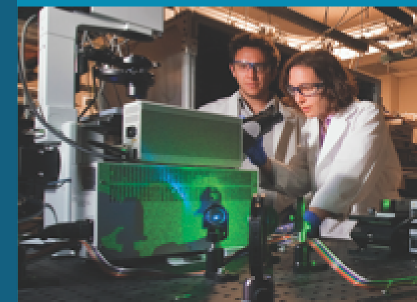
SAND2022-14808C

Sandia National Laboratories

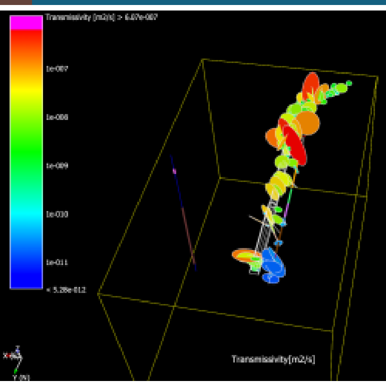
DECOVALEX 2023 TASK G: Step 2 - HM SNL Modeling Progress

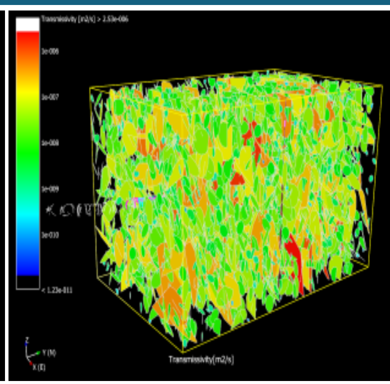


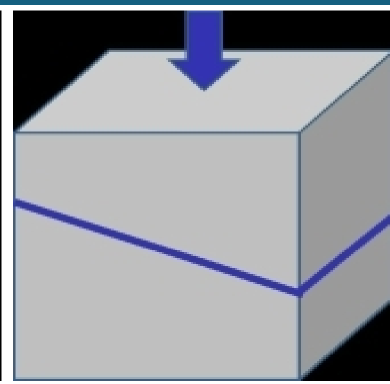
DECOVALEX 2023

Interim Meeting

Oct. 25, 2022







PRESENTED BY

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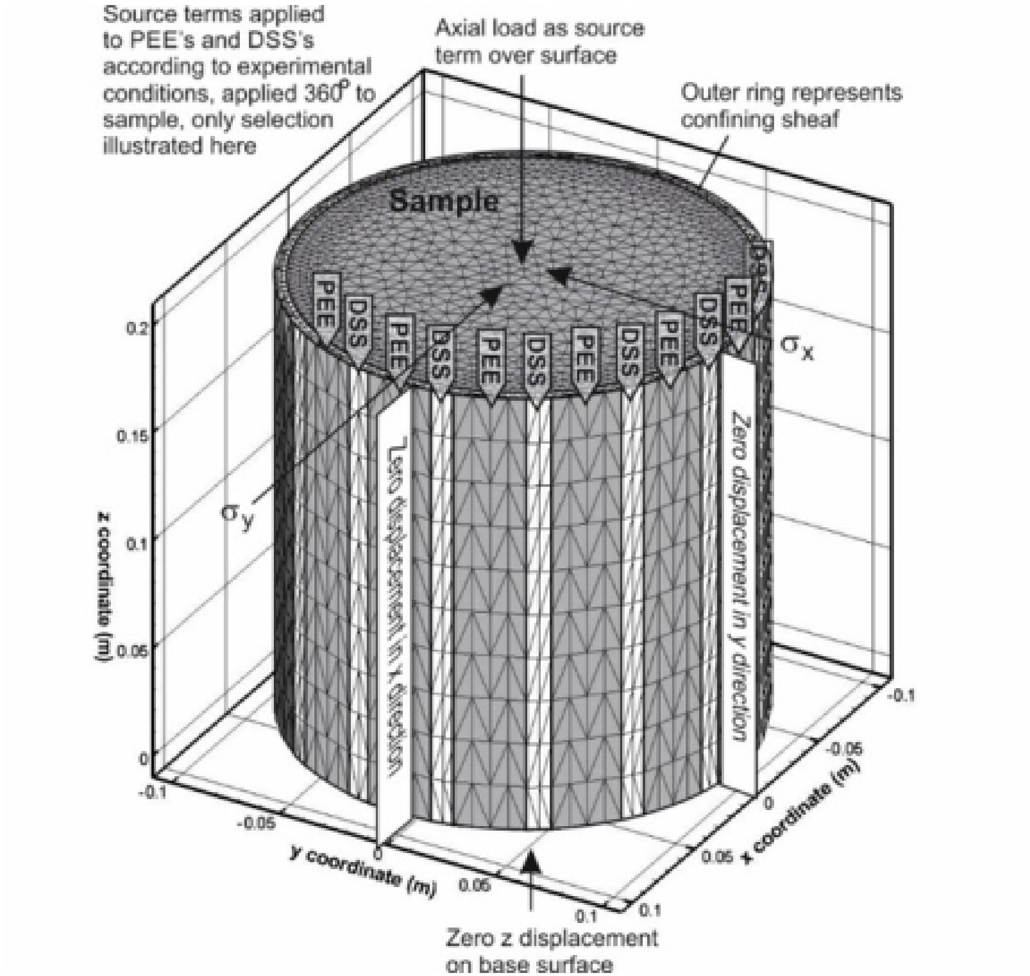
Outline

