The Microgeometry of Pressure Seals

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Mathematical Model → Simulation

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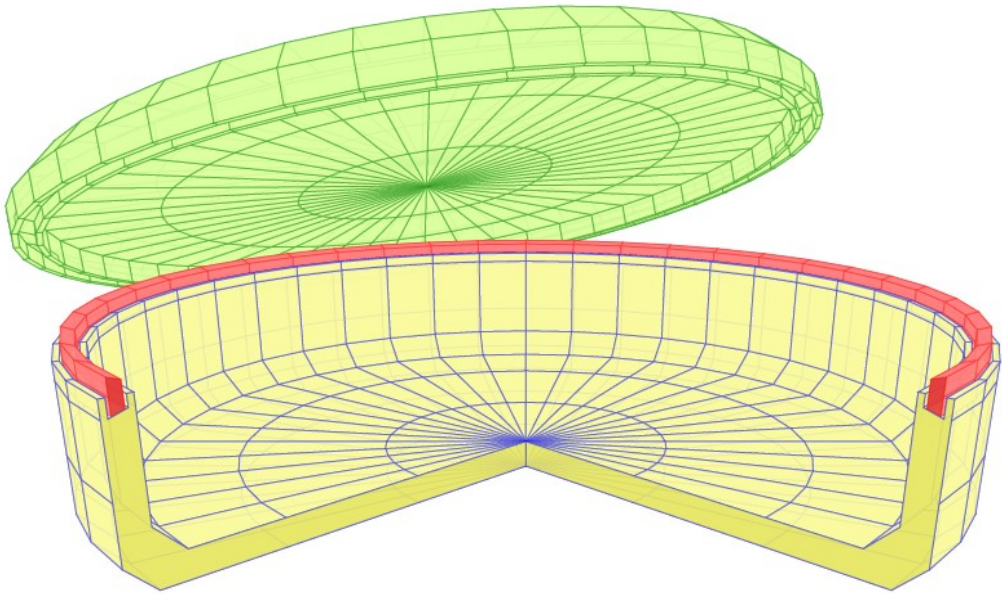
Simulation → Mathematical Model

Multi-Scale Modeling (Homogenization)

- Mathematical theory of coordination between phenomena happening at different scales

Gasket Seals



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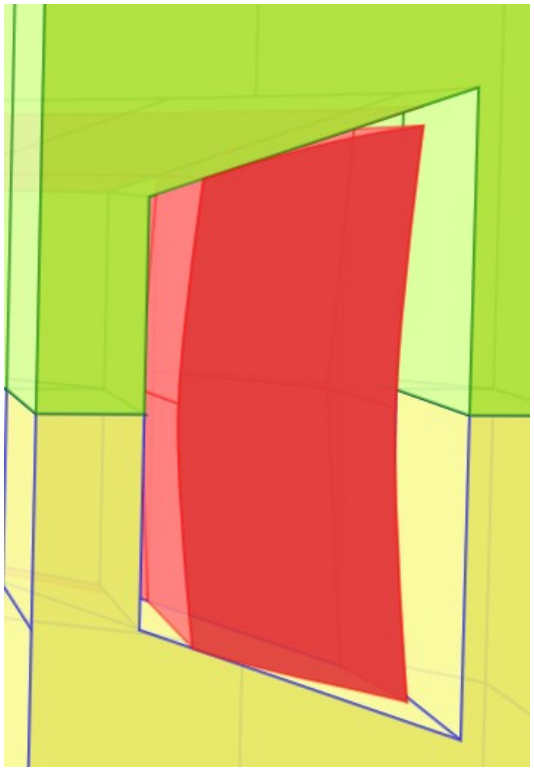
Gasket Seals



Leakage rate depends on:

- Geometries
- Materials
- Surface characteristics
- Clamping forces
- Fluid pressure

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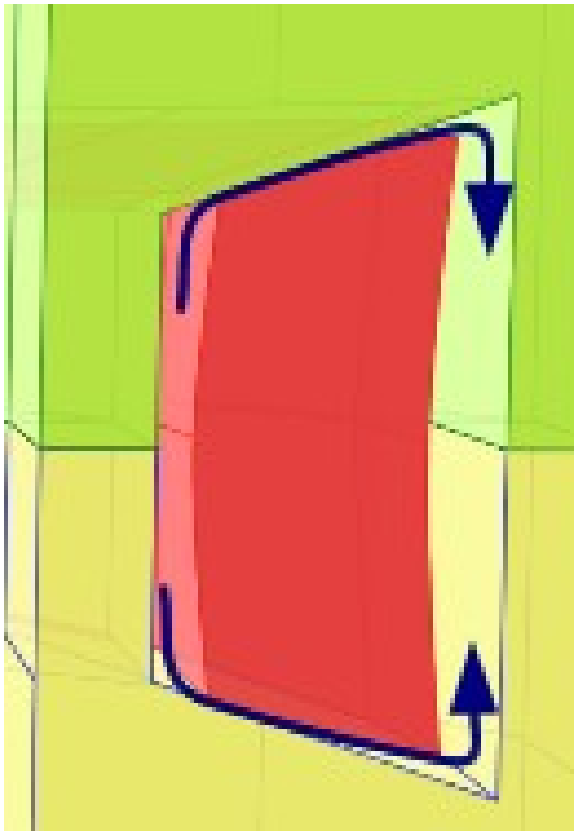
Fluid Leakage



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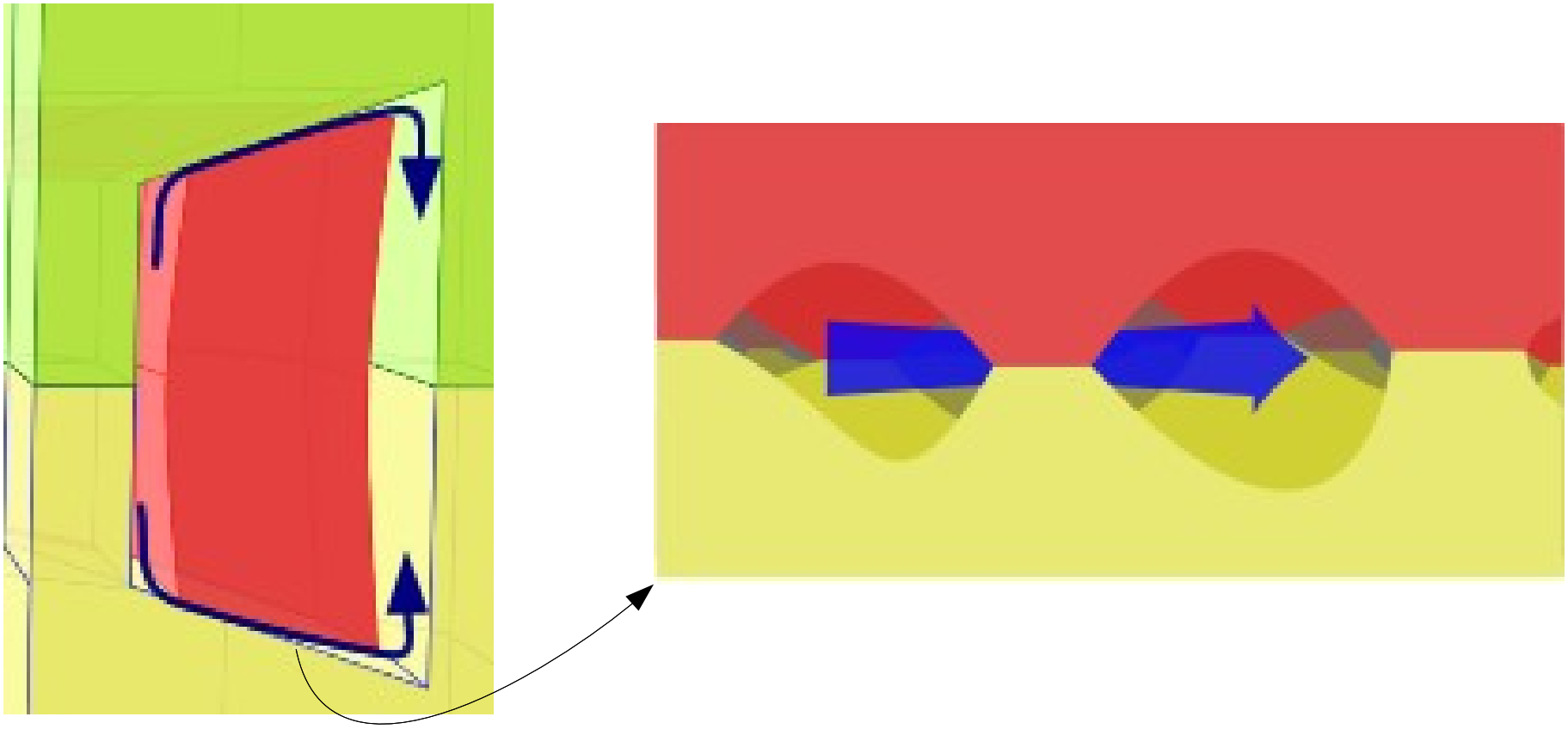
Fluid Leakage



