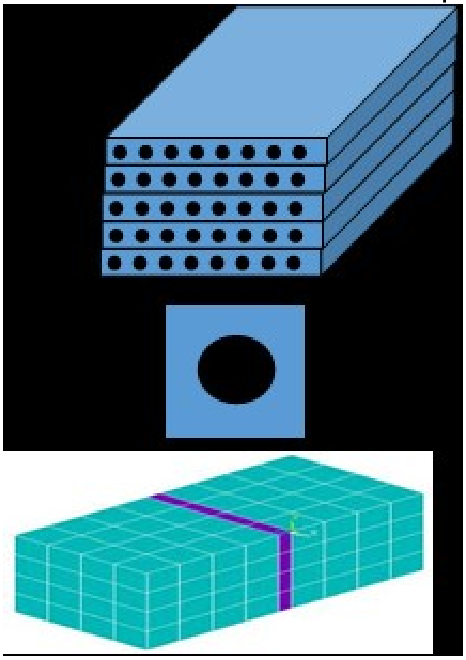
Predictions of 3D effective properties of fiber reinforced composites

The SG of fiber reinforced composites can be represented as shown below.



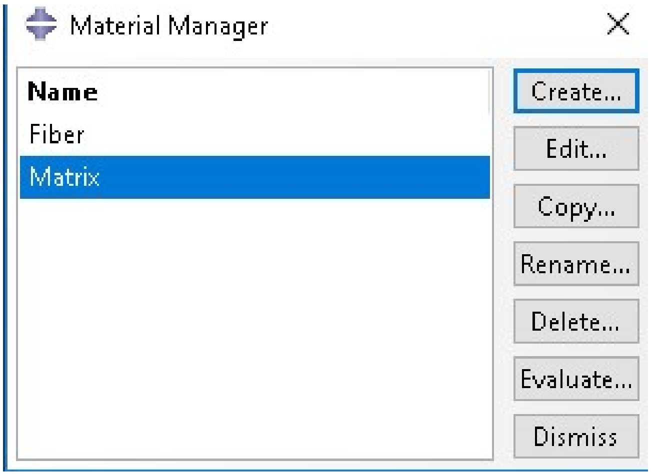
Let the material properties of the fiber and matrix be: Fiber: E_{11} =230 GPa, E_{22} =15 GPa, G_{12}=G_{13} =15GPa, G_{23} =7GPa, v_{12}=v_{13} =0.2000 $?_{23}$ =0.0714.

Matrix: E =4.0GP, ?=0.35

Fiber volume of fraction is assumed to be 60% The material properties are obtained from: “Soden, P. D., Hinton M. J. and Kaddour, A. S., Lamina properties, lay-up configurations and loading conditions for a range of fibre reinforced composite laminates. Compos. Sci. Technol., 1998, 58(7), 1011”
youtube link.
https://youtu.be/Bf-uKbd57uw