- Step 2: Preliminary modeling of 3D experimental work – GREAT cell – Step 1a (Axisymmetric and Triaxial Loading - M)
- Step 2: Preliminary modeling of 3D experimental work – GREAT cell – Step 2a (Coupled HM)

Step 1a: Modeling of Surface Deformation Solid Body – GREAT cell

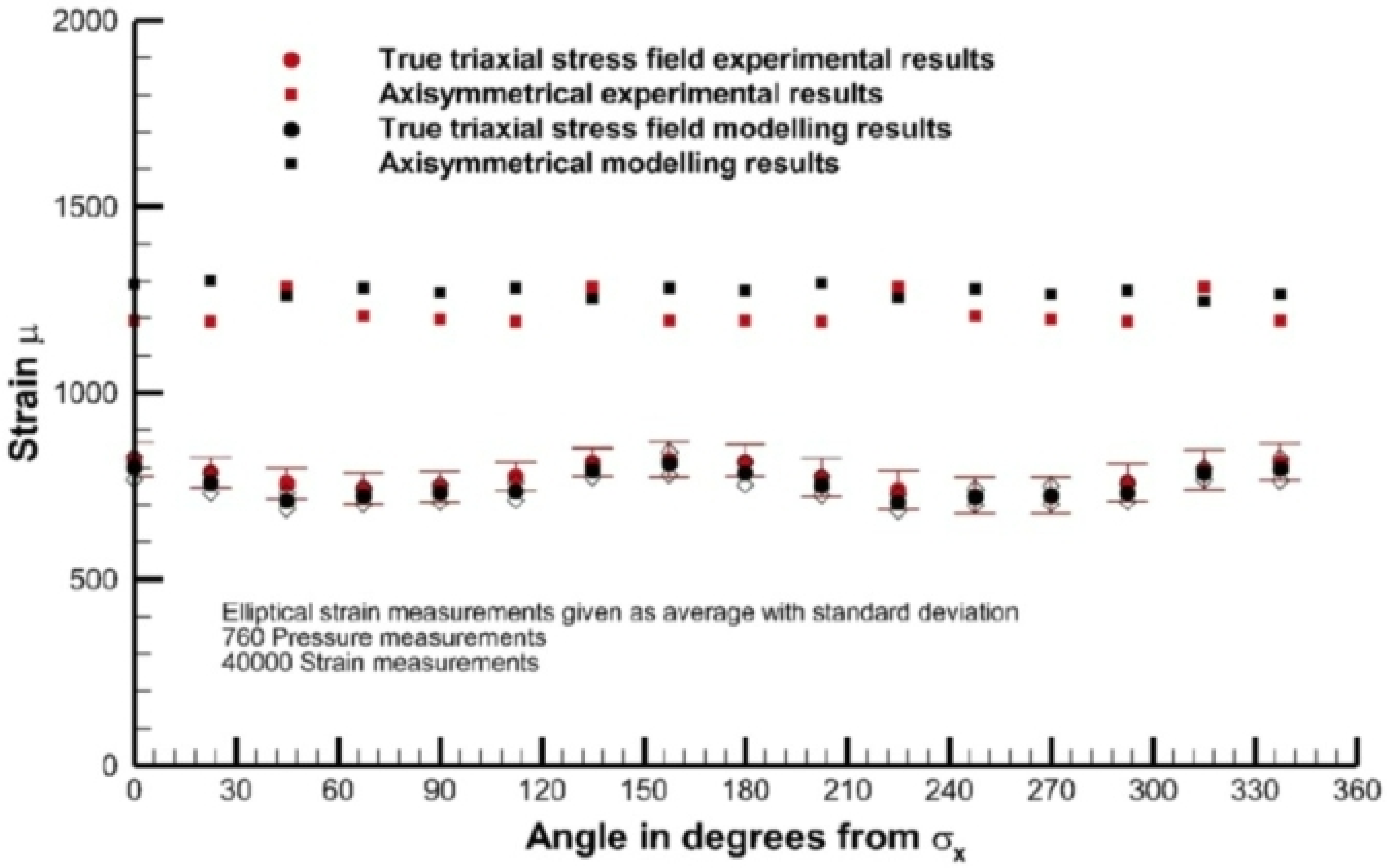
- Solid body deformation - impermeable matrix – no fracture
- Reference: McDermont et al. (2018)
- Homogeneous artificial sample Opaque amorphous thermoplastic polymer
  - Sample represented as a cylinder with 200 mm diameter and 200 mm height.
  - Axisymmetric loading case: S1 = 10 MPa, S2 = S3 = 8 MPa
  - Triaxial loading case: S1 = 10 MPa, S2 = 8 MPa, S3 = 2 MPa
- Boundary Condition:
  - Zero circumferential-displacement boundary conditions along the vertical lines that define the sample circumference intersection with the x- and y-axes.
  - Zero displacement in the z-direction across the entirety of the sample base.
  - No end effects though end plate friction.

Conceptual Numerical Model (McDermont et al. (2018)



Sample	Model 1 (M1)
Parameter	
Sample Young's Modulus (GPa)	3.85
Sample Poisson Ration	0.4

