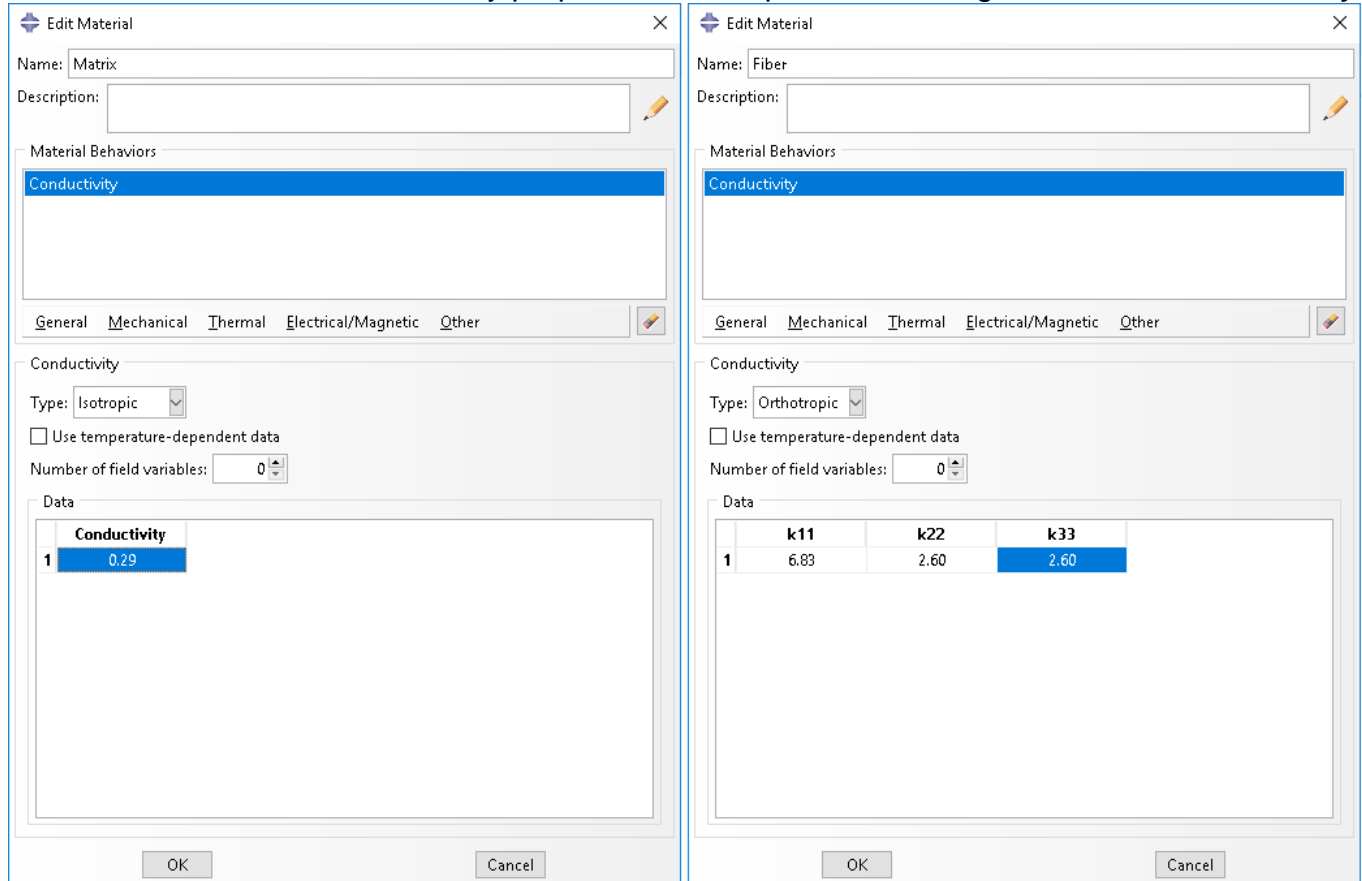


The steps required to compute the effective thermal conductivity using Abaqus [SwiftComp](#) GUI are as follows.

