SSLL10 - Gantry with side connections

Summary:
Static test in linear elasticity, being used to validate the elements of right beam FOU_D_T for a specific loading and a loading distributed (keyword FORCE_POUTRE). The relations and moments bending are tested.
1 Problem of reference

1.1 Geometry

Problem plan

<table>
<thead>
<tr>
<th>Beam</th>
<th>Length</th>
<th>Moment of inertia</th>
</tr>
</thead>
<tbody>
<tr>
<td>$AB$</td>
<td>$l_{AB} = 4m$</td>
<td>$I_{AB} = \frac{64}{3} \times 10^{-8} m^4$</td>
</tr>
<tr>
<td>$AC$</td>
<td>$l_{AC} = 1m$</td>
<td>$I_{AC} = \frac{1}{12} \times 10^{-8} m^4$</td>
</tr>
<tr>
<td>$AD$</td>
<td>$l_{AD} = 1m$</td>
<td>$I_{AD} = \frac{1}{12} \times 10^{-8} m^4$</td>
</tr>
<tr>
<td>$AE$</td>
<td>$l_{AE} = 2m$</td>
<td>$I_{AE} = \frac{4}{3} \times 10^{-8} m^4$</td>
</tr>
</tbody>
</table>

$G$ is in the middle of $DA$.

Another characteristic of the beams not being used for calculations: the beams are of square section.

$A_{AB} = 16 \times 10^{-4} m$

$A_{AD} = 1 \times 10^{-4} m$

$A_{AC} = 1 \times 10^{-4} m$

$A_{AE} = 4 \times 10^{-4} m$

1.2 Material properties

Isotropic linear elastic material: $E = 2 \times 10^{11} Pa$
1.3 Boundary conditions and loadings

1) Not $C$ : articulated $(u_C = v_C = 0)$.

Specific force in $G$ : $F = -10^5 N$
Force distributed on the beam $AD$ : $p = -10^3 N/m$
2 Reference solution

2.1 Method of calculating used for the reference solution

One poses:

\[ k_{An} = \frac{EI_{An}}{l_{An}} \]

with \( n = B, C, D \) or \( E \)

\[ K = k_{AB} + k_{AD} + k_{AE} + \frac{3}{4}k_{AC} \]

\[ r_{An} = \frac{k_{An}}{K} \]

with \( n = B, C, D \) or \( E \)

\[ C_1 = \frac{F_{l_{AD}}}{8} - \frac{p_{l_{AB}}^2}{12} \]

- Rotation in \( A \):
  \[ \theta = \frac{C_1}{4K} \]

- Moment in \( A \):
  \[ M_{AB} = \frac{p_{l_{AB}}^2}{12} + r_{AB} \cdot C_1 \]
  \[ M_{AD} = \frac{F_{l_{AD}}}{8} + r_{AD} \cdot C_1 \]
  \[ M_{AE} = r_{AE} \cdot C_1 \]
  \[ M_{AC} = r_{AC} \cdot C_1 \]

2.2 Results of reference

Value of rotation and the moments in \( A \).

2.3 Bibliographical references

3 Modeling A

3.1 Characteristics of modeling

Elements **POU_D_T**
- 1 element for the section \( AG \)
- 1 element for the section \( GD \)
- 1 element for the section \( AE \)
- 1 element for the section \( AC \)
- 1 element for the section \( AB \)

Boundary conditions:

```plaintext
DDL_IMPO (
    TOUT=' OUI', DX=0, DRX=0, DRY=0
    NOEUD= (D, B, E), DX=0, DY=0, DRZ=0
    NOEUD=C, DX=0, DY=0
)
FORCE_NODALE NOEUD=G Fy = -1. 105
FORCE_AUTRE MAILLE=AB Fy = -1. 103
```

3.2 Characteristics of the grid

5 elements **POU_D_T**
6 nodes

3.3 Sizes tested and results

<table>
<thead>
<tr>
<th>Not</th>
<th>Size and unit</th>
<th>Reference</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A )</td>
<td>( \theta ), rotation ( ( rad ) )</td>
<td>0.227118</td>
<td>0.140</td>
</tr>
<tr>
<td>( A )</td>
<td>( M_{AB} ), moment ( ( Nm ) )</td>
<td>-11023.72</td>
<td>-0.030</td>
</tr>
<tr>
<td>( A )</td>
<td>( M_{AC} ), moment ( ( Nm ) )</td>
<td>-113,559</td>
<td>0.140</td>
</tr>
<tr>
<td>( A )</td>
<td>( M_{AD} ), moment ( ( Nm ) )</td>
<td>+12348.588</td>
<td>-0.009</td>
</tr>
<tr>
<td>( A )</td>
<td>( M_{AE} ), moment ( ( Nm ) )</td>
<td>-1211.2994</td>
<td>0.120</td>
</tr>
</tbody>
</table>
4 Summary of the results

The results show the good performance of the elements POU_D_T in cross-bending under loading concentrated and distributed (FORCE_POUTRE).