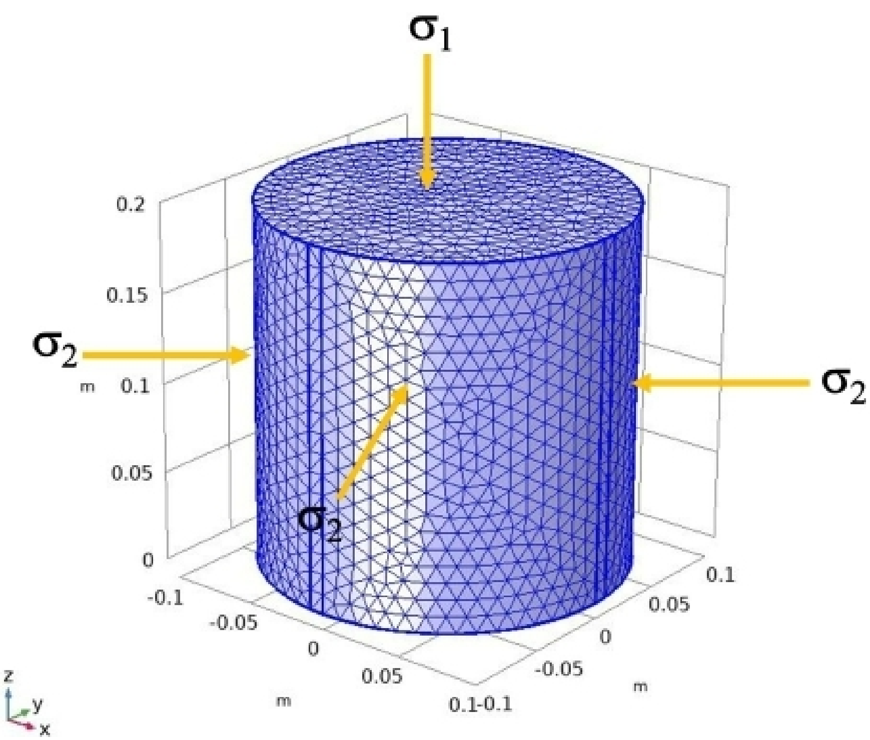
Modeling and Experimental Results of McDermont et al. (2018)



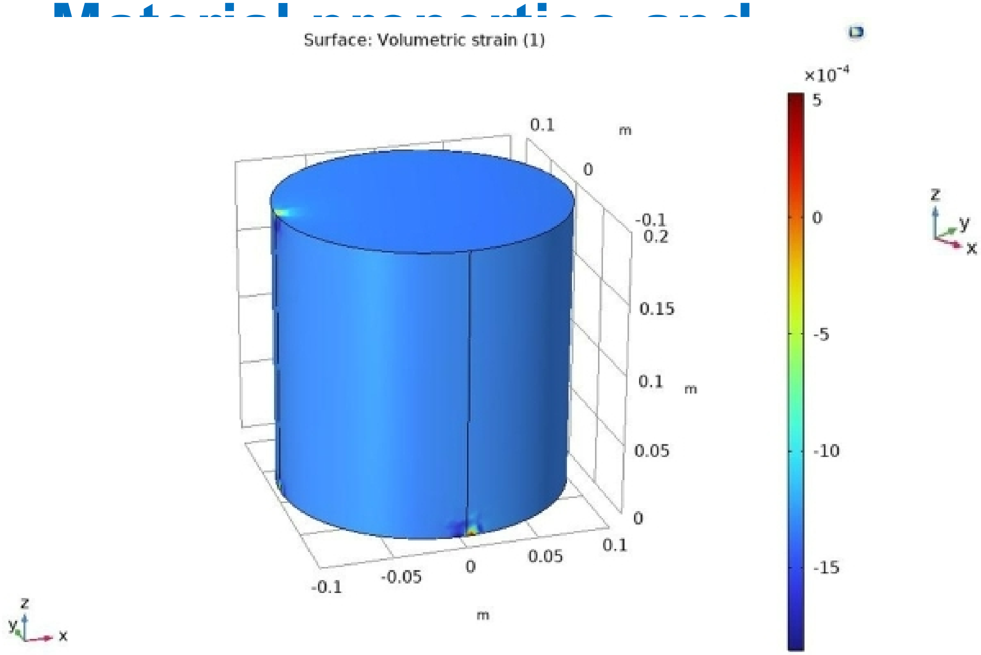
Strain Results for Test M1 (McDermont et al., 2018, Fig. 6

Step1a: Preliminary Modeling of Axisymmetric Case

- **Axisymmetric loading of uniform resin sample case: S1 = 10 MPa, S2 = S3 = 8 MPa**
- **COMSOL Multiphysics used**