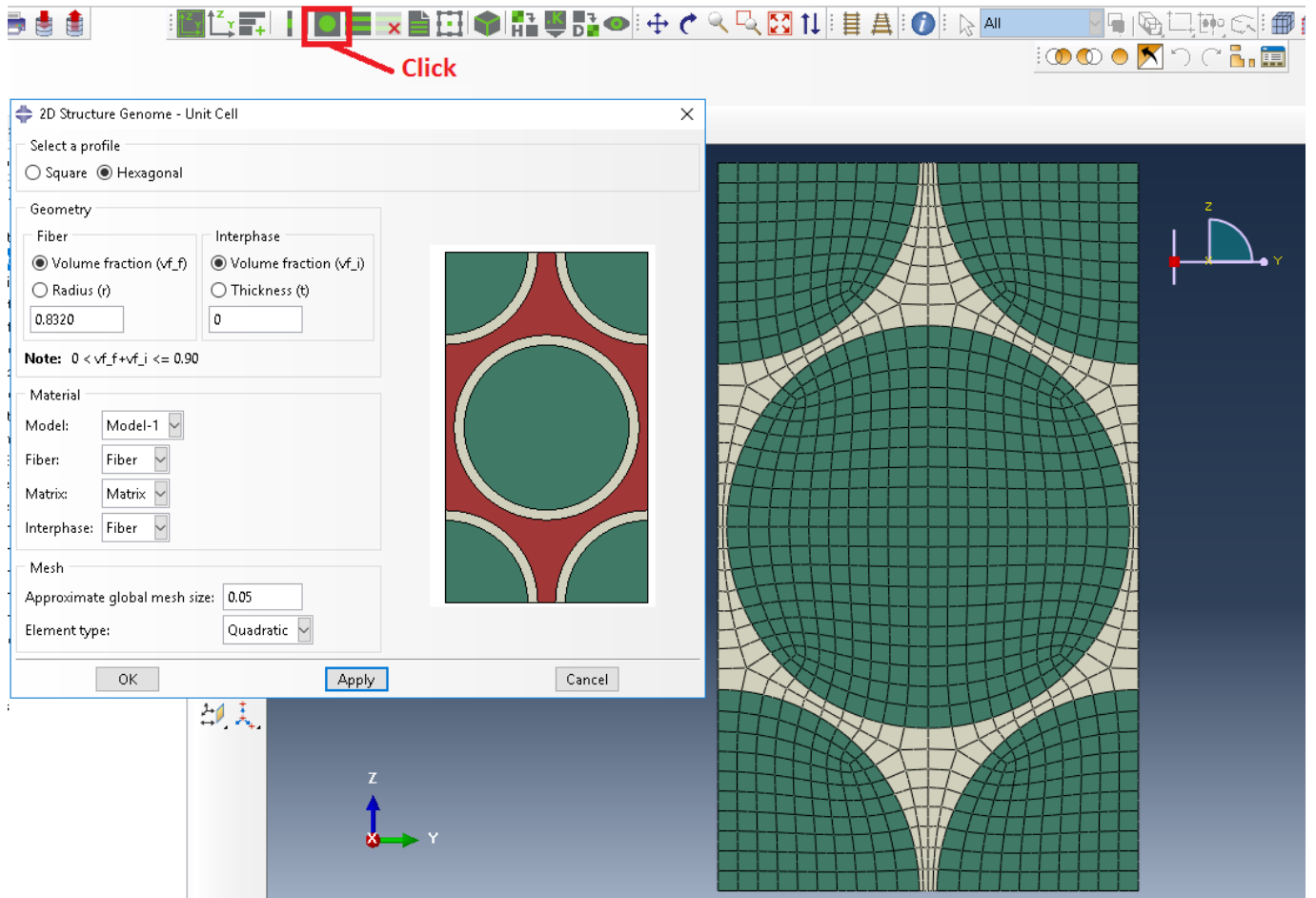
Step 1. We define the material properties in global coordinate system. In this case, we only need to define thermal conductivity properties in Abaqus CAE clicking on *Thermal, Conductivity*.



