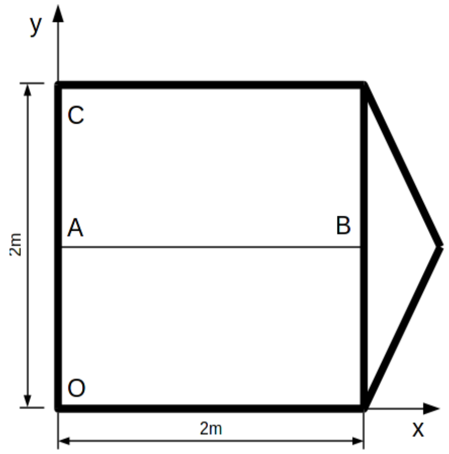
1 Description

1.1 Geometry

the concrete plate is formed of a square on $2\,m$ side and an isosceles triangle of a base $2\,m$ and a height of $0{,}5\,m$.

The thickness of the plate is worth $e=0{,}6\,m$.

A cable, located on the segment $[AB]$, crosses the wife-swapping party horizontally of the plate, with middle height, without eccentricity in the thickness. The area of the straight section cable is worth $S_a=1{,}5.10^{-4}m^2$.



1.2 Properties of the materials

the plate is out of concrete and the rope steel wire.

Concrete material		Steel
Modulus Young	$E_b=3.0^{10}\,Pa$	$E_a=2.1.10^{11}\,Pa$
Poisson's ratio	$\nu_b=0.3$	$\nu_a=0.3$
Density	$m_b=2500\,Kg/m^3$	$m_a=7500\,Kg/m^3$

1.3 Boundary conditions

the nodes O and C are clamped: all the degrees of freedom of translation and rotation are blocked.

2 Modelization A

2.1 Characteristic of the modelization

the plate of concrete is modelled by two elements Q4GG, first is supported by a quadrangular mesh and the second by a triangular mesh.

The cable is represented by 4 elements BARS, supported by 4 meshes segments with 2 nodes.

2.2 Loadings

the plate is subjected to a pressure which varies according to time:

Time	0,0	1.00E-005	2.00E-004	5.00E-004	1.00E-003	2.00E-003	3.00E-003
Pressure in Pa	0,0	2.00E+003	1.00E+005	1.00E+006	2.50E+006	7.00E+006	0,0

One initially imposes no tension in the cable.

2.3 Stages of the test

After the definition of the model, the materials and the loadings, one uses macro-command DEFI_CABLE_BP to obtain the kinematic relations between the plate and the cable.

One launches then commands CALC_EUROPLEXUS and DYNA_NON_LINE with the same models, materials, loadings,… etc displacements resulting from the results of these two commands are compared to validate the good taking into account of the kinematic relations between plate and cable in Europlexus.

Command IMPR_RESU is called to make sure that the recovery of the results resulting from Europlexus is well carried out.

2.4 Values tested

One compares the displacements obtained with CALC_EUROPLEXUS with those obtained with DYNA_NON_LINE on the node in the middle of the cable, the latter being used as reference.

Urgent	node	Component	Value of reference
NB001003	4.00E-004	DZ	2.810884. 10-5

3 Modelization B

3.1 Characteristic of the modelization

Identical to the modelization A

3.2 Loadings

One imposes an initial tension in the cable of a value of $2{,}0\text{E}5\ N$.

3.3 Stages of the test

After the definition of the model, the materials and the loadings, one uses macro-command DEFI_CABLE_BP to obtain the kinematic relations between the plate and the cable and to determine the initial tension in each cable element. The key word RELAXATION is not indicated, all the cable elements thus have a tension of $2{,}0\text{E}5\ N$.

One uses macro-command CALC_PRECONT to carry out the setting in tension of the concrete starting from the concept cable_precont resulting from DEFI_CABLE_BP.

The result resulting one from macro-command CALC_PRECONT is then given like initial state to CALC_EUROPLEXUS. Displacements and the forced (FORCED = ' OUI') are transmitted to Europlexus. No additional expenditure is given, the goal being checking the equilibrium of the system. This is why one does not force the equilibrium in Europlexus (EQUILIBRE = "NON").

After several time step, it is checked that displacements and the forced did not evolve.