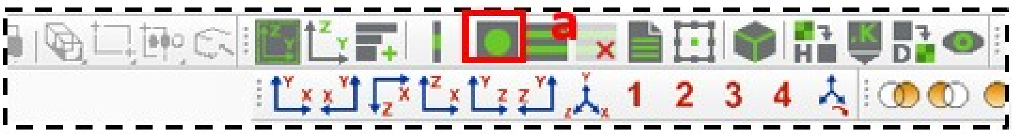
Step 1: Input material properties

There are two materials namely fiber and matrix

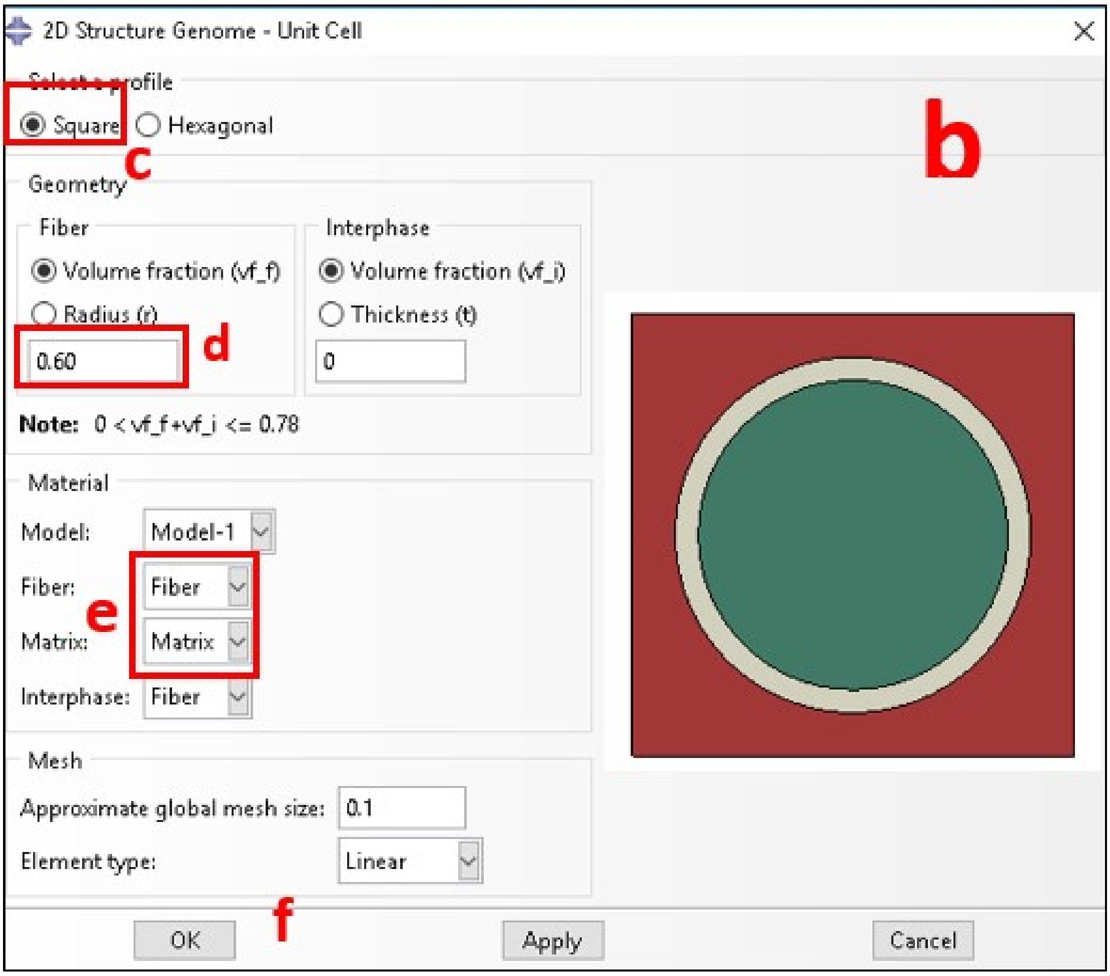


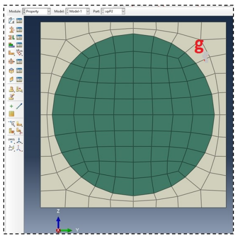
Step 2: Select appropriate SG

a. Select 2D SG that represent the current example



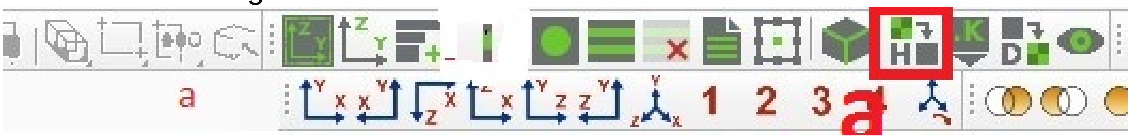
b. 2D SG wizard shows up
c. Select Square pack as microstructure
d. Add fiber volume fraction
e. Select material properties for fiber and matrix
f. Click on OK to generate the SG
g. See generated 2D SG


2D Structure Genome - Unit Cell
Select a profile
Square
Hexagonal
b
c
Geometry
Fiber
Volume fraction (vf_f)
Radius (r)
0.60
d
Interphase
Volume fraction (vf_i)
Thickness (t)
0
Note: 0 < vf_f+vf_i <= 0.78
Material
Model: Model-1
Fiber: Fiber
e
Matrix: Matrix
Interphase: Fiber
Mesh
Approximate global mesh size: 0.1
Element type: Linear
f
OK
Apply
Cancel



