Predictions of ABD matrices and 3D effective properties of composite laminates

Predictions of ABD matrice or 3D effective properties of composite laminates.

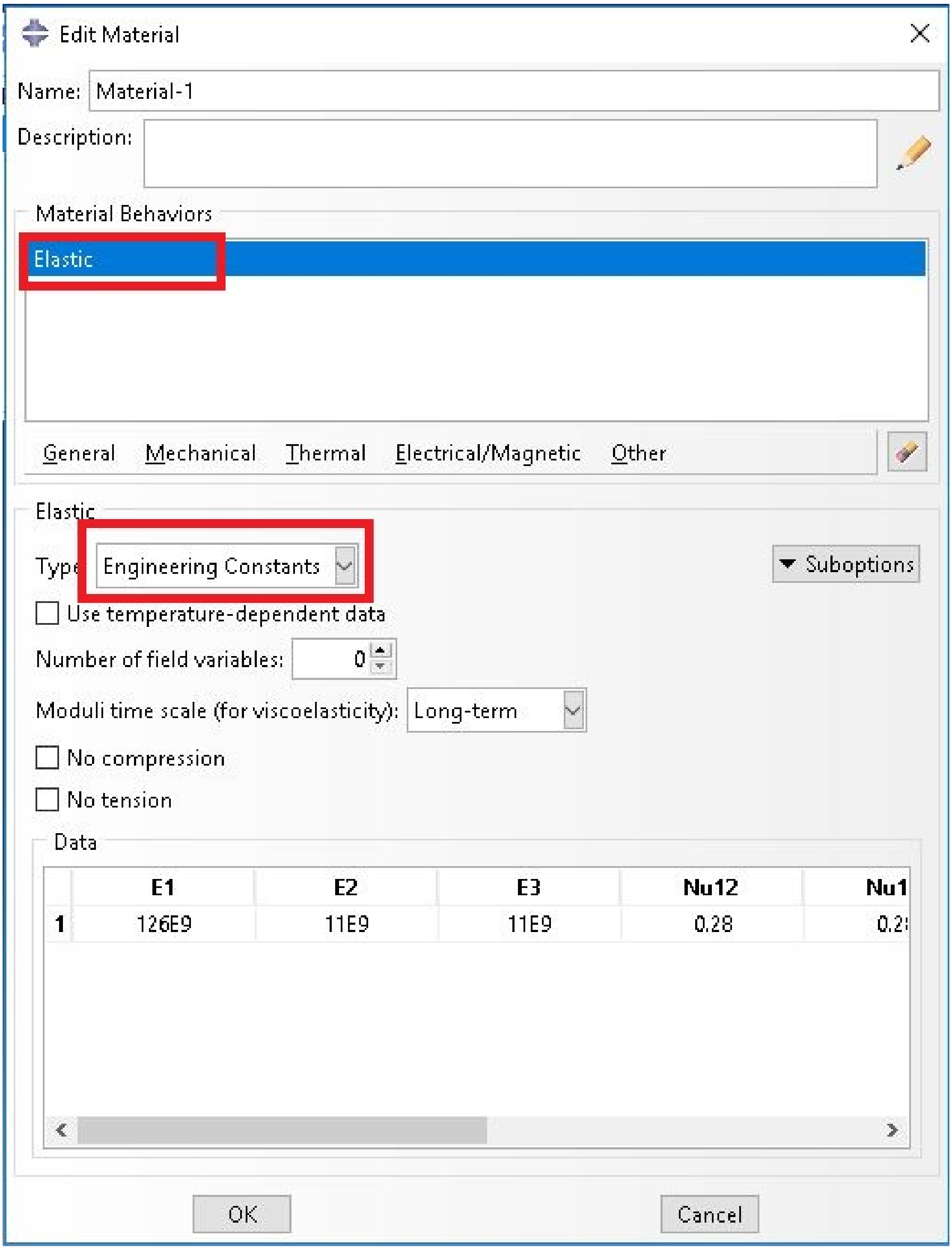
Let the material properties a lamina (AS4 3501-6) be: : E_{11}=126 GPA, E_{22}=11 GPA, v_{12}=0.28, v_{23}=0.4, G_{12}=6.6GPa, G_{23}=3.928GPa.
"Soden, P. D., Hinton M. J. and Kaddour, A. S., Lamina properties, lay-up configurations and loading conditions for a range of fibre reinforced composite laminates. Compos. Sci. Technol., 1998, 58(7), 1011"

Laminate lay-up: $[0/90/\pm45]_{2s}$
Thickness = 0.25mm.