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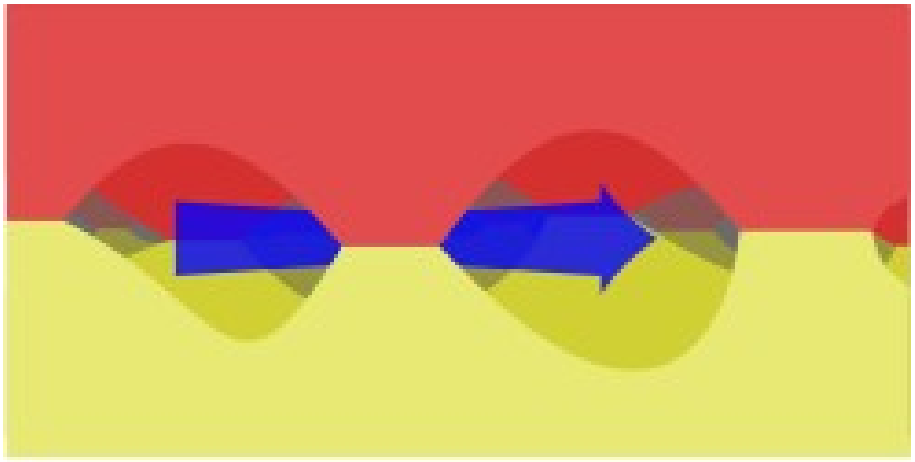
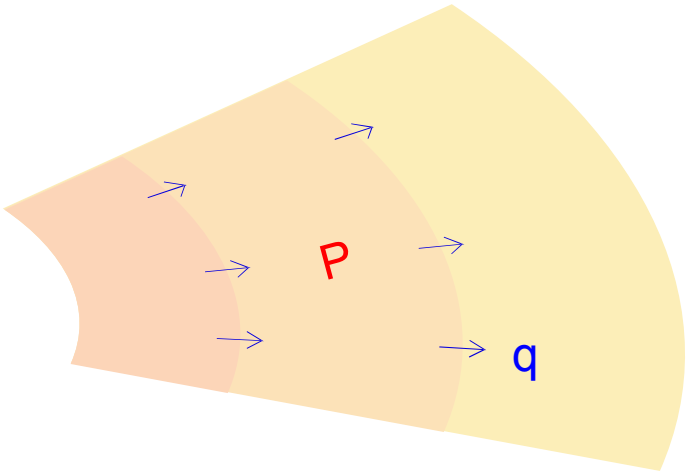
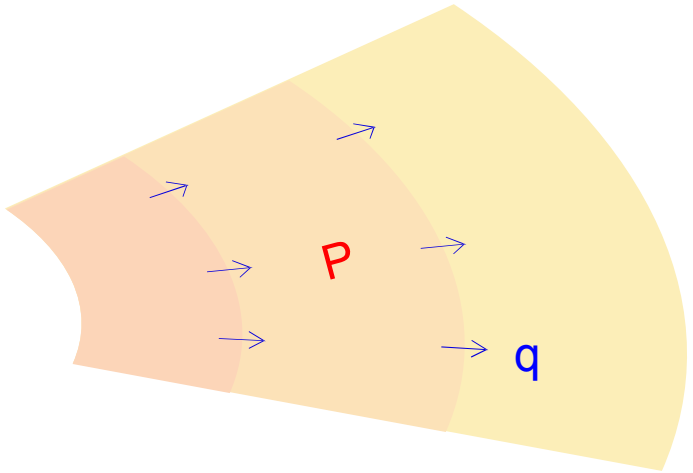
Homogenization





Homogenization

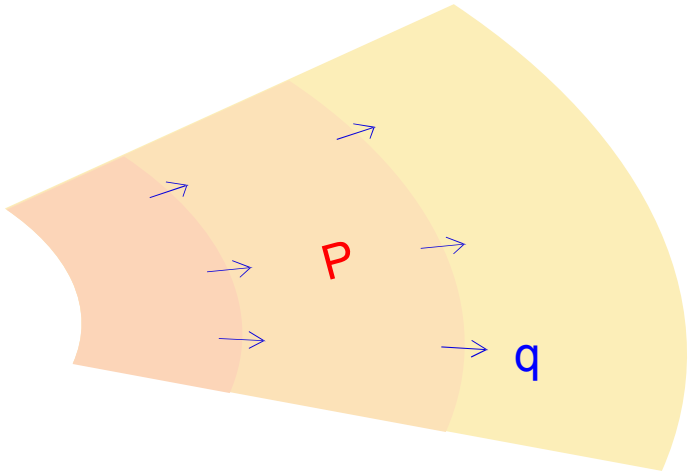
$$q = a \nabla P$$



Homogenization

$$q = a \nabla P$$

$$a = a\,(S, P, |\nabla P|)$$



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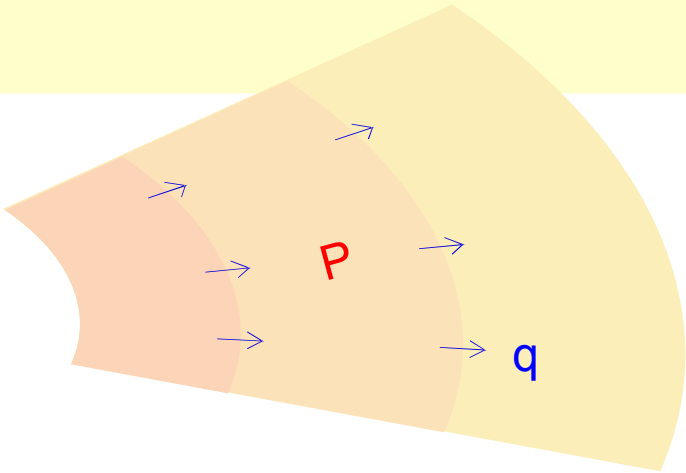