Step 3- Homogenization- 3D effective properties

a. Click on Homogenization



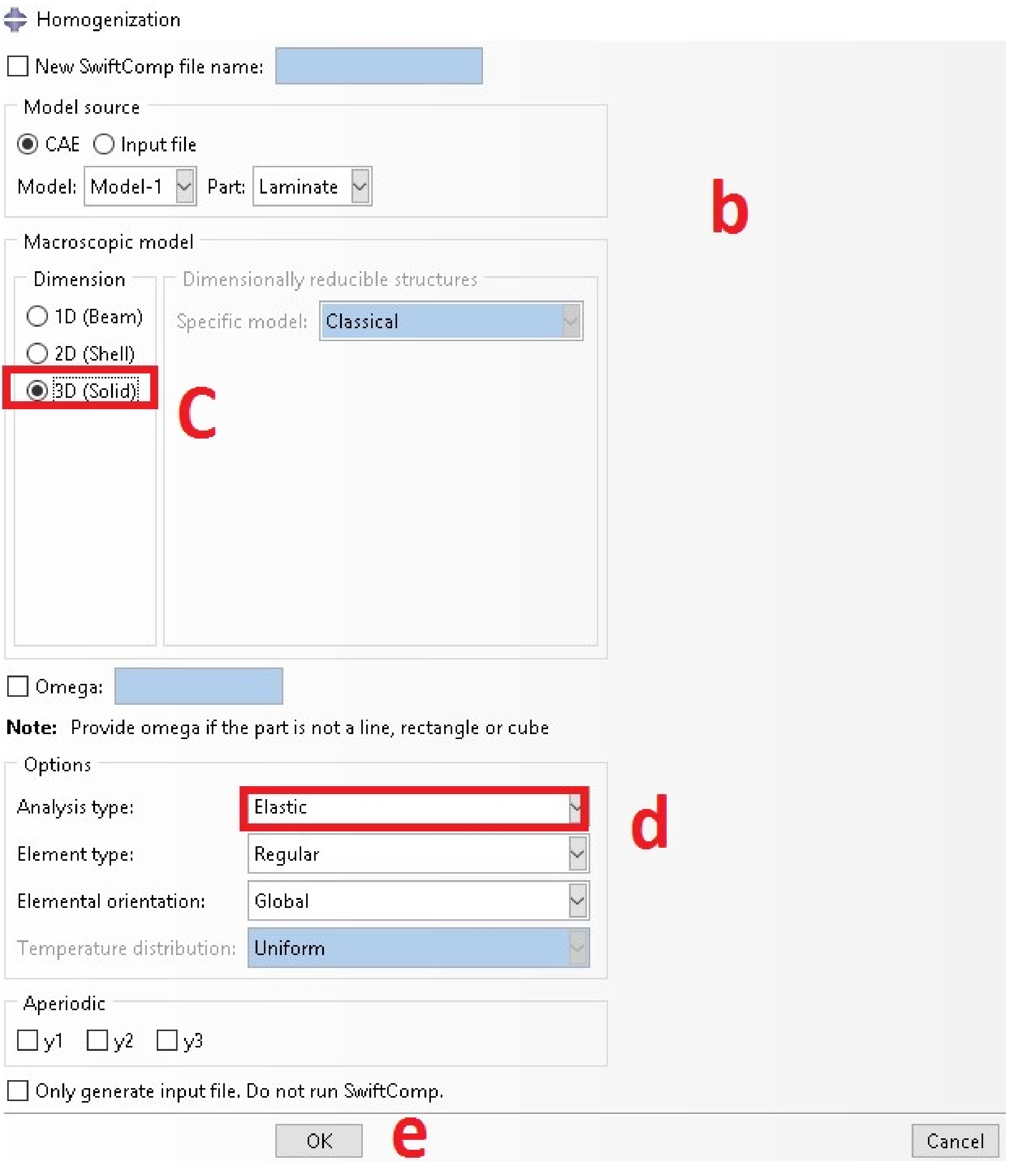
b. Homogenization wizard shows up (see below)

