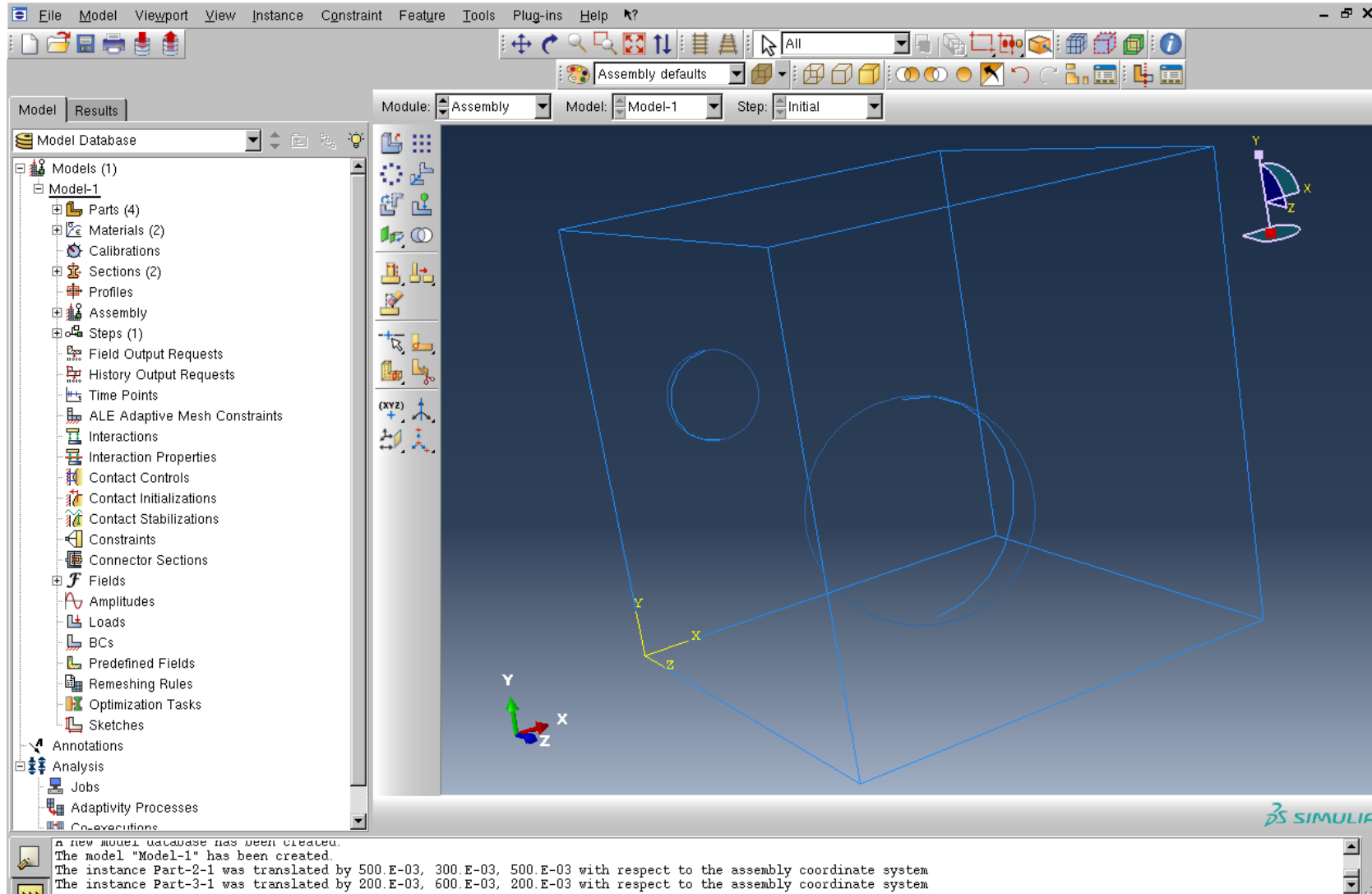
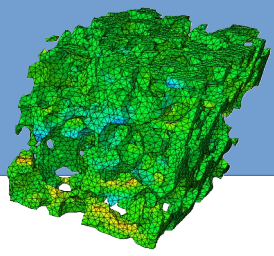


HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media *step 1 : part creation (in this case merging two sphere and a cube)*