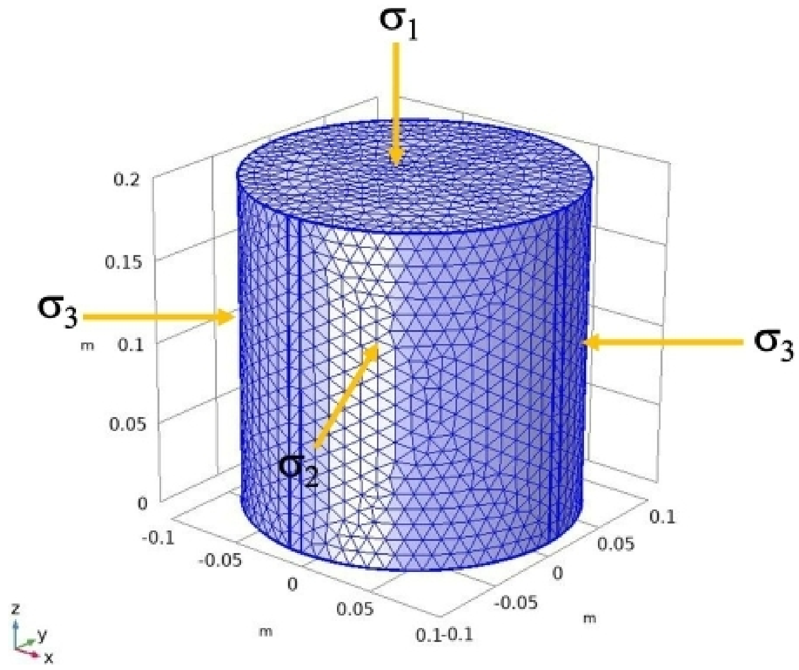
COMSOL Mesh



Surface Volumetric Strain

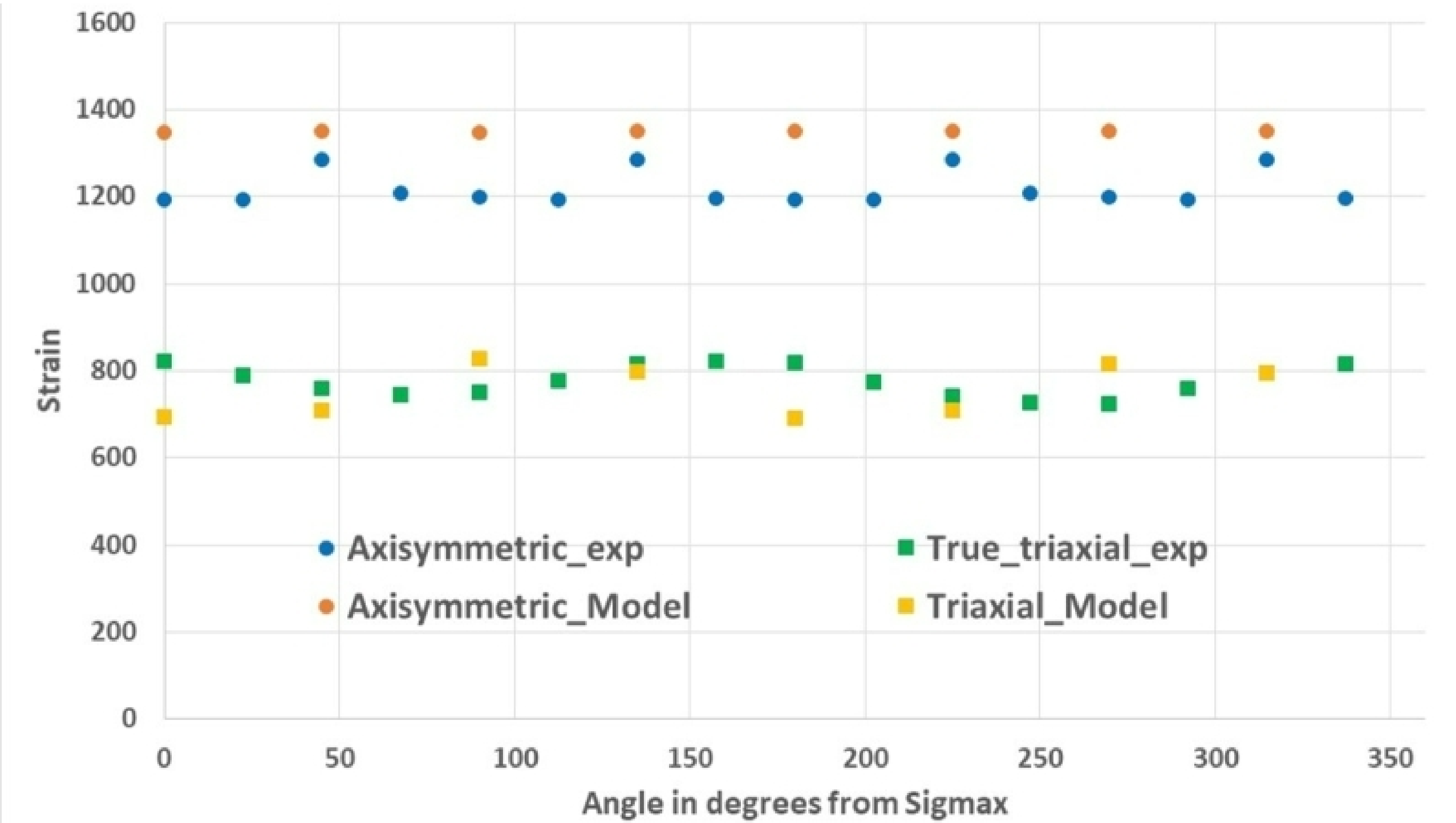
Step1a: Modeling of Triaxial Case

- Triaxial loading of uniform resin sample case: S1 = 10 MPa, S2 = 8 MPa , S3 = 2 MPa
- COMSOL Multiphysics used
- Material properties and BC as in McDermont et al., 2018



