

# Verification - Example 4: Multi-material example

## Problem Description

This verification example demonstrates a tunnel built in a 3 layered medium.

The stiffness of the top and bottom layers are the same, which is different from the middle layer.

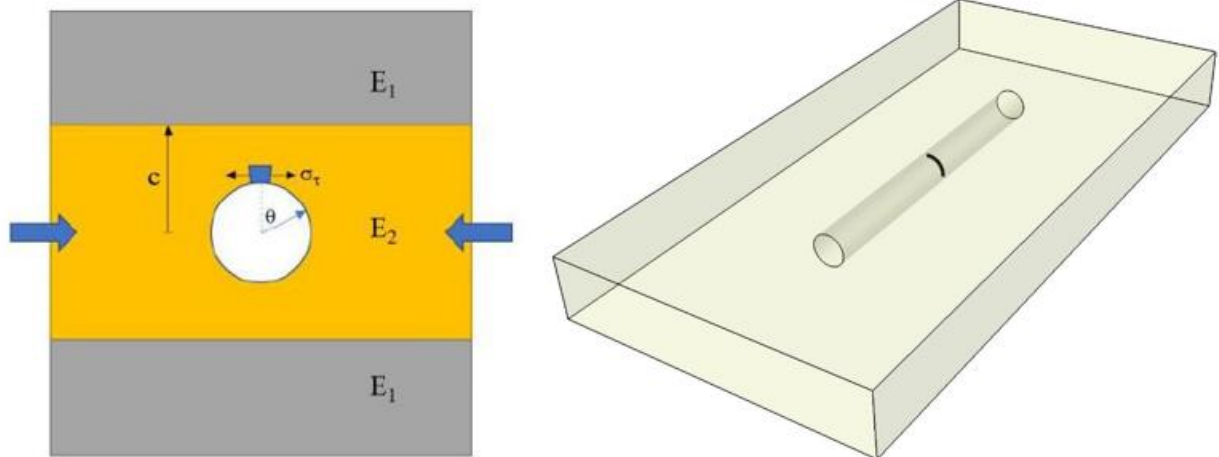
## Model Information

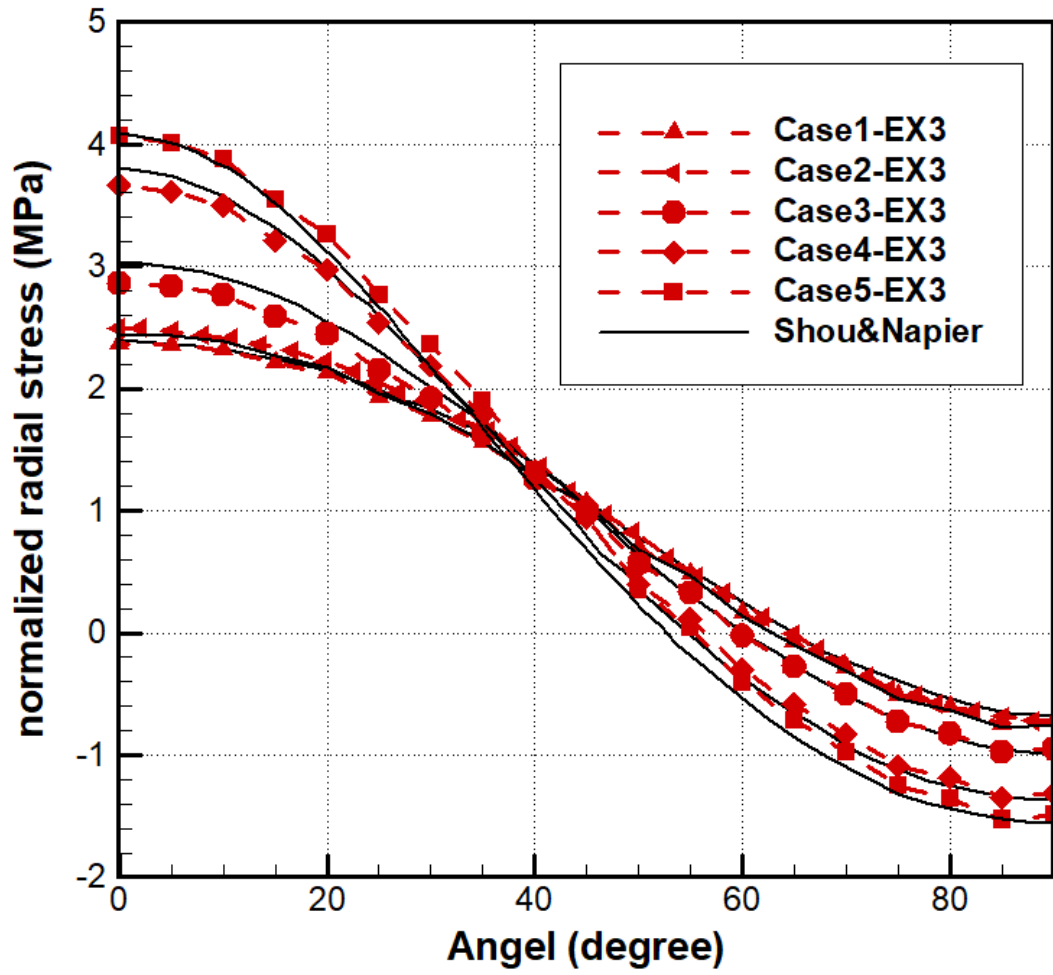
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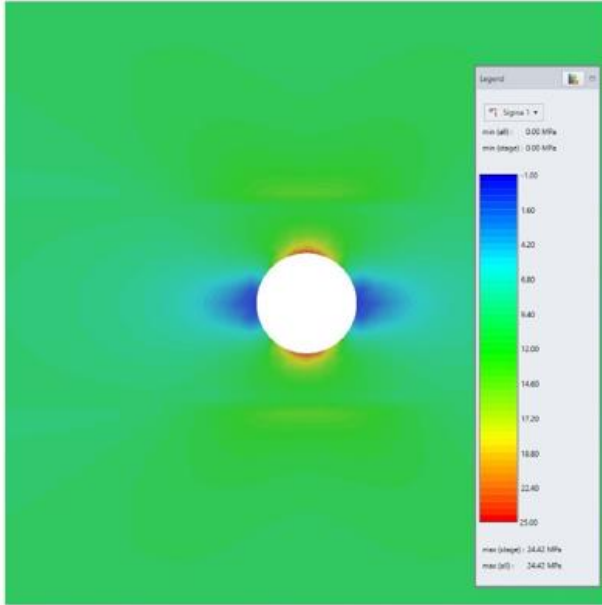
- The tunnel has a radius of 1.0 m.
- The distance from the tunnel center to the top and bottom layer is  $c = 2.0$  m.
- Only horizontal field stress (10 MPa) is applied in the domain.
- The distribution of normalized tangential stress all around the tunnel is calculated for 5 different cases ( $E_1 = 5000$  MPa):
  - Case 1:  $E_1/E_2 = 100$
  - Case 2:  $E_1/E_2 = 10$
  - Case 3:  $E_1/E_2 = 1.0$
  - Case 4:  $E_1/E_2 = 0.1$
  - Case 5:  $E_1/E_2 = 0.01$