c. Select 3D (solid) Model

d. Select analysis type, elastic

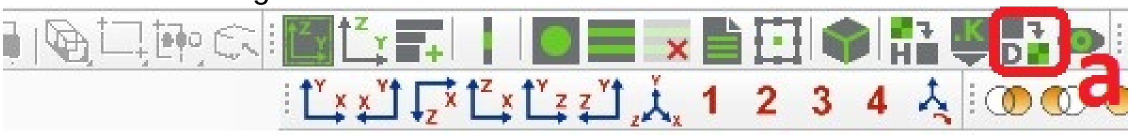
e. Click on OK to start homogenization

f. See the predicted 3D effective properties

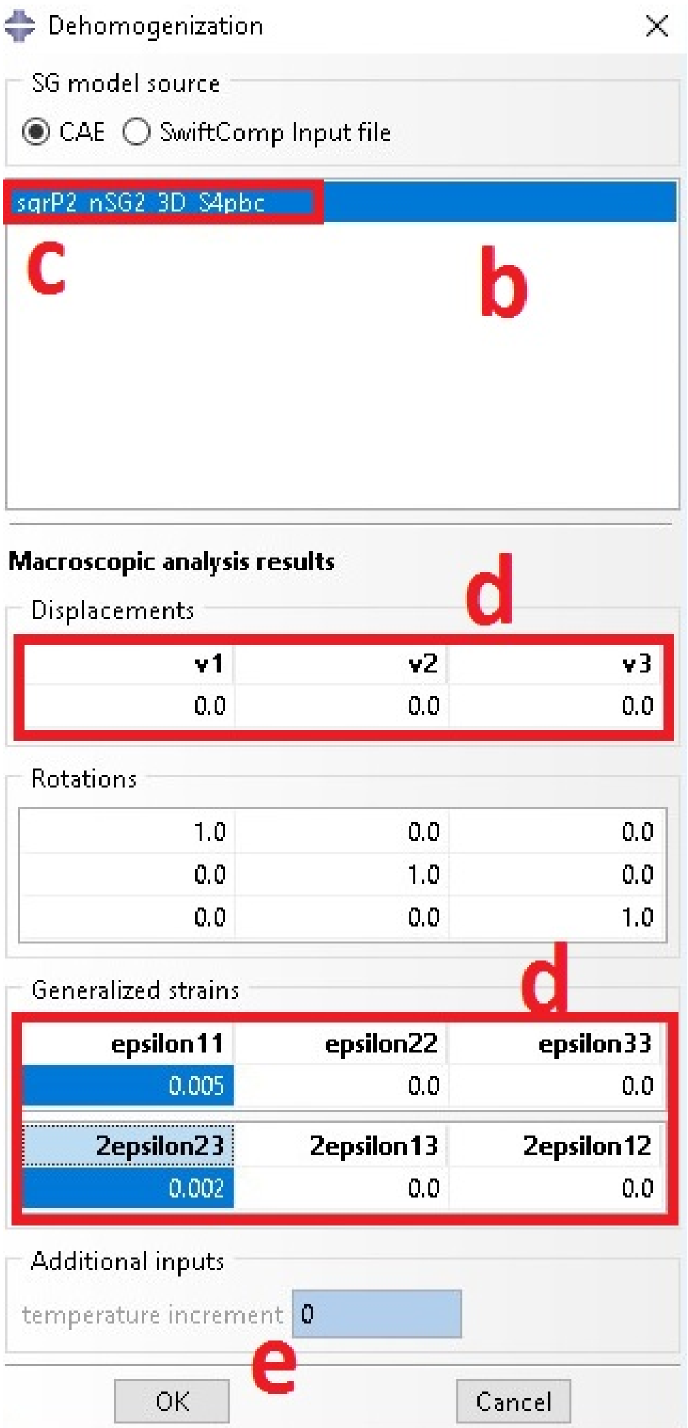

Homogenization
New SwiftComp file name:
Model source
CAE
Input file
Model: Model-1
Part: Laminate
b
Macroscopic model
Dimension
1D (Beam)
2D (Shell)
3D (Solid)
Dimensionally reducible structures
Specific model: Classical
c
Omega:
Note: Provide omega if the part is not a line, rectangle or cube
Options
Analysis type: Elastic
d
Element type: Regular
Elemental orientation: Global
Temperature distribution: Uniform
Aperiodic
y1
y2
y3
Only generate input file. Do not run SwiftComp.
OK
e
Cancel