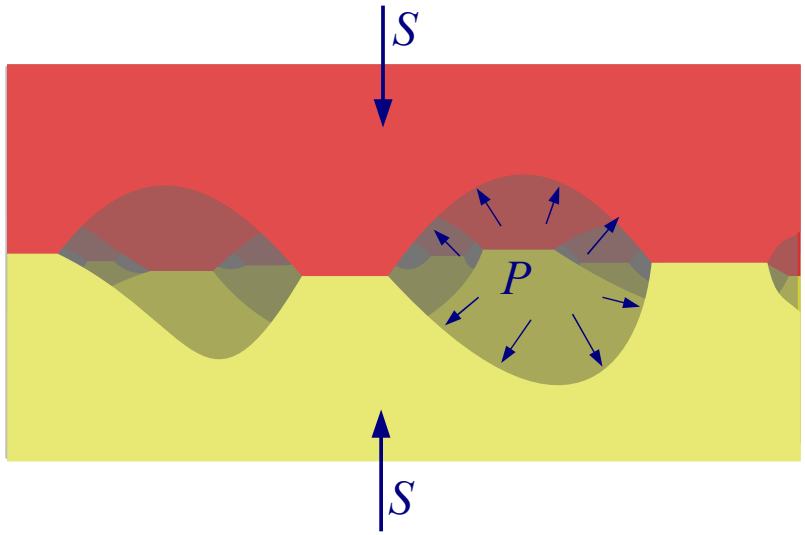

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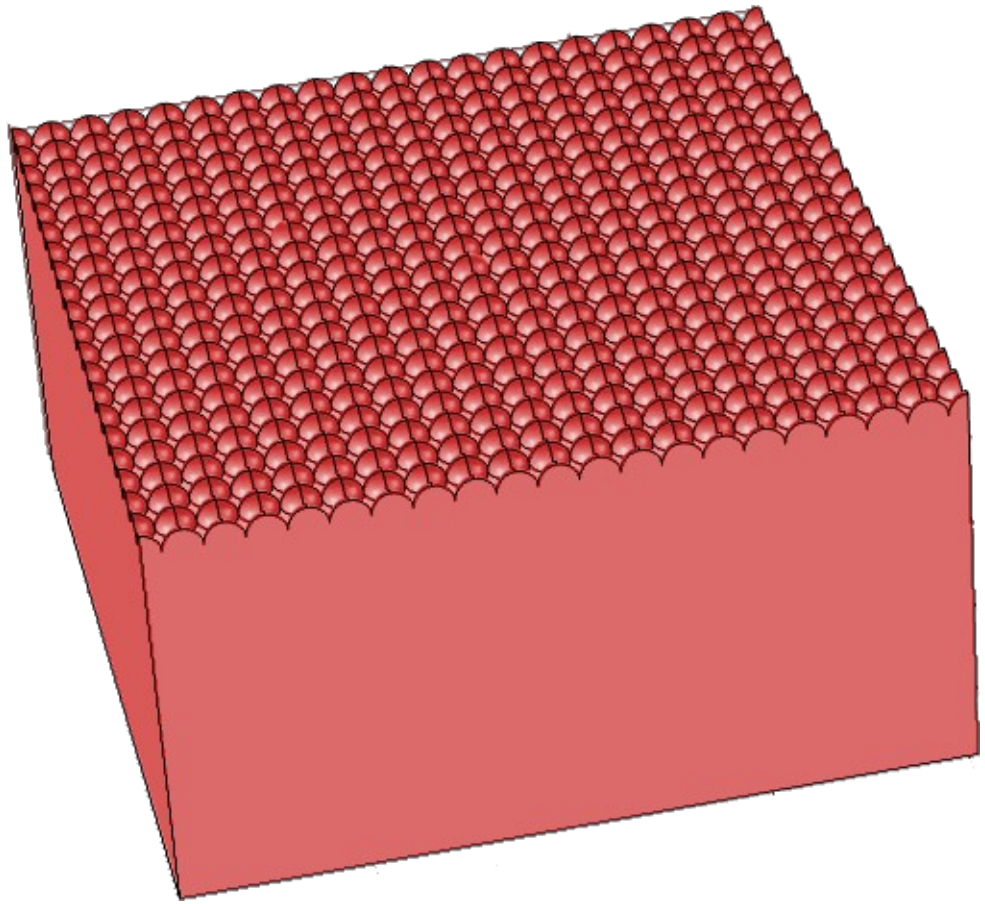
Idealization



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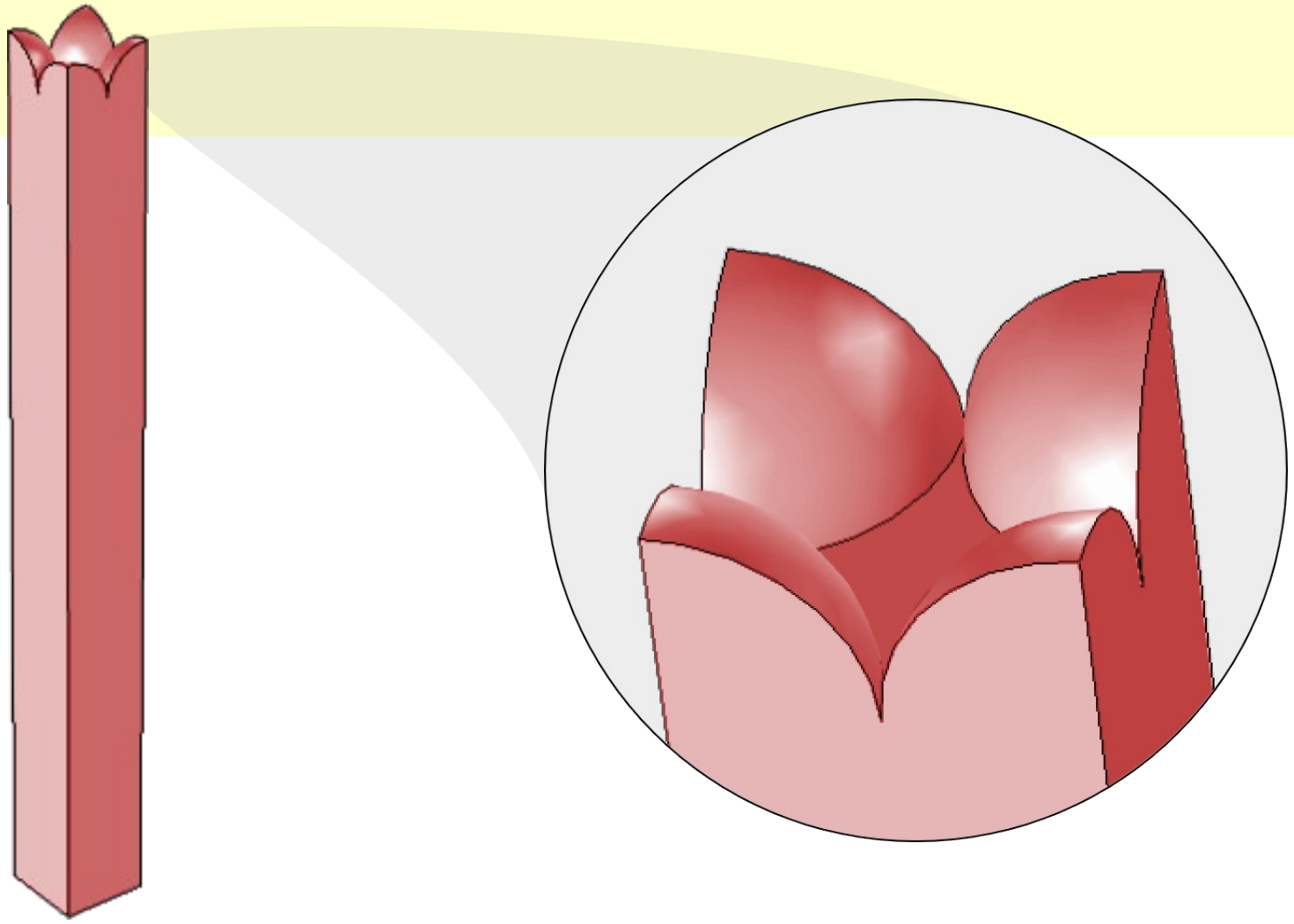