Definition of thermal conductivity as constituent properties

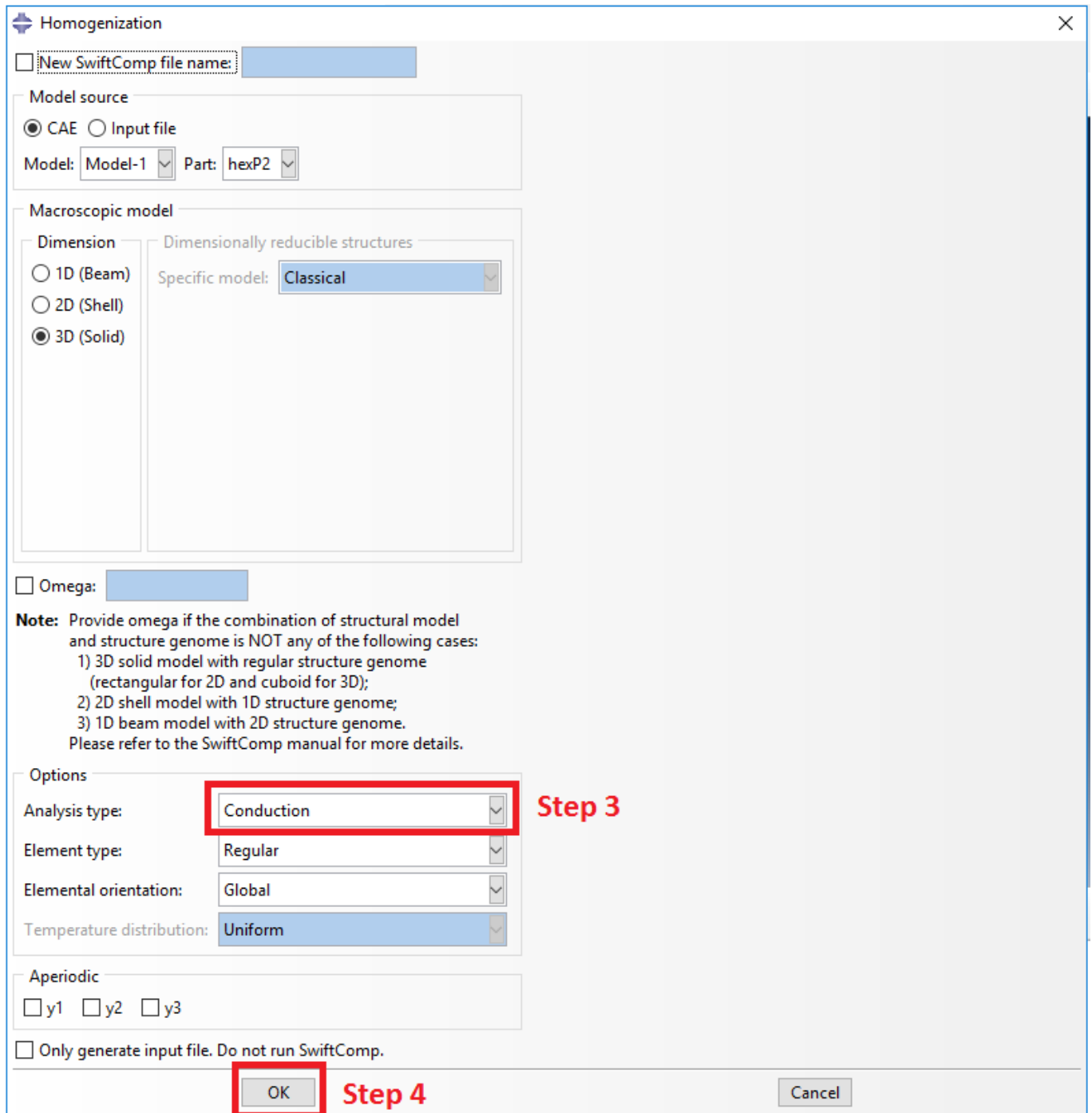
Step 2. From the default the Abaqus [SwiftComp](#) GUI SGs, we pick the 2D Structure Genome with Hexagonal pack.

