SSNP305 - Element of bar in compression - Appearance of a negative pivot

Summary:

This test of linear quasi-static mechanics 2D consists in charging an element with bar in compression. On a side, the element is fixed according to the degrees of translation on a node. Other side, the element is fixed according to the second degree of translation on a node in order to model the slip along a line. At a certain moment the stiffness becomes negative (= negative slope). This test is drawn from guide NAFEMS (analytical solution). The structure will be charged by using a piloting by displacement.

The plate is modelled by 12 elements plans (MECPQU4). The material has a linear behavior and one takes into account non the geometrical linearities. The keyword factor is used BEHAVIOR option GREEN.
1 Problem of reference

1.1 Geometry

1.2 Material properties

Isotropic elastic material

\[ E = 200000 \text{ MPa} \]
\[ \nu = 0.0 \]

1.3 Boundary conditions and loadings

Not \( A \):
\[ u_x = 0. \]
\[ u_y = 0. \]

Not \( B \):
\[ u_x = 0. \]

Loading by a force \( P \) on the point \( B \). The force will be increased by using a piloting by displacement of the point \( B \).

\[ L = 2500 \]
\[ \alpha L = 2500 \]
\[ A = 250 \]
2 Reference solution

2.1 Method of calculating used for the reference solution

Analytical solution.

2.2 Results of reference

Vertical displacement \( v = (Q_1 - \alpha) L \)

Deformation ‘GREEN’

\[ P = -E A Q_1 \left( \frac{Q_1^2 - \alpha^2}{2(1 + \alpha^2)^{3/2}} \right) \]

2.3 Bibliographical references

- Benchmark tests for solution procedures for geometric non-linearity, NAFEMS, 1987
3 Modeling A

3.1 Characteristics of modeling A

Modeling in plane constraints: C_PLAN

The loading and boundary conditions are modelled by:

```
DDL_IMPO: (NODE: N7 DX: 0.)
          (NODE: N1 DX: 0. DY: 0.)
```

In order to respect the best possible behavior of bar, one prolongs the length of the bar and one imposes on this surplus of matter a Young modulus of $2E7 \text{ MPa}$.

The other meshes are affected face value of 200000 MPa.

3.2 Characteristics of the grid

Many nodes: 21
Many meshes: 12 MECPQU4

3.3 Values tested

<table>
<thead>
<tr>
<th>Identification</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$FY(N7)$</td>
<td>with 1511441</td>
</tr>
<tr>
<td>$DX = -250$</td>
<td></td>
</tr>
<tr>
<td>$FY(N7)$</td>
<td>with 2545584</td>
</tr>
<tr>
<td>$DX = -500$</td>
<td></td>
</tr>
<tr>
<td>$FY(N7)$</td>
<td>with 3155464</td>
</tr>
</tbody>
</table>

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3.4 Remarks

The application of the loading is carried out with 100 increments.

4 Summary of the results

The results provided by Aster are in perfect agreement with the reference solution.