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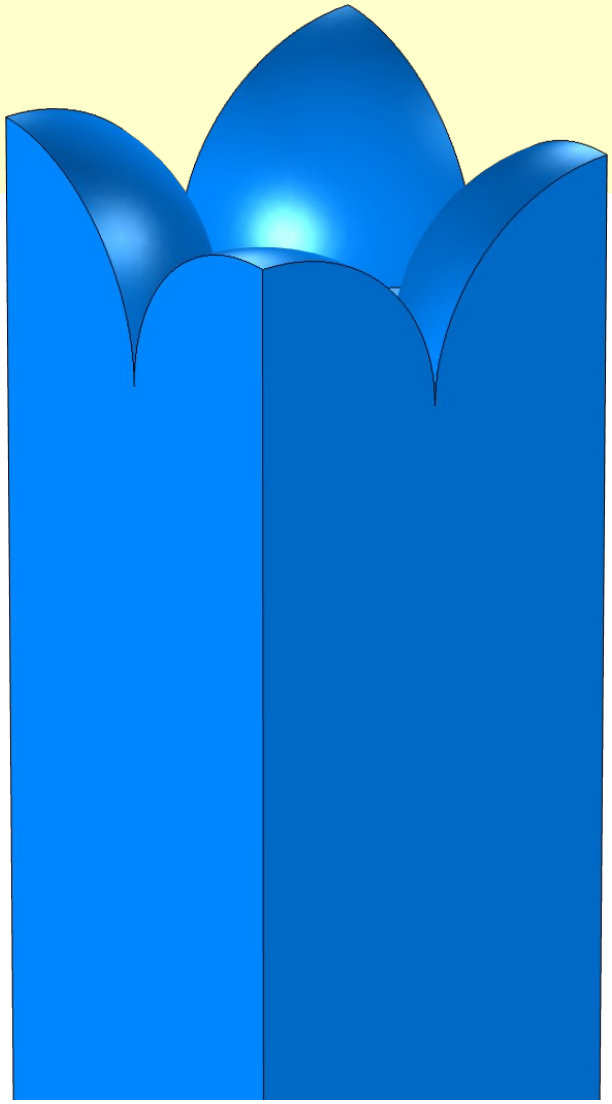
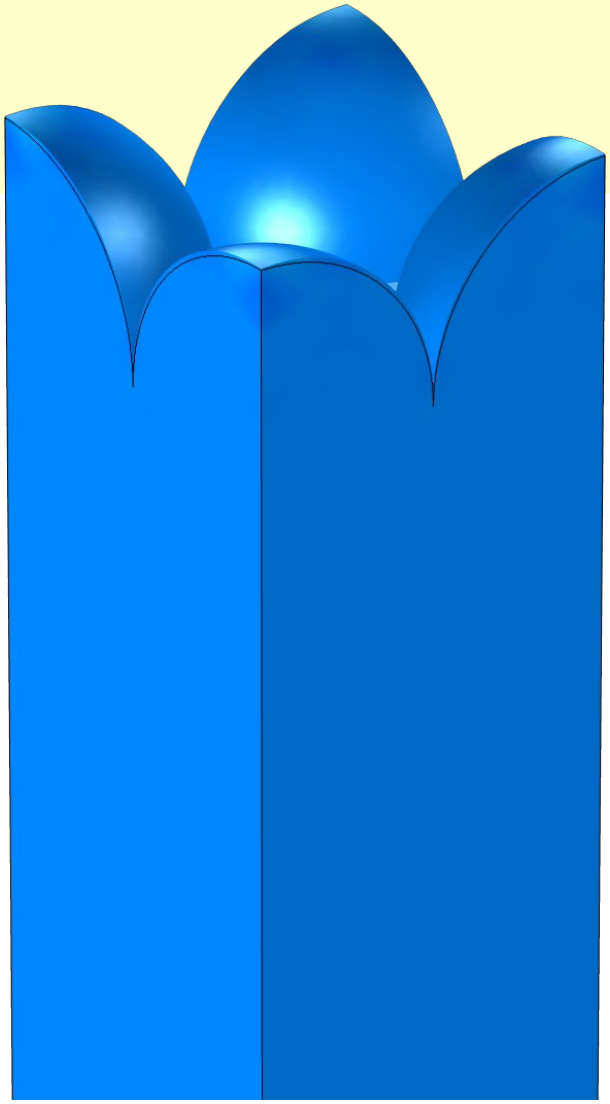
Results

- S = 300 kPa
- P = 300 kPa
- S – P = 0 kPa



Results

- S = 304 kPa
- P = 300 kPa
- S – P = 4 kPa



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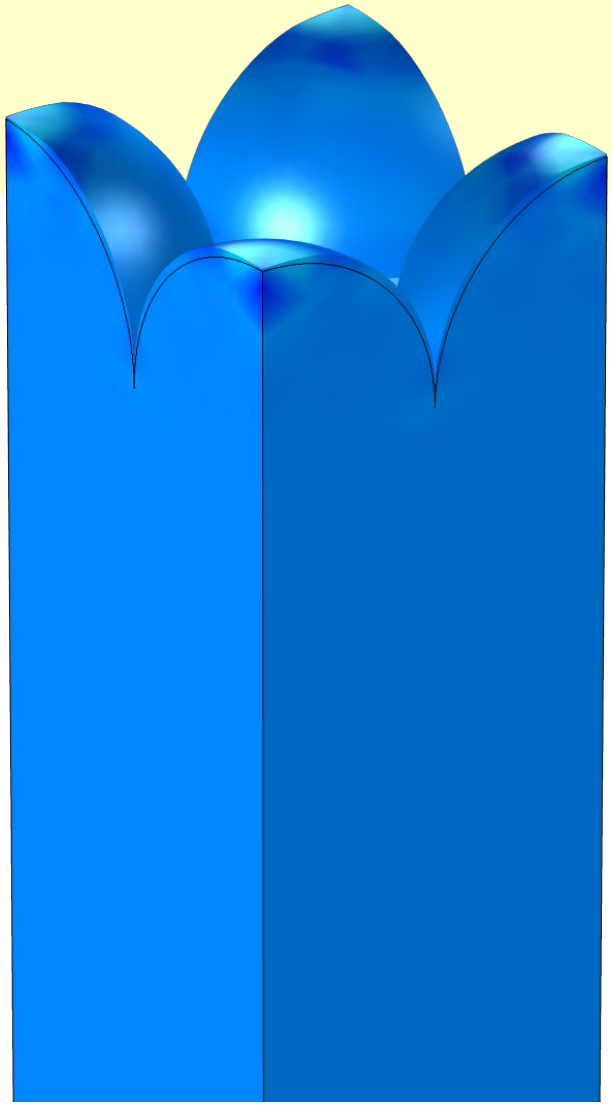
Results

- S = 313 kPa
- P = 300 kPa
- S – P = 13 kPa



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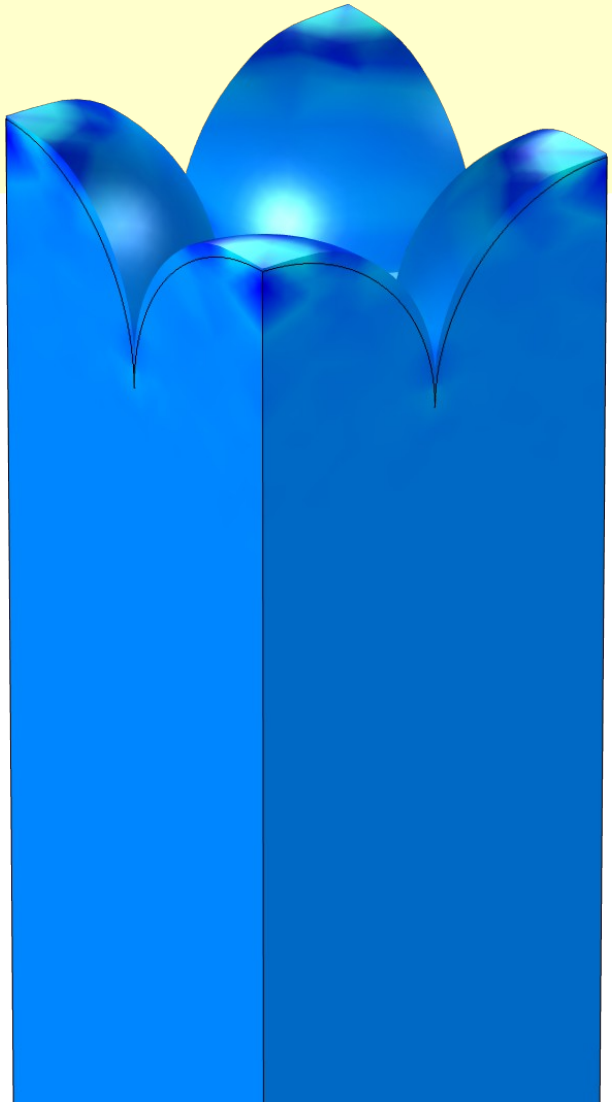
Results