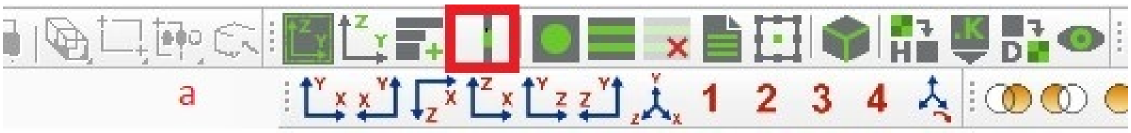
The youtube video of this problem can be obtained
https://www.youtube.com/watch?v=zz-F_Zmt6kY

1. Steps to obtain the ABD matrix for composite laminates using SwiftComp-Abaqus GUI

Step 1: a. Input material properties as elastic and engineering constants.

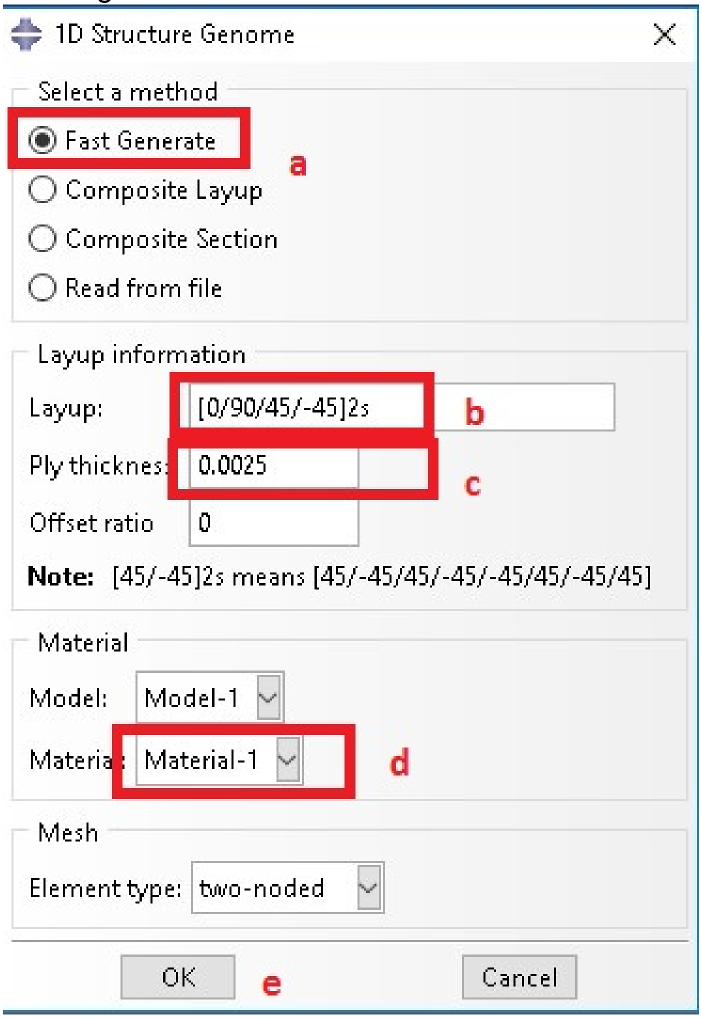


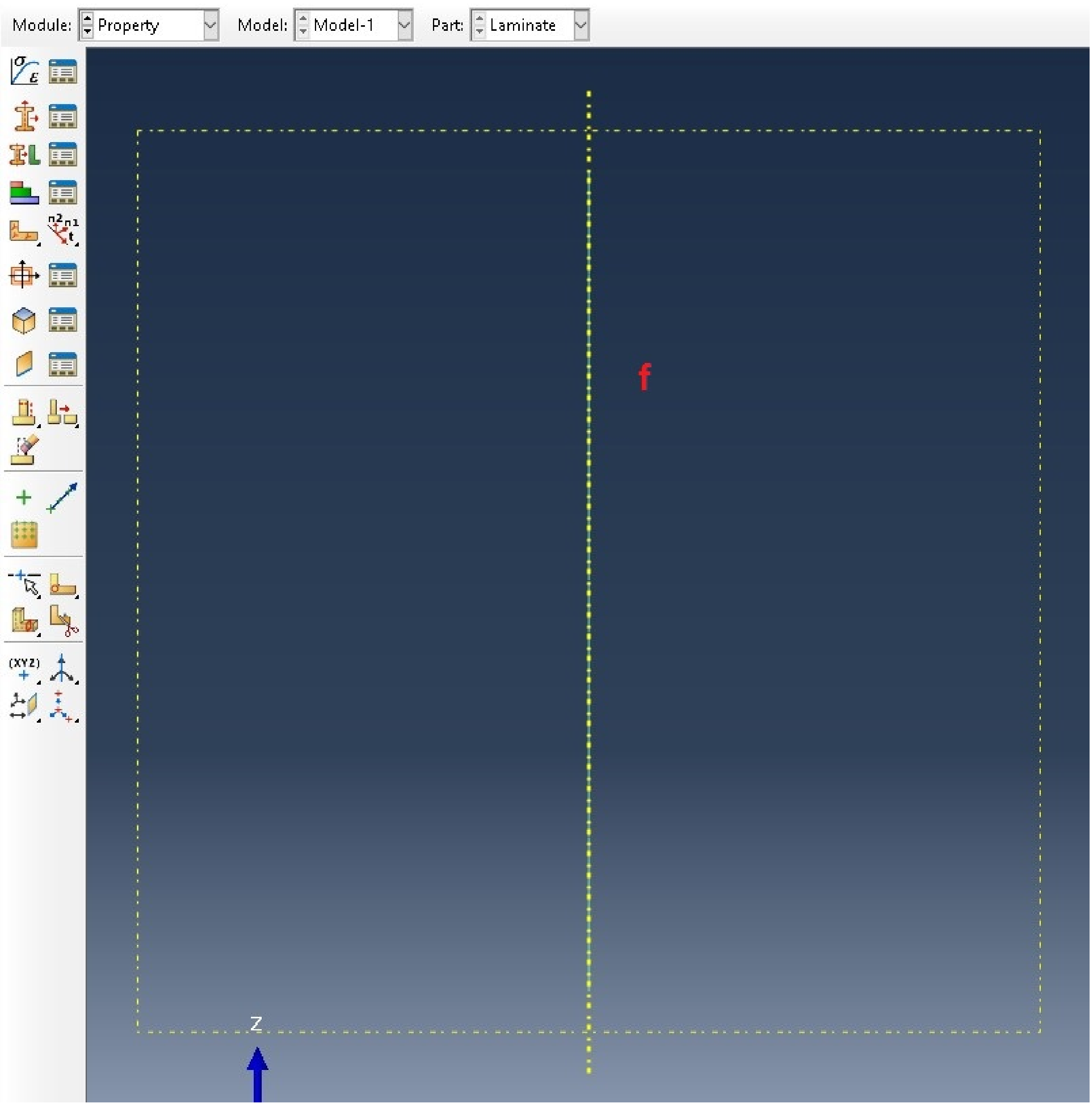
Step 2: a. Select Suitable SG – for this problem click on 1D SG and the laminate generating wizard pops up as “1D Structure Genome” (see below)



Step 3: Generate laminate

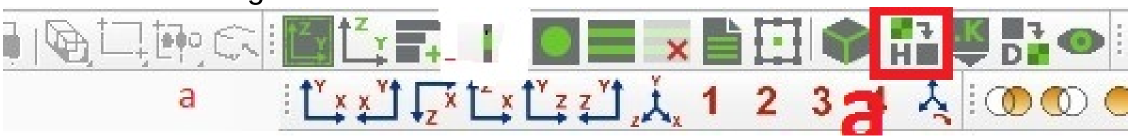
a. Click on fast Generate to generate composite laminate
b. Add the layup information
c. Add thickness of each laminate
d. Select material type
e. Click OK to generate the laminate
f. See generated laminate below