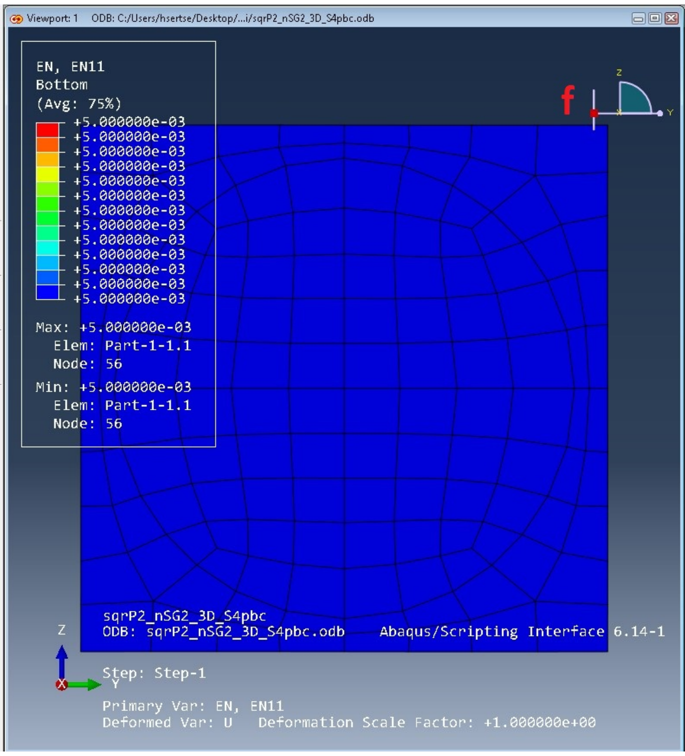
Step 4: Perform dehomogenization

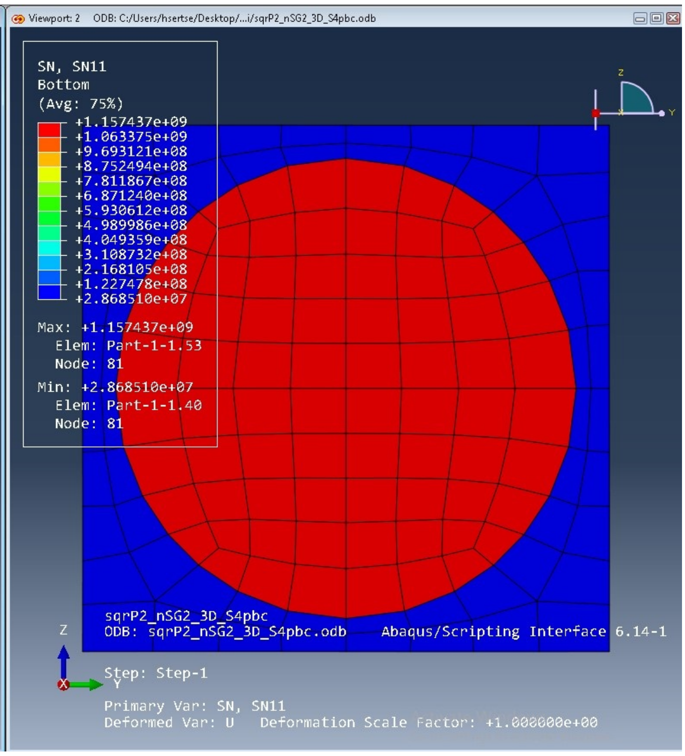
a. Select dehomogenzation



b. Dehomogenization wizard shows up
c. Select opt file
d. Add displacement to recovery displacement or strain loading to recover both local strain and stress, for current example problem let e_{11} be 0.005 and $2e_{23}$ be 0.002 e. Click on OK to start dehomogenization
f. See, dehomogenization


Dehomogenization
SG model source
CAE
SwiftComp Input file
sqrP2_nSG2_3D_S4pbc
c
b
Macroscopic analysis results
d
Displacements
v1
v2
v3
0.0
0.0
0.0
Rotations
1.0
0.0
0.0
0.0
1.0
0.0
0.0
0.0
1.0
Generalized strains
d
epsilon11
epsilon22
epsilon33
0.005
0.0
0.0
2epsilon23
2epsilon13
2epsilon12
0.002
0.0
0.0
Additional inputs
temperature increment
0
e
OK
Cancel





youtube link.
https://youtu.be/Bf-uKbd57uw