- S = 327 kPa
- P = 300 kPa
- S – P = 27 kPa



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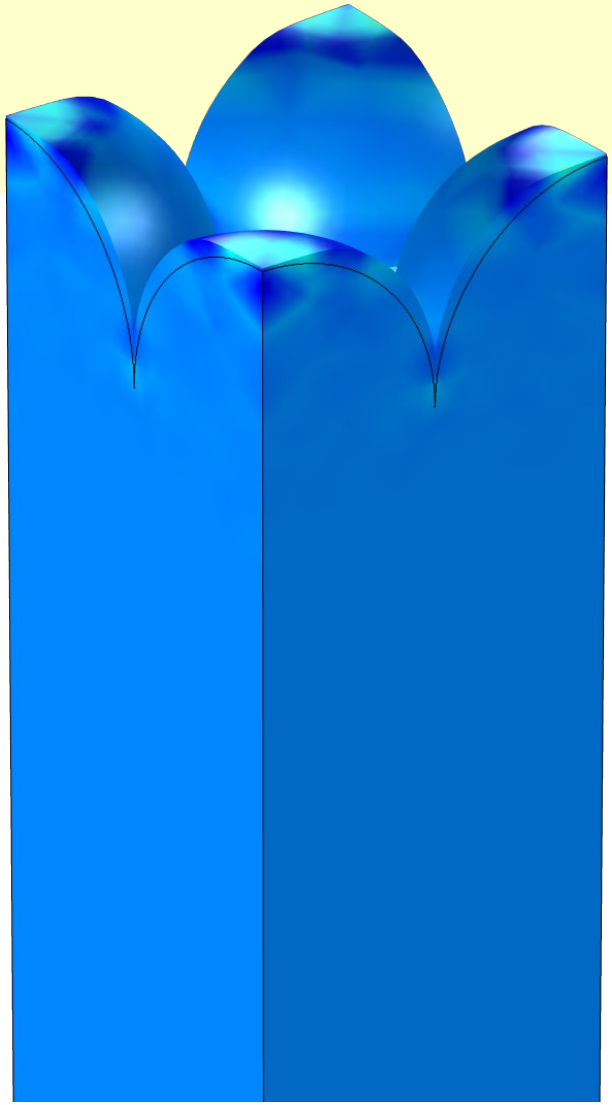
Results

- S = 345 kPa
- P = 300 kPa
- S – P = 45 kPa



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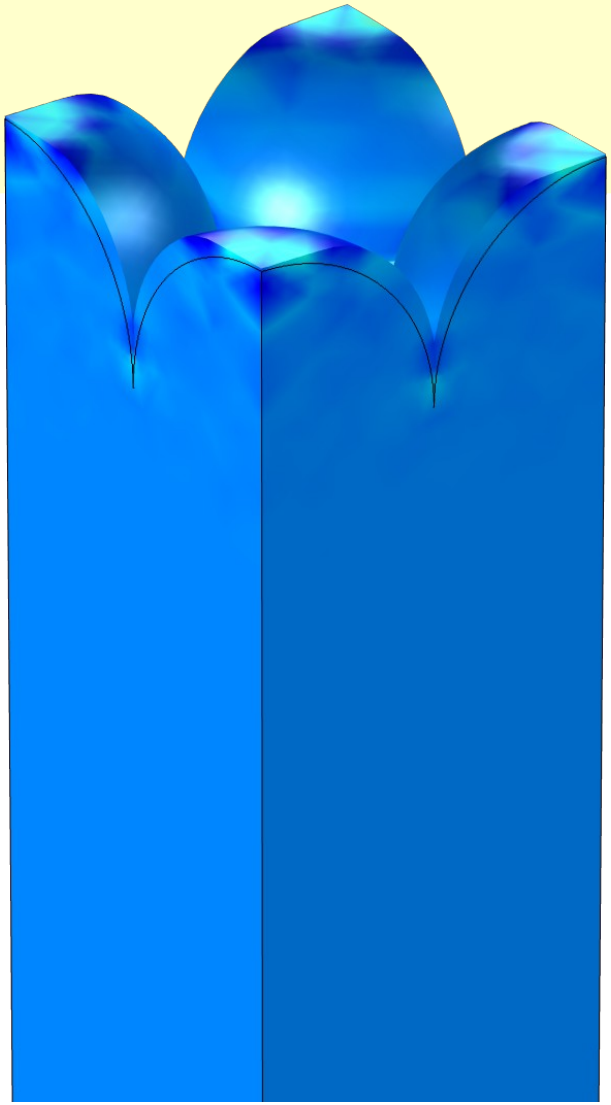
Results

- S = 367 kPa
- P = 300 kPa
- S – P = 67 kPa



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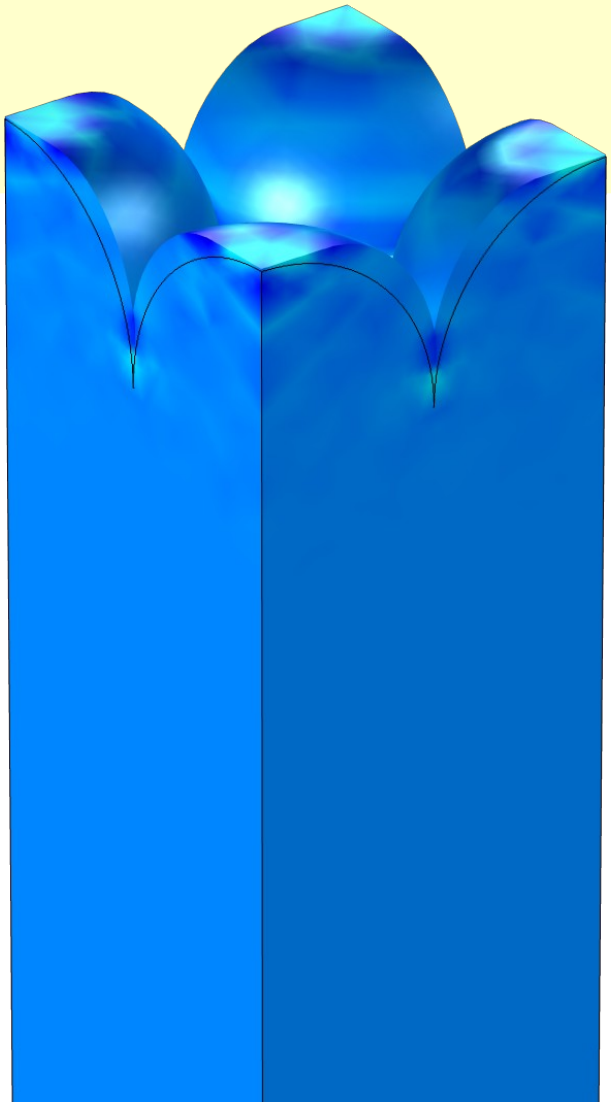
Results