Step 4: Perform Homogenization-ABD Matrix

a. Click on Homogenization



b. Homogenization Wizard shows up(see below)

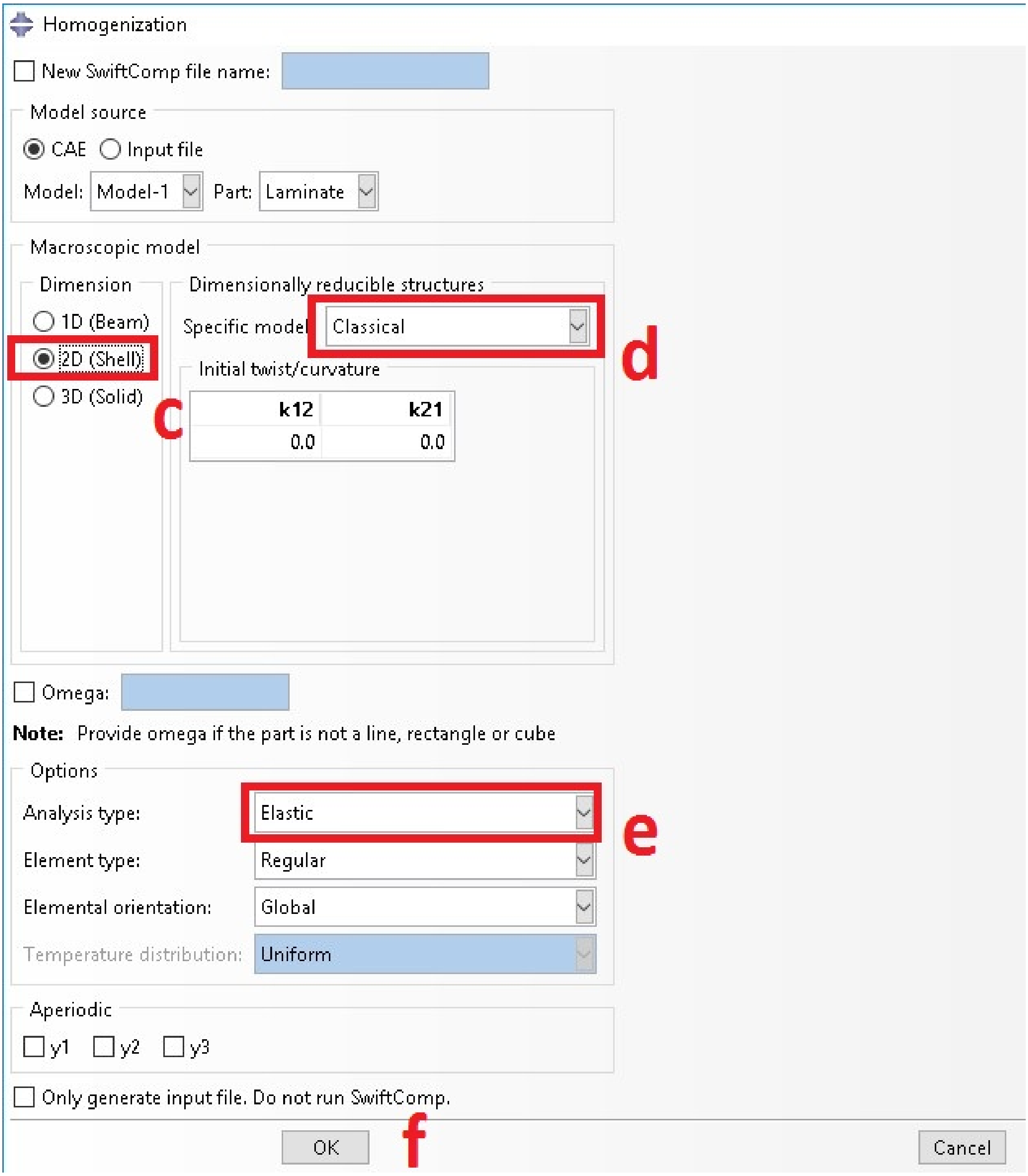
c. Select the macroscopic model

d. Select the specific model for laminate analysis, let classical model is selected
e. Select analysis type
f. Click on OK to perform homogenization
g. The predicted effective properties are shown below