COMPUTATION OF EFFECTIVE THERMAL CONDUCTIVITY WITH ABAQUS SWIFT COMP GUI



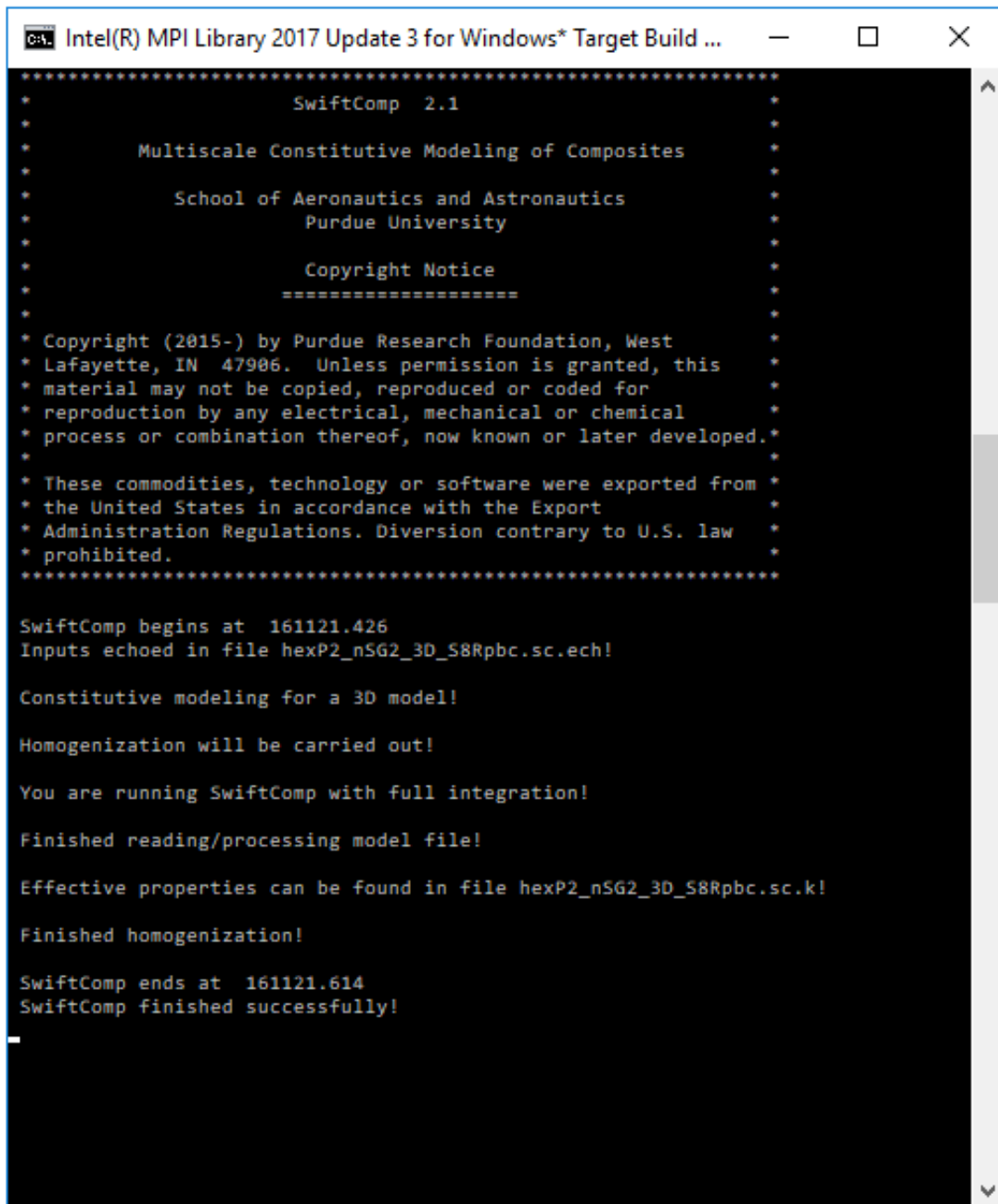
Definition of the 2D SG hexagonal pack microstructure

Step 3. Now, in order to compute the homogenized thermal conductivity properties, we click on *Homogenization* and we select *Conduction* in Analysis Type.