- S = 391 kPa
- P = 300 kPa
- S – P = 91 kPa



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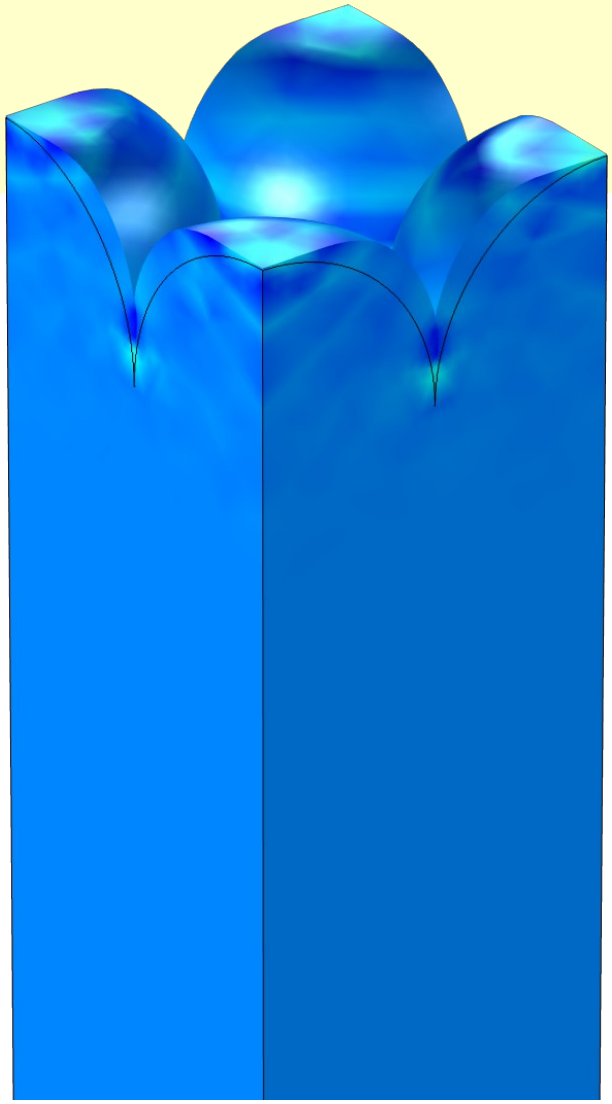
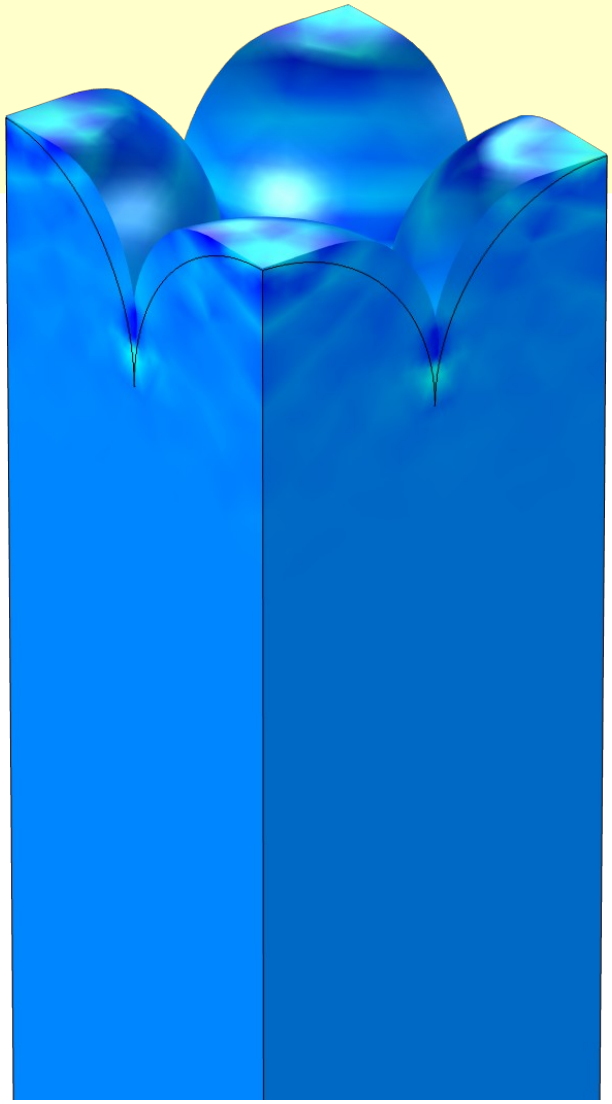
Results

- S = 419 kPa
- P = 300 kPa
- S – P = 119 kPa



Results

- S = 519 kPa
- P = 400 kPa
- S – P = 119 kPa



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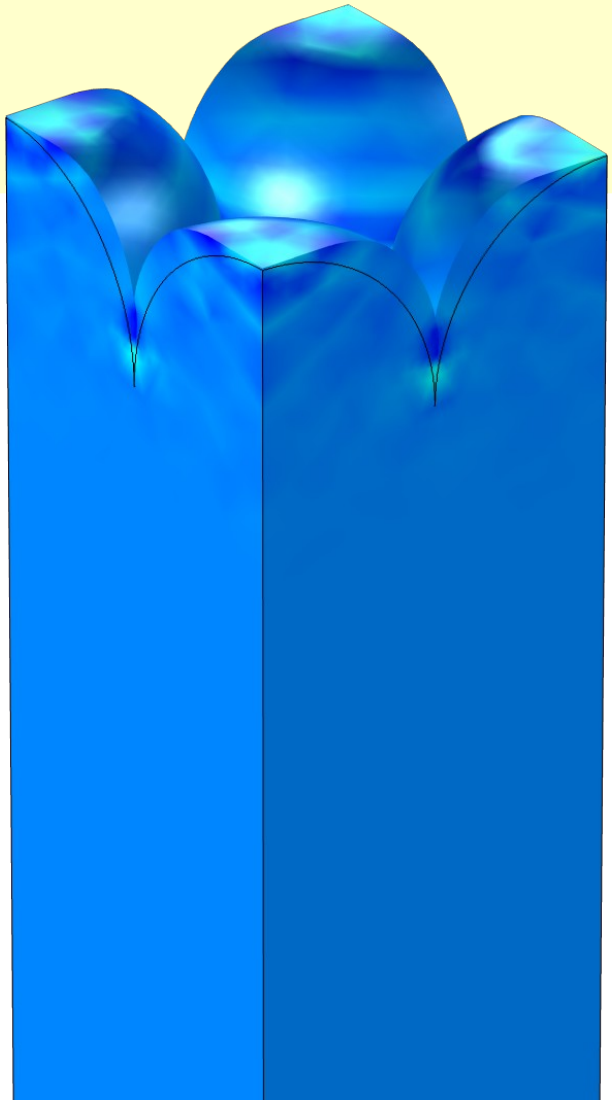
Results

- S = 619 kPa
- P = 500 kPa
- S – P = 119 kPa



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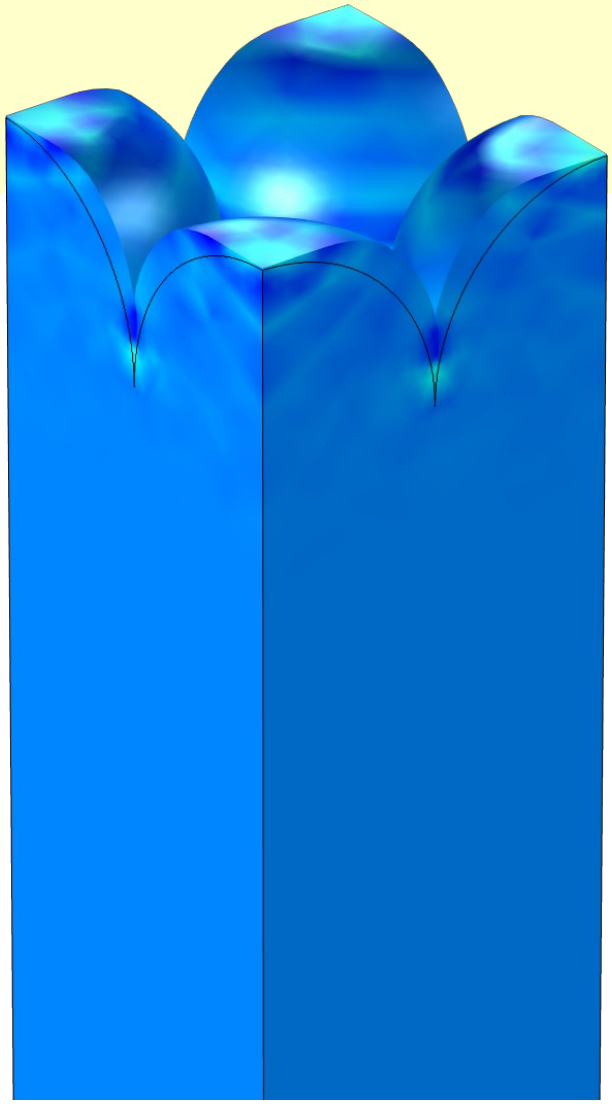
Results