## Results

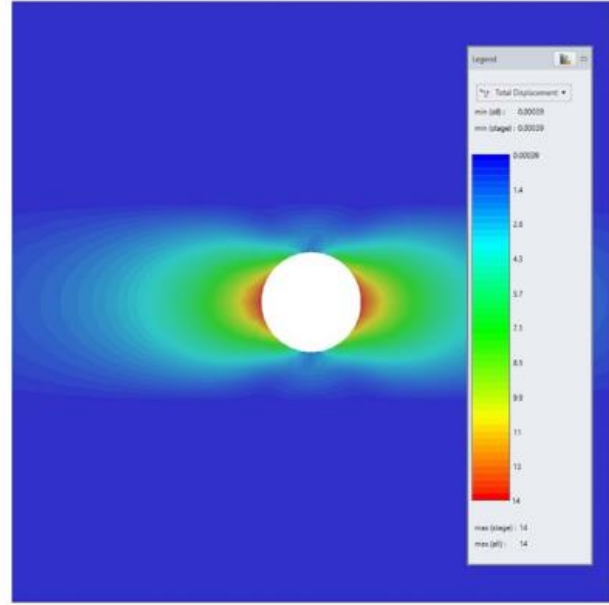
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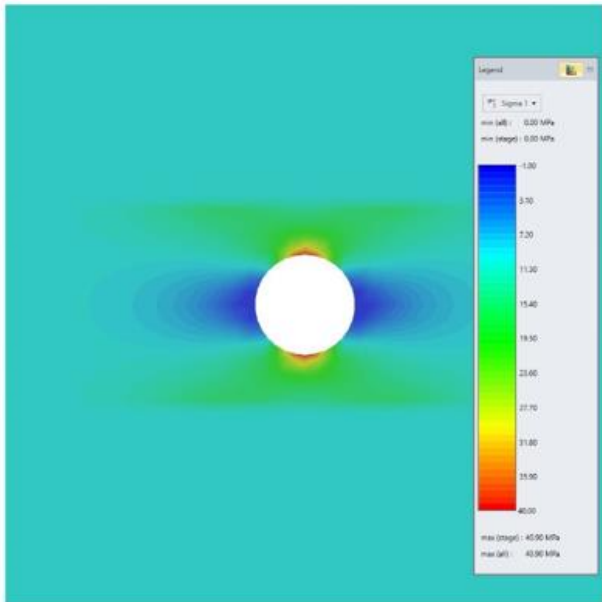




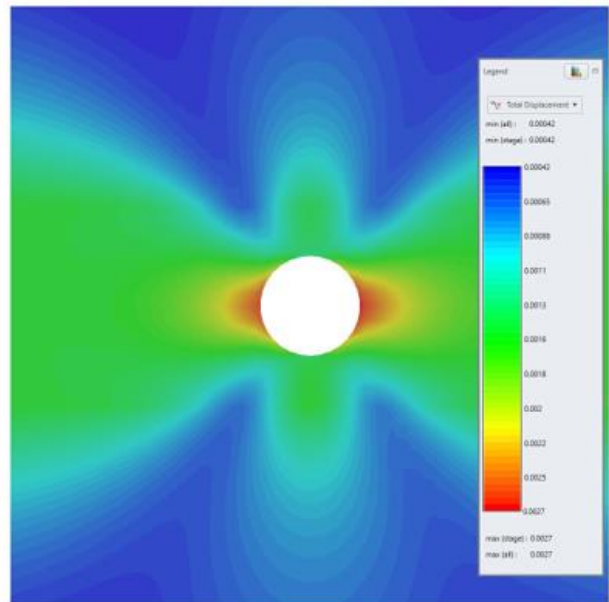
Sigma 1- Case 1



Total Displacement- Case 1



Sigma 1- Case 5



Total Displacement- Case 5

As it can be expected, for the stiffer materials above and below the tunnel, the tangential stress at the top of tunnel ( $\theta=0.0$ ) should be decreased.

## References

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Shou, K., Napier, J.A.L. 1999. A two-dimensional linear variation displacement discontinuity method for three-layered elastic media. *International Journal of Rock Mechanics and Mining Science* 36: 719- 729.

## Data Files

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The data input file(s) and file for the finished model can be found in the EX3 installation folder.