Laminate_nSG1_3D_n5.sc - Notepad

File Edit Format View Help

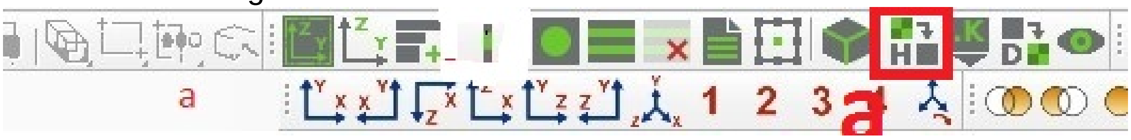
```
The Effective Stiffness Matrix
-------------------------------------------
  5.7957064E+10  1.8421639E+10  5.3526488E+09  0.0000000E+00  0.0000000E+00  3.7440181E-06
  1.8421639E+10  5.7957064E+10  5.3526488E+09  0.0000000E+00  0.0000000E+00  4.5192577E-06
  5.3526488E+09  5.3526488E+09  1.3309257E+10  0.0000000E+00  0.0000000E+00 -1.0249975E-08
  0.0000000E+00  0.0000000E+00  0.0000000E+00  4.9249240E+09  6.6977932E-08  0.0000000E+00
  0.0000000E+00  0.0000000E+00  0.0000000E+00  6.6977932E-08  4.9249240E+09  0.0000000E+00
  3.7440181E-06  4.5192577E-06 -1.0249975E-08  0.0000000E+00  0.0000000E+00  1.9767712E+10

The Effective Compliance Matrix
-------------------------------------------
  1.9584267E-11 -5.7095041E-12 -5.5800813E-12  0.0000000E+00  0.0000000E+00 -2.4068706E-27
 -5.7095041E-12  1.9584267E-11 -5.5800813E-12  0.0000000E+00  0.0000000E+00 -3.3988283E-27
 -5.5800813E-12 -5.5800813E-12  7.9624013E-11  0.0000000E+00  0.0000000E+00  2.3738657E-27
  0.0000000E+00  0.0000000E+00  0.0000000E+00  2.0304882E-10 -2.7614213E-27  0.0000000E+00
  0.0000000E+00  0.0000000E+00  0.0000000E+00 -2.7614213E-27  2.0304882E-10  0.0000000E+00
 -2.4068706E-27 -3.3988283E-27  2.3738657E-27  0.0000000E+00  0.0000000E+00  5.0587543E-11

The Engineering Constants (Approximated as Orthotropic)
-------------------------------------------------------------------f
 E1  =   5.1061394E+10
 E2  =   5.1061394E+10
 E3  =   1.2559025E+10
 G12 =   1.9767712E+10
 G13 =   4.9249240E+09
 G23 =   4.9249240E+09
 nu12=   2.9153524E-01
 nu13=   2.8492673E-01
 nu23=   2.8492673E-01


Effective Density =   0.0000000E+00
```


Homogenization
New SwiftComp file name:
Model source
CAE
Input file
Model:
Model-1
Part:
Laminate
Macroscopic model
Dimension
1D (Beam)
2D (Shell)
3D (Solid)
Dimensionally reducible structures
Specific model
Classical
Initial twist/curvature
k12
k21
0.0
0.0
c
d
Omega:
Note: Provide omega if the part is not a line, rectangle or cube
Options
Analysis type:
Elastic
e
Element type:
Regular
Elemental orientation:
Global
Temperature distribution:
Uniform
Aperiodic
y1
y2
y3
Only generate input file. Do not run SwiftComp.
OK
f
Cancel