- S = 719 kPa
- P = 600 kPa
- S – P = 119 kPa



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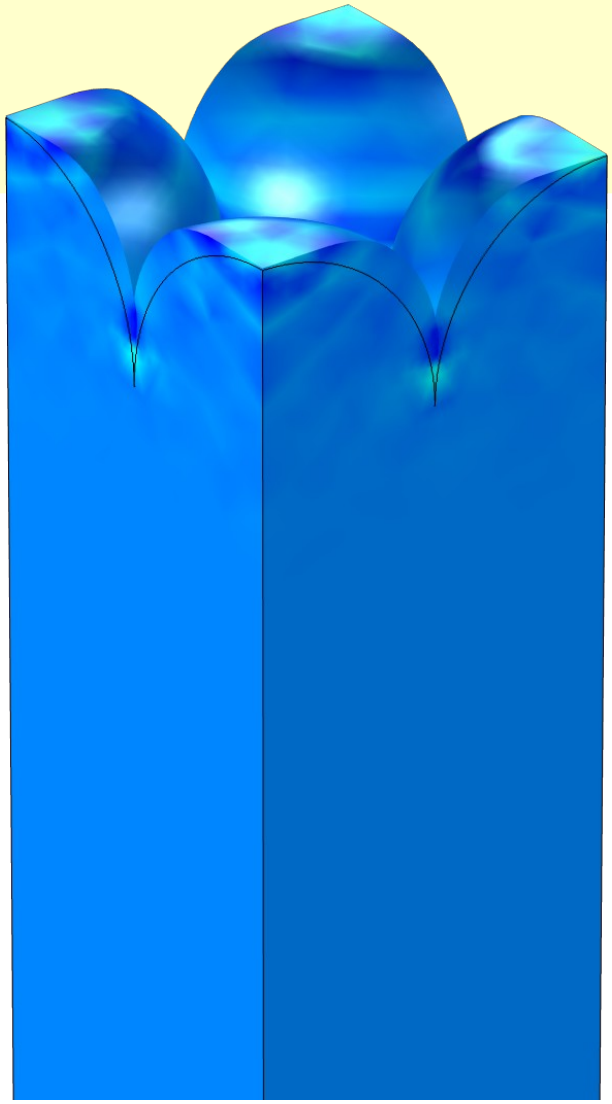
Results

- S = 819 kPa
- P = 700 kPa
- S – P = 119 kPa



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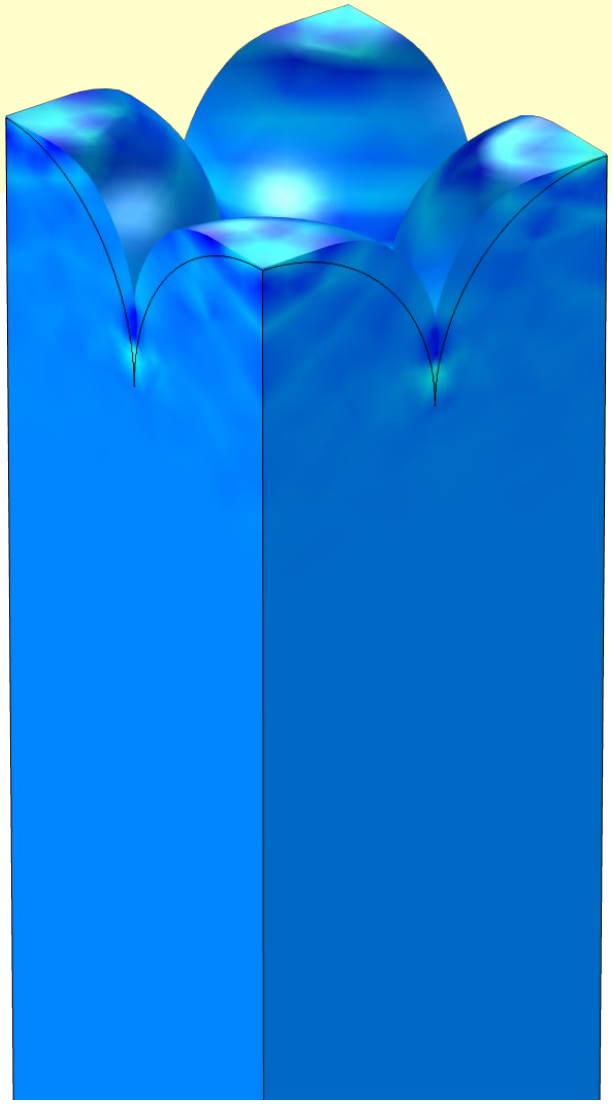
Results

- S = 919 kPa
- P = 800 kPa
- S – P = 119 kPa



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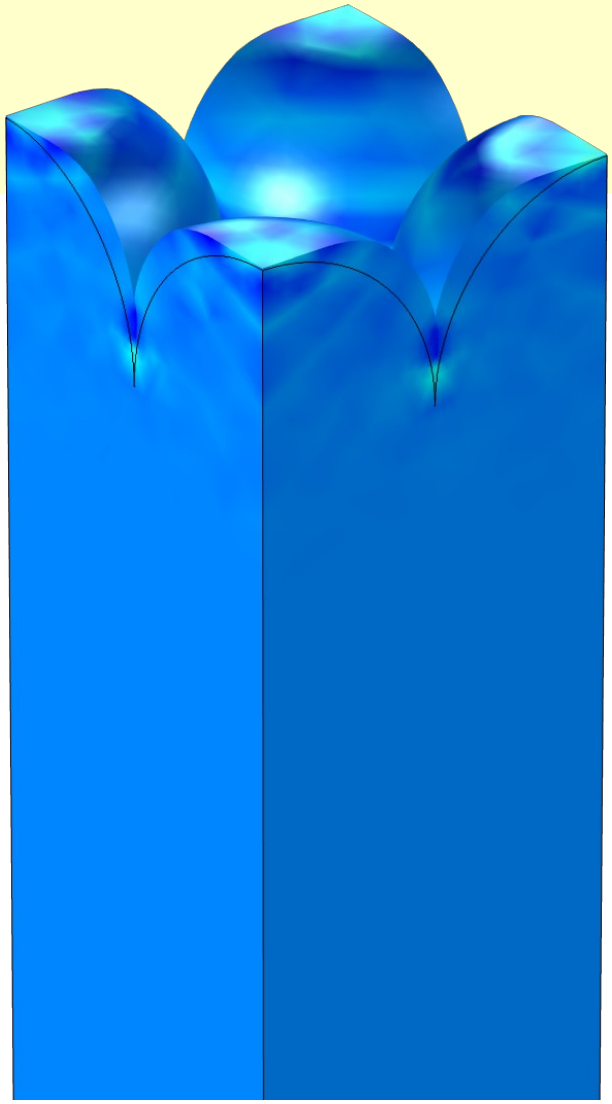
Results

- S = 1019 kPa
- P = 900 kPa
- S – P = 119 kPa



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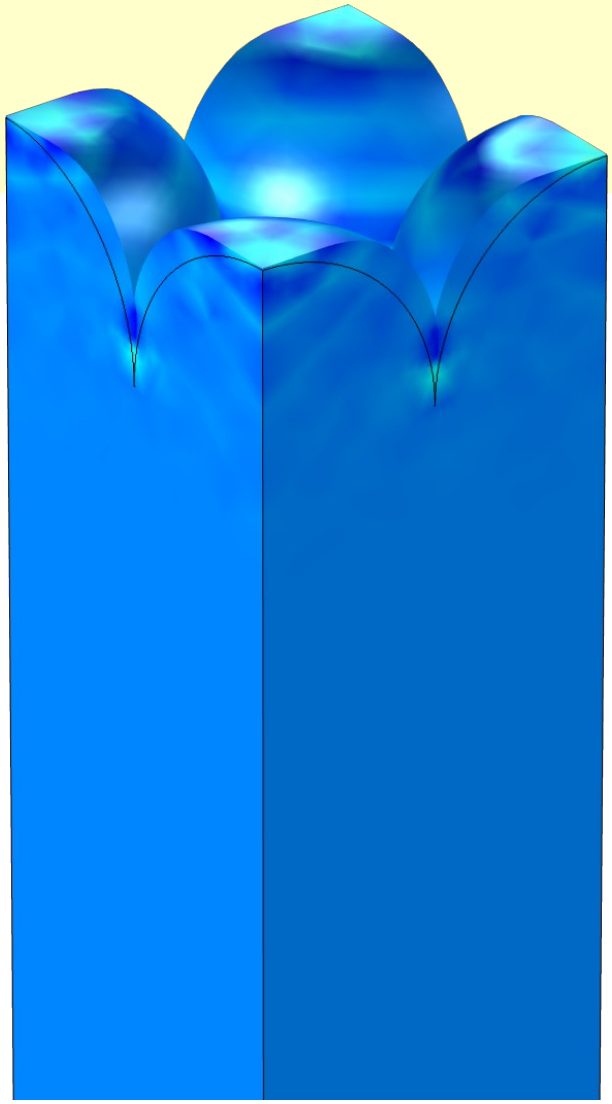
Results