Step1a:COMSOL Mesh

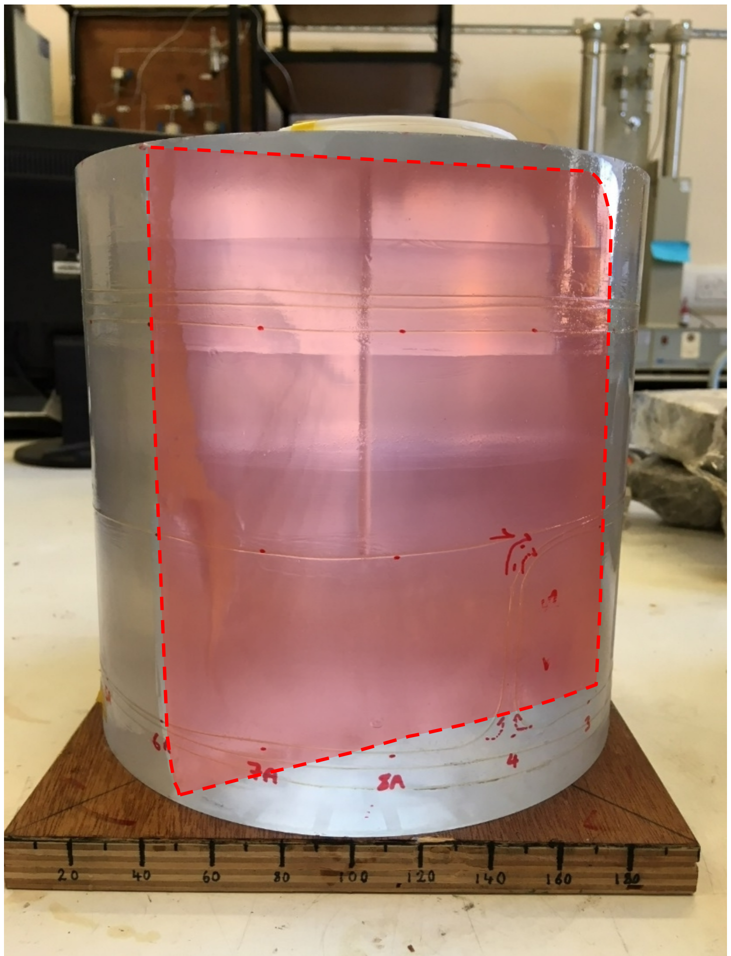
Step 1a: Model and Experimental Results



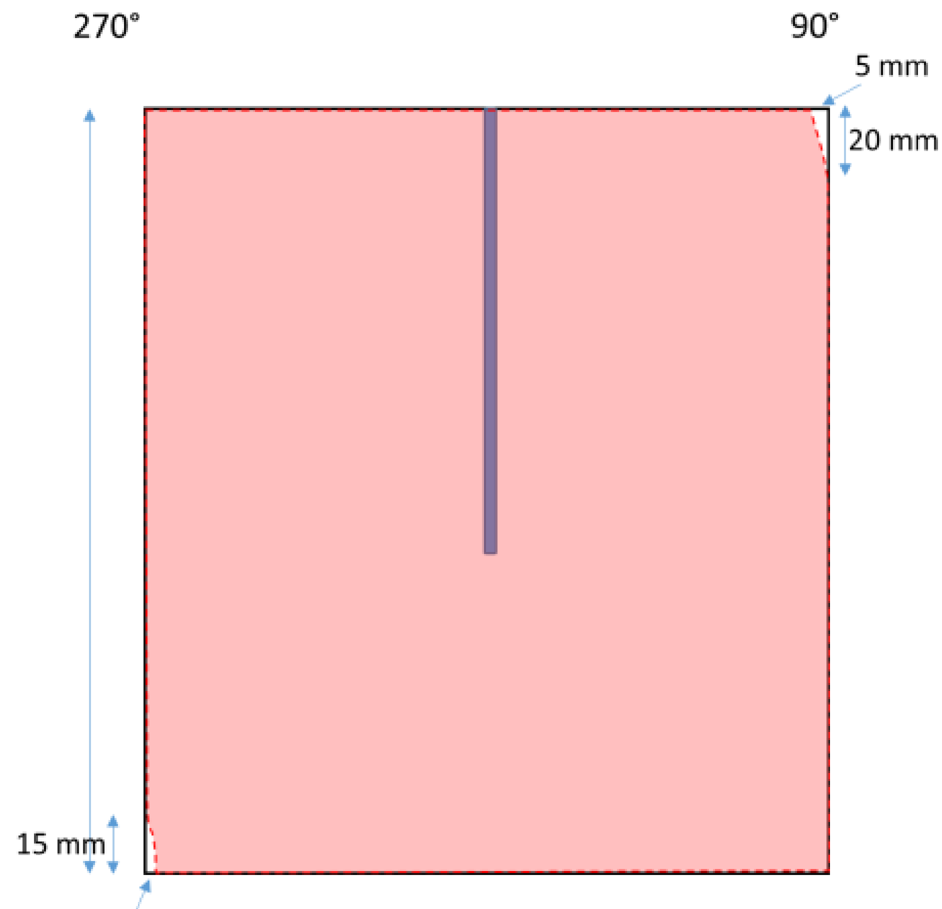
COMSOL axisymmetric and triaxial modeling results together with experimental data

Step 2a: Representation of Fracture

Step 2a Fracture Geometry



Angles correspond to Figure 11 in paper



(not drawn to scale)

