PLEXU05 – Prestressed reinforced concrete plate under uniform pressure with the law GLRC DAMAGE

Summary:

The purpose of this test is to validate the chaining of a calculation of setting in tension of a cable of prestressed in Code_Aster with a fast calculation of dynamics in Europlexus via the macro-order of Code_Aster CALC_EUROPLEXUS, and in the presence of the law of behavior GLRC DAMAGE.

More precisely, it validates the following points:

• good transmission of information of the law GLRC DAMAGE of Code_Aster towards Europlexus via the macro-order CALC_EUROPLEXUS,
• the taking into account of the relations kinematics resulting from DEFI_CABLE_BP in the presence of the law GLRC DAMAGE.
1 Description

1.1 Geometry

The concrete plate is made of a square length of edges $L=0.9\,m$ and thickness $e=0.6\,m$. The four tops of the plate are named $A_1$, $A_2$, $A_3$, and $A_4$.

A cable, located on the segment $[A_3,A_4]$, the plate crosses horizontally, without eccentricity in the thickness. The surface of the cross-section of the cable is worth $S_a=1.10^{-4}\,m^2$.

![Figure 1.1-1: Geometry](image)

1.2 Properties of materials

The plate is out of reinforced concrete and the rope steel wire. The properties of the reinforced concrete results from the homogenisation of the properties of the concrete and the properties of the reinforcements thanks to the order `DEFI_GLRC`.

<table>
<thead>
<tr>
<th>Material</th>
<th>Concrete</th>
<th>Reinforcements</th>
<th>Steel of the cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young modulus</td>
<td>$E_b=3.57\times10^9,Pa$</td>
<td>$E_a=2.1\times10^{11},Pa$</td>
<td>$E_a=2.1\times10^{11},Pa$</td>
</tr>
<tr>
<td>Poisson's ratio</td>
<td>$\nu_b=0.2$</td>
<td>$\nu_a=0$</td>
<td>$\nu_a=0$</td>
</tr>
<tr>
<td>Density</td>
<td>$m_b=2500,kg/m^3$</td>
<td>$m_a=7500,kg/m^3$</td>
<td>$m_a=7500,kg/m^3$</td>
</tr>
</tbody>
</table>

Table 1.2-1: Properties of materials.

1.3 Boundary conditions and loadings

Segments $[A_1,A_2]$ and $[A_1,A_3]$ are respectively blocked according to the direction $Y$ and direction $X$. The segment $[A_2,A_4]$ as for him is blocked according to the direction $Z$ like in rotation around the three axes.

The loading is applied in two stages. The first quasistatic calculation makes it possible to prestress the cable with a tension $T=2.0\times10^5\,N$. Then one applies a uniform pressure directed positively according to the direction $-Z$ on the complete surface of the plate. Its maximum amplitude is $P_{\text{max}}=0.15\,MPa$, and it is associated with a slope going from 0 with 1 between the moments $t_{\text{initial}}=0\,s$ and $t_{\text{final}}=0.004\,s$.
2 Reference solution

It is about a test of nonregression concerning the calculation carried out with the order DYNA_NON_LINE. This last is used then as reference to the calculation carried out by Europlexus thanks to the macro-order CALC_EUROPLEXUS.
3 Modeling A

3.1 Characteristics of modeling

The reinforced concrete plate uses modeling Q4GG while the cable is in modeling BAR.

3.2 Characteristics of the grid

The reinforced concrete plate is made up of 72 elements T3GG, while the cable is modelled by 6 elements BAR.

3.3 Sizes tested and results

One tests displacement according to the direction $Z$ top $A_1$. The first calculation with DYNA_NON_LINE is instrumented by a test of nonregression, which is used as reference to the calculation carried out with Europlexus via the macro one - order CALC_EUROPLEXUS.

<table>
<thead>
<tr>
<th>Identification</th>
<th>Type of reference</th>
<th>Value of reference</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>DYNA_NON_LINE - Not $A_1$ - $DZ$</td>
<td>‘NON_REGRESSION’</td>
<td>-4.3214499919696. 10$^4$</td>
<td>1.10$^{-6}$ %</td>
</tr>
<tr>
<td>CALC_EUROPLEXUS - Not $A_1$ - $DZ$</td>
<td>‘AUTRE_ASTER’</td>
<td>-4.3214499919696. 10$^4$</td>
<td>0.5 %</td>
</tr>
</tbody>
</table>

Table 3.3-1: Sizes tested
Calculation done with Europlexus via CALC_EUROPLEXUS took well into account the various parameters of the law GLRC_DAMAGE.

The calculation of prestressed cable made it possible to validate this functionality when the concrete is modelled by the law of behavior GLRC_DAMAGE.