- S = 1119 kPa
- P = 1000 kPa
- S – P = 119 kPa



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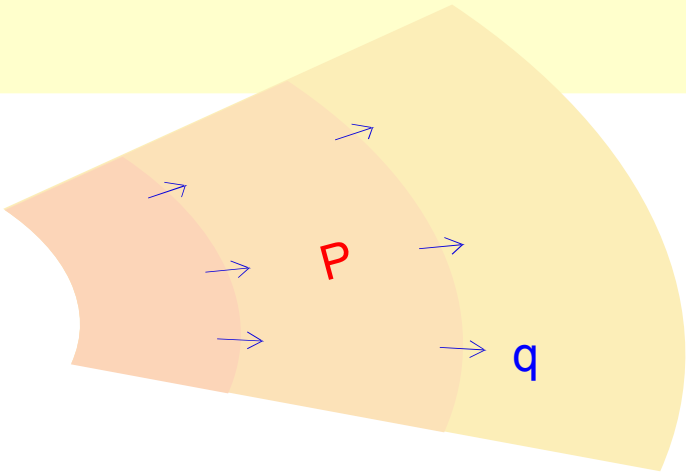
Results

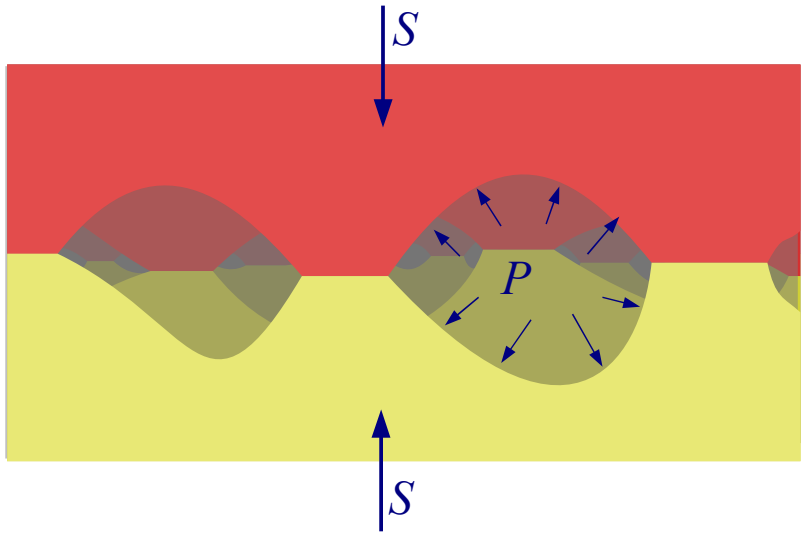
- Microgeometry depends only on $S - P$

What we have Achieved

$$q = a \nabla P$$

$$a = a\,(S, P, |\nabla P|)$$





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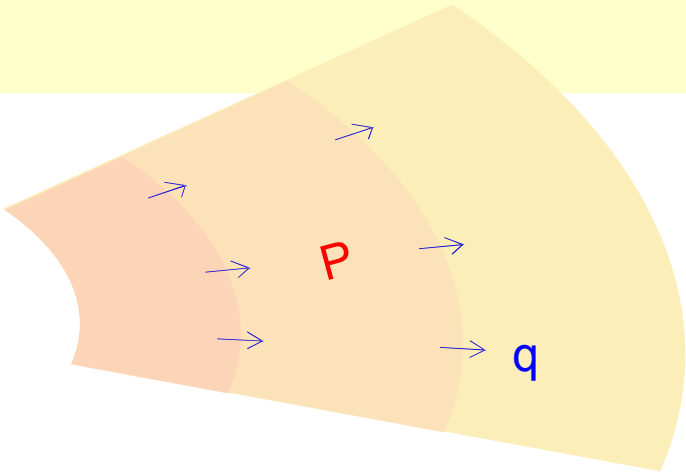
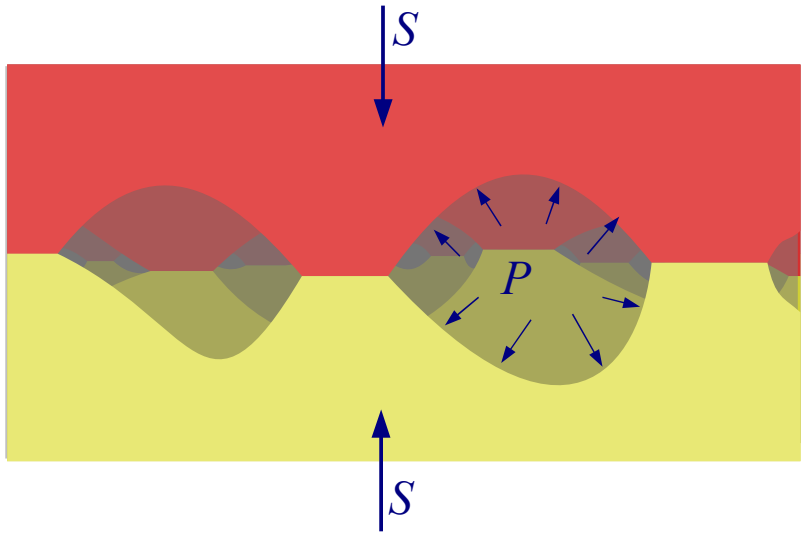
What we have Achieved

$$q = a \nabla P$$

$$a = a\,(S, P, |\nabla P|)$$

- $q = \sigma\,(S - P)\,P\,\nabla P$





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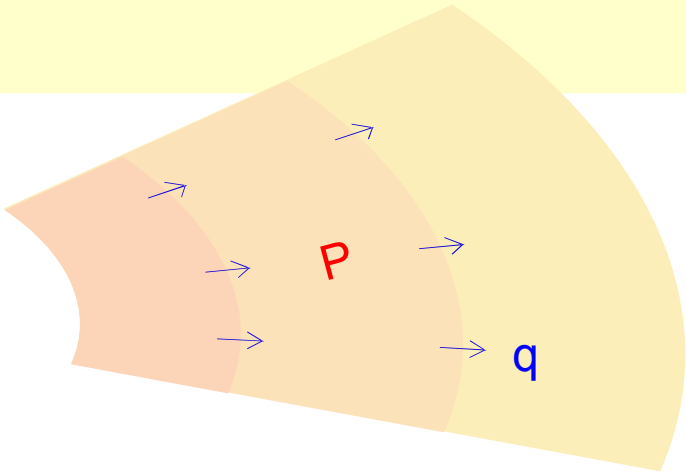
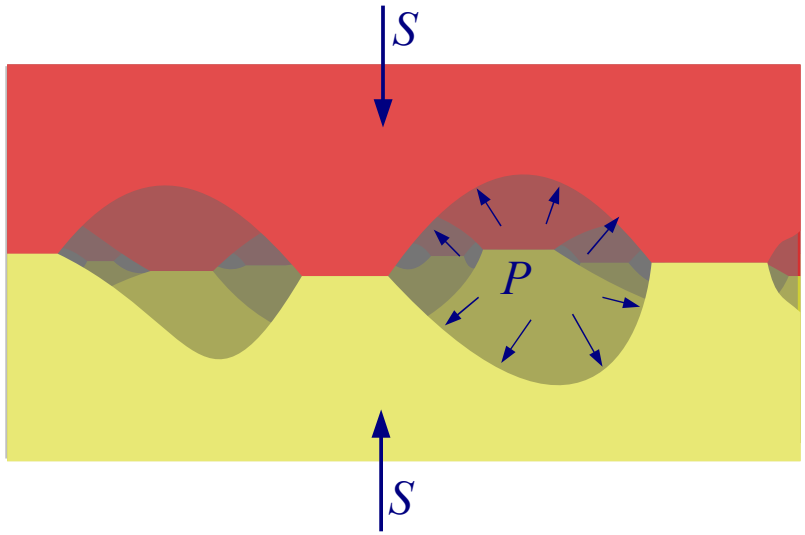
Thank You!

$$q = a \nabla P$$

$$a = a\,(S, P, |\nabla P|)$$

- $q = \sigma\,(S - P)\,P\,\nabla P$





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