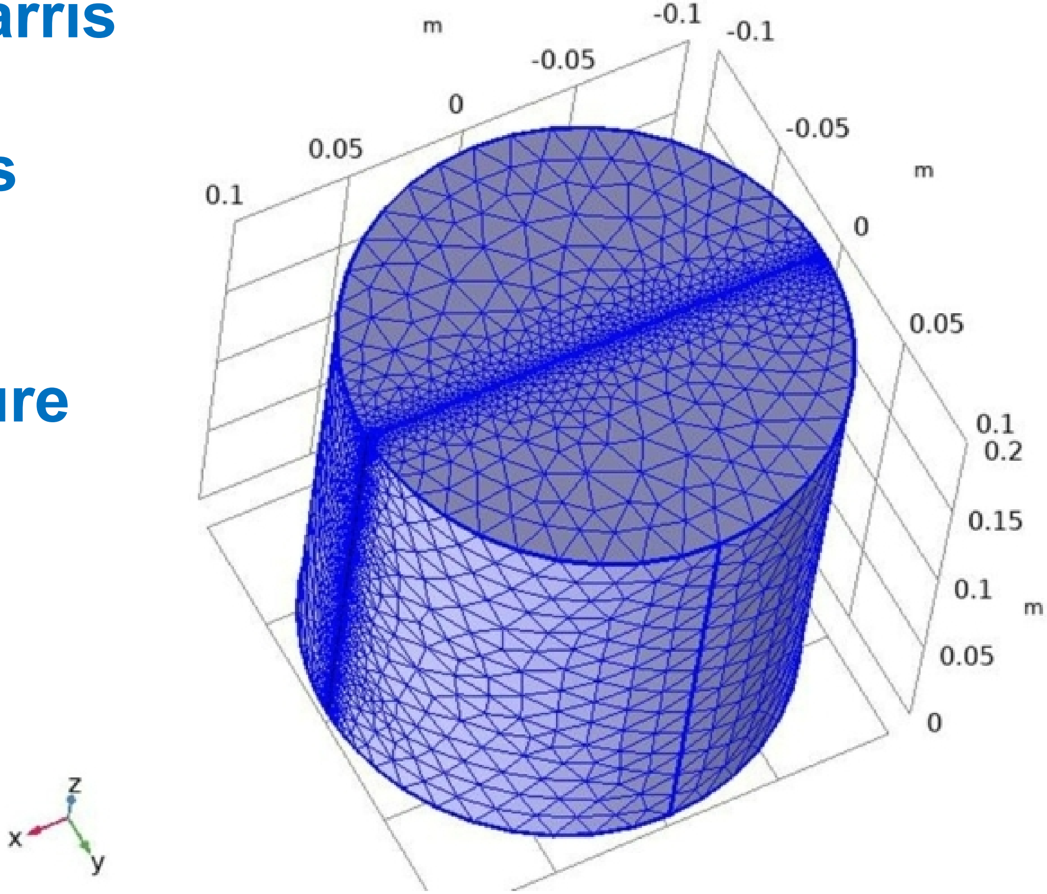
Step 2a: Preliminary Coupled HM Modeling

- Explicit representation of fracture and fluid flow
- COMSOL Multiphysics modeling with simplified representation of fracture and fluid flow
- Homogeneous artificial sample Opaque amorphous thermoplastic polymer
- Geometry: cylinder with 200 mm diameter and 200 mm height.
- Fracture represented as a spring foundation using Hooke's law.
- Material properties:

Parameter	Sample	Fracture
Elastic Modulus (GPA)	3.85	0.3
Poisson's ratio	0.4	0.4

Step 2a: Preliminary HM Modeling

- References: McDermont et al. (2018) and Fraser-Harris et al. (2020)
- COMSOL Multiphysics used
- Geometry with representation of fracture



Step2a:COMSOL Mesh

Step 2a: Preliminary HM Modeling

- Hydro-mechanical modeling with fracture and flow
- Fracture represented as a spring foundation – planar
- Preliminary modeling with axisymmetric loading: S1 = 10 MPa, S2 = 8 MPa , S3 = 8 MPa
- Triaxial loading: S1 = 10 MPa, S2 = 8 MPa , S3 = 4 MPa
- Fluid Flow: Darcy Flow
  - Flow and pressure applied at inlet
  - Pressure applied at outlet
- Fracture permeability evaluation:

$$K = b^2/12$$