SSLV324 - Elliptic crack in a 3D body subject to tensile loading

Abstract:

This test case models a planar elliptic crack within a 3D body subject to a tensile loading. The purpose is to study the idealised behaviour of a crack using linear-elastic-fracture mechanics.
1 Reference problem

1.1 Geometry

The specimen configuration is presented in half symmetry, as shown in figure 1. It represents a cube with dimensions \((h = w = t = 16)\) containing a planar, elliptic crack with dimensions \(c = a = 1\). The specimen is subjected to a tensile load perpendicular to the plane of the crack and represents pure mode 1 crack opening.

![Specimen geometry](image)

**Fig.1 Specimen geometry**

1.2 Material properties

The material of the specimen is assumed to be homogeneous isotropic linear elastic with the following parameters:

- Young modulus \(E = 200\,000\,\text{MPa}\)
- Poisson's ratio \(\nu = 0.3\)

1.3 Boundary conditions and loading

The structure is subjected to a tensile stress \(\sigma = 1\,\text{MPa}\). Due to symmetry, only one quarter of the elliptical crack is considered and symmetric conditions are implemented on two faces `FACE_LAT` and `FACE_AV`.

2 Reference solution

2.1 Method used for the reference solution

For a circular crack of radius $a$ in an infinite medium, subjected to a uniform tension $\sigma$ according to the normal to the plane of the crack lips, T-stress is independent of the curvilinear abscisse along the crack front $s$ and is expressed in the following way [1]:

$$T(s) = -\sigma_0$$

2.2 Reference results

By considering the numerical values of the statement, we get: $T = -1 \text{ MPa}$.

2.3 Bibliographical references

3 Model A

3.1 Mesh

The quadratic mesh of structure is provided as a MED format. Due to symmetry, only one quarter of the structure is represented, as shown in figure 2.

![Mesh](Image)

Fig.2 Mesh

3.2 Quantities tested and results

<table>
<thead>
<tr>
<th>Identification</th>
<th>Type de Référence</th>
<th>Référence</th>
<th>% tolérance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$ - MAX</td>
<td>ANALYTIQUE</td>
<td>-1.E6</td>
<td>5.0</td>
</tr>
<tr>
<td>$T$ - MIN</td>
<td>ANALYTIQUE</td>
<td>-1.E6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

![Graph](Image)
4 Conclusion

Results are in good agreement with the theory.