Definition of the homogenization step

Step 4. We click on *Ok* to run the homogenization step. [SwiftComp](#) on the background will run the homogenization.

A screenshot of a terminal window titled "Intel(R) MPI Library 2017 Update 3 for Windows* Target Build ...". The terminal displays the output of the SwiftComp 2.1 software. The output includes a header with the software name and version, followed by the affiliation: "Multiscale Constitutive Modeling of Composites, School of Aeronautics and Astronautics, Purdue University". A copyright notice follows, stating it is from Purdue Research Foundation, West Lafayette, IN, 2015-. The main execution log shows the start time (161121.426), the input file (hexP2_nSG2_3D_S8Rpbcc.sc.ech), and the process steps: "Constitutive modeling for a 3D model!", "Homogenization will be carried out!", "You are running SwiftComp with full integration!", "Finished reading/processing model file!", "Effective properties can be found in file hexP2_nSG2_3D_S8Rpbcc.sc.k!", "Finished homogenization!". The process ends at 161121.614 and reports "SwiftComp finished successfully!".

```
Intel(R) MPI Library 2017 Update 3 for Windows* Target Build ...
SwiftComp 2.1
Multiscale Constitutive Modeling of Composites
School of Aeronautics and Astronautics
Purdue University
Copyright Notice
=====
Copyright (2015-) by Purdue Research Foundation, West
Lafayette, IN 47906. Unless permission is granted, this
material may not be copied, reproduced or coded for
reproduction by any electrical, mechanical or chemical
process or combination thereof, now known or later developed.
These commodities, technology or software were exported from
the United States in accordance with the Export
Administration Regulations. Diversion contrary to U.S. law
prohibited.
SwiftComp begins at 161121.426
Inputs echoed in file hexP2_nSG2_3D_S8Rpbcc.sc.ech!
Constitutive modeling for a 3D model!
Homogenization will be carried out!
You are running SwiftComp with full integration!
Finished reading/processing model file!
Effective properties can be found in file hexP2_nSG2_3D_S8Rpbcc.sc.k!
Finished homogenization!
SwiftComp ends at 161121.614
SwiftComp finished successfully!
```

SwiftComp

running on the background

Step 5. The results can be found in the `.sc.k` file as shown next. Note that the first matrix corresponds to the effective thermal conductivity matrix in the form of K_{ij}^* . The second matrix corresponds to the compliance matrix in the form of $(K_{ij}^*)^{-1}$.

```
hexP2_nSG2_3D_S8Rpbcs.sc.k x
1 The Effective Stiffness Matrix
2 -----
3 5.7312758E+00 0.0000000E+00 0.0000000E+00
4 0.0000000E+00 1.5043834E+00 -3.9399052E-16
5 0.0000000E+00 -3.9399052E-16 1.5043833E+00
6
7 The Effective Compliance Matrix
8 -----
9 1.7448122E-01 0.0000000E+00 0.0000000E+00
10 0.0000000E+00 6.6472414E-01 1.7408795E-16
11 0.0000000E+00 1.7408795E-16 6.6472420E-01
12
13
14 Effective Density = 0.0000000E+00
15
```

length: 733 | Ln: 15 Col: 1 Sel: 0|0 Windows (CR LF) UTF-8 INS

Results corresponding to the effective thermal conductivities

References

1. Rique, O.; Barocio, E.; Yu, W.: "Experimental and Numerical Determination of the Thermal Conductivity Tensor for Composites Manufacturing Simulation," ASC 32nd Technical Conference, October 2017, Purdue University.