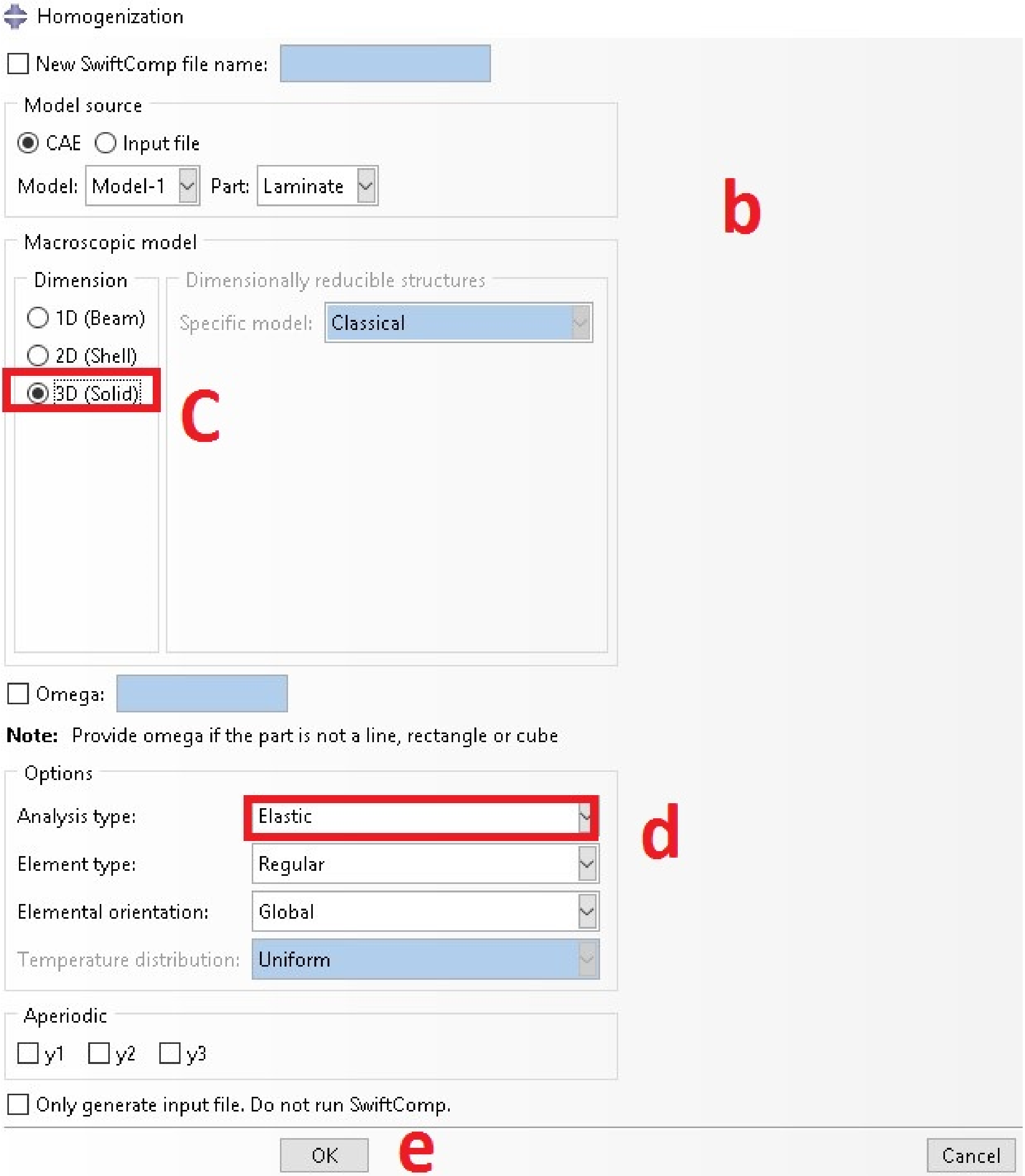
2. Steps to obtain the 3D effective properties for composite laminates using SwiftComp -Abaqus GUI

This is similar to the ABD matrix except at the homogenization step, i.e., from steps 1 to step 3, it is the same.

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



Users can also use youtube video for this problem

https://www.youtube.com/watch?v=zz-F_Zmt6kY