3.4 Values tested

Results resulting from CALC_PRECONT :

Node	Inst	Field.	Comp.	Value of ref.	Reference	Tolerance
NB002002	FORC_NODA	1,0	DY	$-1.81986\text{E}+00$	SOURCE_EXTERNE	1,0E-5
NC001004	FORC_NODA	1,0	DY	$2.60310+00$	SOURCE_EXTERNE	1,0E-5

Urgent	Node	Component	Value of reference	Tolerance
NB001002	1,0	DX	$-1.06118202625\text{E}-04$	1,0E-6
NC001004	1,0	DY	$-6.50655304367\text{E}-06$	1,0E-6

Does not net		Urgent	Component	Value of reference	Tolerance
SG001001	1	1,0	N	$2.0\text{E}+05$	1,0E-6
TR001001	1	1,0	NYY	30079.629671	1,0E-6
QD001001	4	1,0	NYY	-24502.131453	1,0E-6

Results resulting from `CALC_EUROPLEXUS` :

Urgent	node	Component	Value of reference	Tolerance
NB001002	0,1	DX	$-1.06118202625E-04$	1,0E-6
NC001004	0,1	DY	$-6.50655304367E-06$	1,0E-4

Mesh	Not	Urgent	Component	Value of reference	Tolerance
SG001001	1	0,1	N	$2.0E+05$	1,0E-6
TR001001	1	0,1	NYY	30079.629671	1,0E-6
QD001001	4	0,1	NYY	-24502.131453	3,0E-5

4 Modelization C

4.1 Characteristic of the modelization

Identical to the modelization A

4.2 Loadings

the plate is subjected to a static loading of pressure which varies linearly according to time.

Time	0.0	1.0
Pressure out of Pa	0.0	10.0

One initially imposes no tension in the cable.

4.3 Stages of the test

After the definition of the model, the materials and the loadings, one uses macro-command `DEFI_CABLE_BP` to obtain the kinematic relations between the plate and the cable.

One does a static calculation with the loading of pressure using operator `STAT_NON_LINE` in order to build an initial state.

The result resulting one from operator `STAT_NON_LINE` is then given like initial state to `CALC_EUROPLEXUS`. Only displacements are transmitted to Europlexus (`FORCED = ' NON'`). No additional expenditure is given, the goal being checking that the stresses calculated by Europlexus are the same ones as those calculated by Code_Aster.

Note: To find the same stresses static computation in Code_Aster must imperatively be made in large displacements because it is the kinematics used by Europlexus. Moreover it is necessary to give to operand `NITER` the number of time step which carried out with Code_Aster to arrive in its final state during static computation.

`CALC_EUROPLEXUS` is called 3 times:

• `STRESS = ' NON'` and `EQUILIBRE = ' OUI'` :

One checks at initial time and final moment that the found stresses are equal to those calculated by Code_Aster. As the equilibrium was forced there should not be differences between the initial state and the final state.

• `STRESS = ' NON'` and `EQUILIBRE = ' OUI'` :

This time one does not give the load of static computation to `CALC_EUROPLEXUS`. That should not modify the results compared to the preceding case. The only difference is that the fictitious external forces added by Europlexus to be with the equilibrium will be more important. One checks at initial time and final moment that the found stresses are equal to those calculated by Code_Aster.

• `STRESS = ' NON'` and `EQUILIBRE = ' NON'` :

One checks at initial time that the found stresses are equal to those calculated by Code_Aster. The equilibrium not being forced, one can note light evolutions of displacement and stresses between the initial state and the final state.

4.4 Values tested

Results resulting from STAT_NON_LINE :

Do not net		Urgent	Component	Value of reference	Tolerance
QD001001	4	1.00E+000	QX	$1.24999999663E+01$	1E-6
TR001001	1	1.00E+000	MXX	-0.416666620634	1E-6
SG001001	1	1.00E+000	N	$6.67652805347E-05$	1E-6

Results resulting from computation CALC_EUROPLEXUS n°1 and n°2:

Initial time and final moment:

Do not net		Component	Value of reference	Tolerance
QD001001	4	QX	$1.24999999663E+01$	1E-6
TR001001	1	MXX	-0.416666620634	2E-6
SG001001	1	N	$6.67652805347E-05$	1E-6

Results resulting from computation CALC_EUROPLEXUS n°3:

Initial time:

Do not net		Component	Value of reference	Tolerance
QD001001	4	QX	$1.24999999663E+01$	1E-6
TR001001	1	MXX	-0.416666620634	2E-6
SG001001	1	N	$6.67652805347E-05$	1E-6

Final moment:

Do not net		Component	Value of reference	Tolerance	CRITERE
QD001001	4	QX	$1.24999999663E+01$	5E-6	"RELATIF"
TR001001	1	MXX	-0.416666620633	5E-5	"RELATIF"
SG001001	1	N	$6.67652805347E-05$	1E-5	"ABSOLU"

5 Synthesis

The computation made with Europlexus via CALC_EUROPLEXUS took well into account the elements BARS.

The test on displacement shows that the kinematic relations were correctly taken into account. The processing of the elements quadrangles and triangles in the same mesh group was well made.

One could also note that the taking into account of an initial state is made correctly, as well as the computation of the stresses starting from displacements by Europlexus.