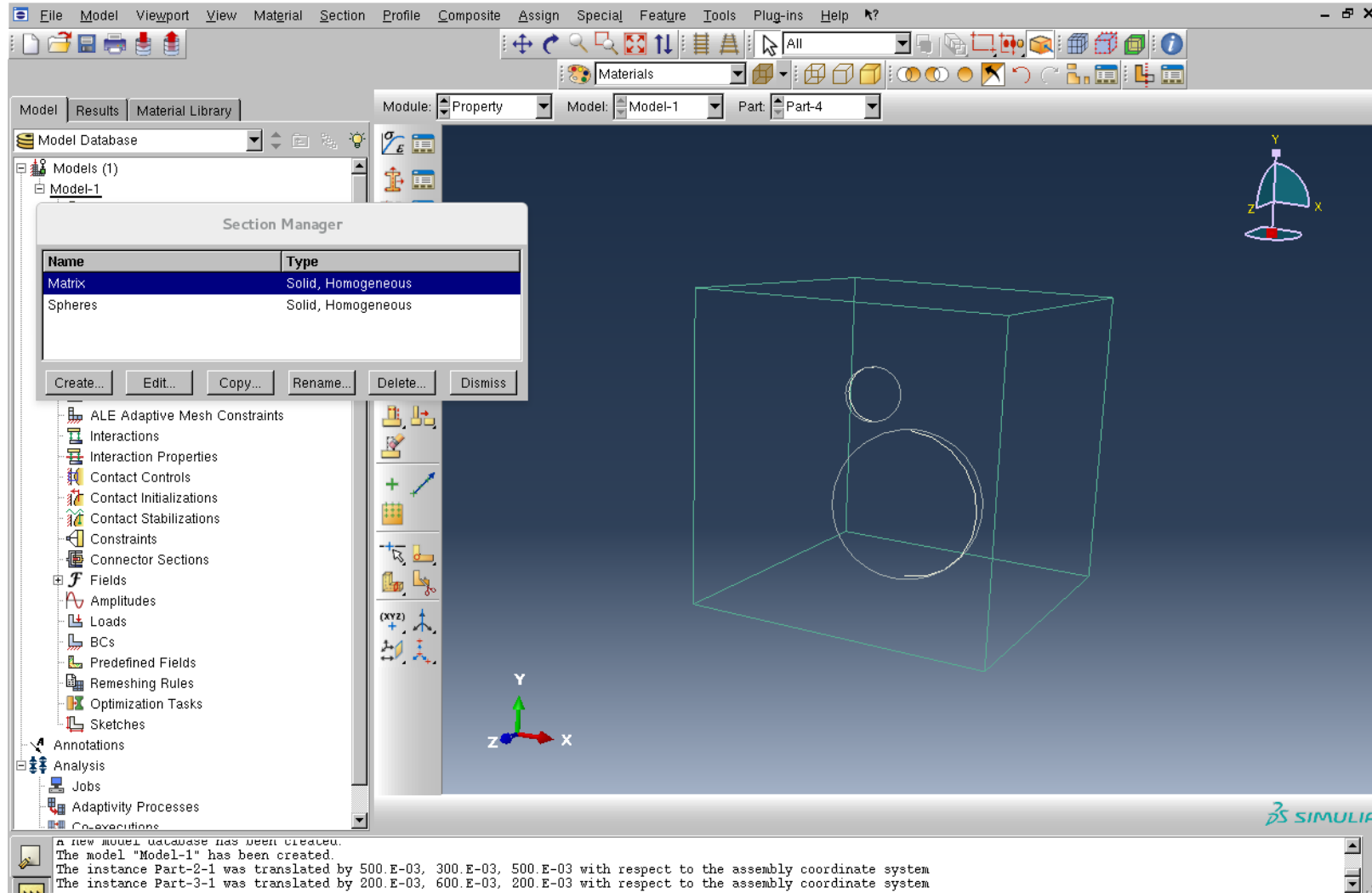


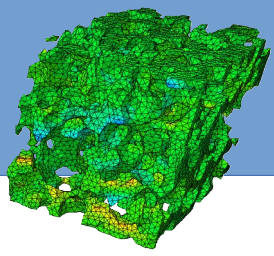


HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 2 : properties assignment, in this case two elastic and isotropic behavior but homtools is not limited to a particular behavior





HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

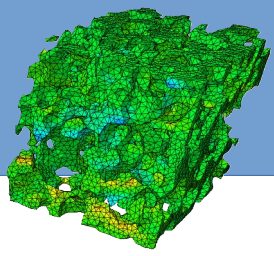
step 3 : step definition, in this linear (small strain) but homtools can be used with nlgeom option

The screenshot displays the Abaqus CAE interface. The main viewport shows a 3D model of a cube with three spherical inclusions. The Step Manager dialog box is open, showing the following table:

Name	Procedure	Nlgeom	Time
Initial	(Initial)	N/A	N/A
Step-1	Static, General	OFF	1

Below the table, there are buttons for 'Create...', 'Edit...', 'Replace...', 'Rename...', 'Delete...', 'Nlgeom...', and 'Dismiss'. The left-hand side of the interface shows a tree view of the model database, including 'Parts (4)', 'Materials (2)', 'Calibrations', 'Sections (2)', and 'Profiles'. The bottom status bar contains the following text:

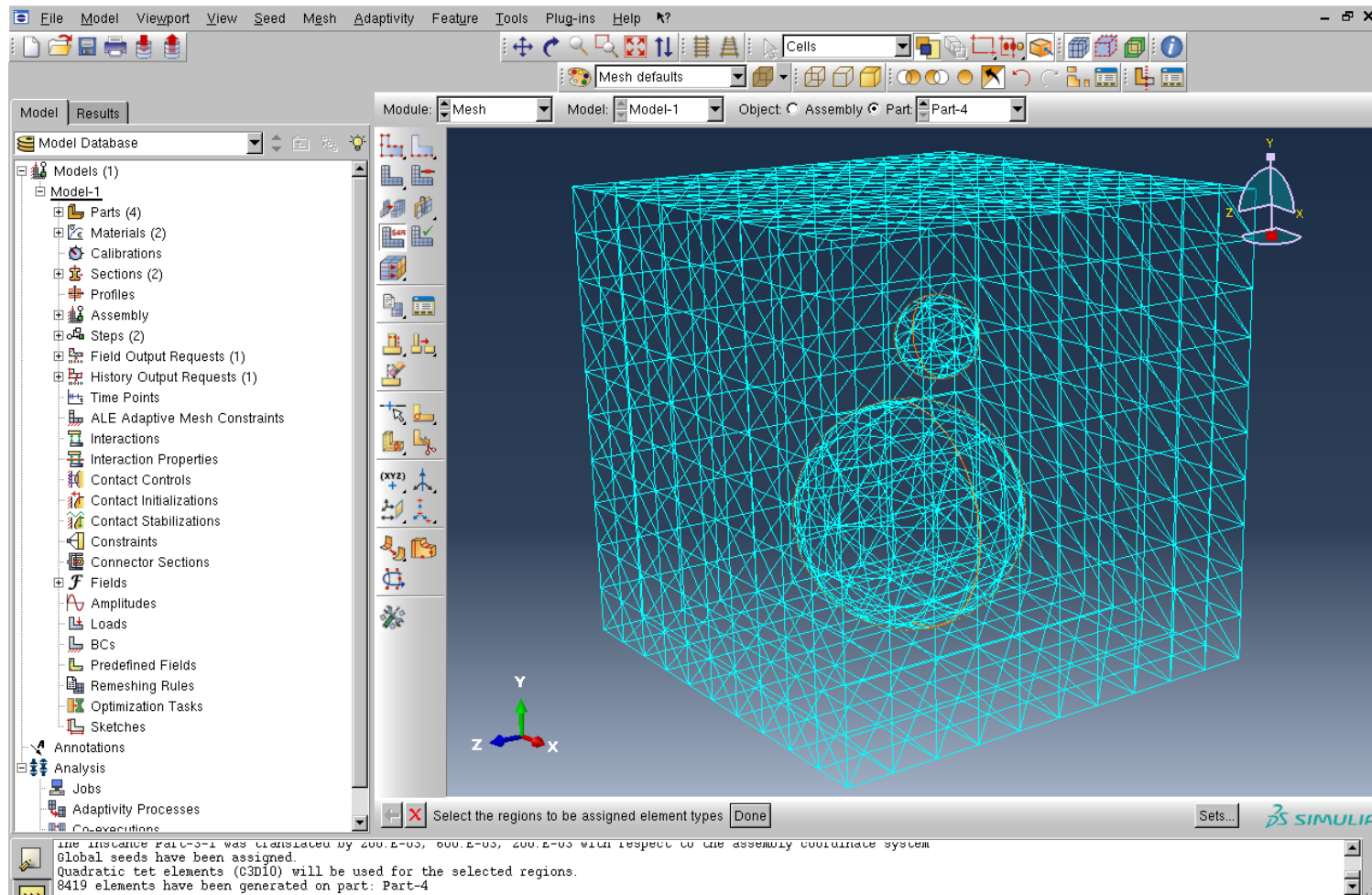
A new model database has been created.
The model "Model-1" has been created.
The instance Part-2-1 was translated by 500.E-03, 300.E-03, 500.E-03 with respect to the assembly coordinate system
The instance Part-3-1 was translated by 200.E-03, 600.E-03, 200.E-03 with respect to the assembly coordinate system

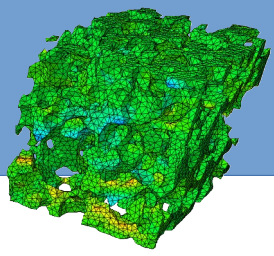


HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 4 : mesh definition, Homtools required a mesh to generate linear equations on the boundary. For each meshing modification the equations needs to be re-generated by homtools (old equations needs to be previously deleted)

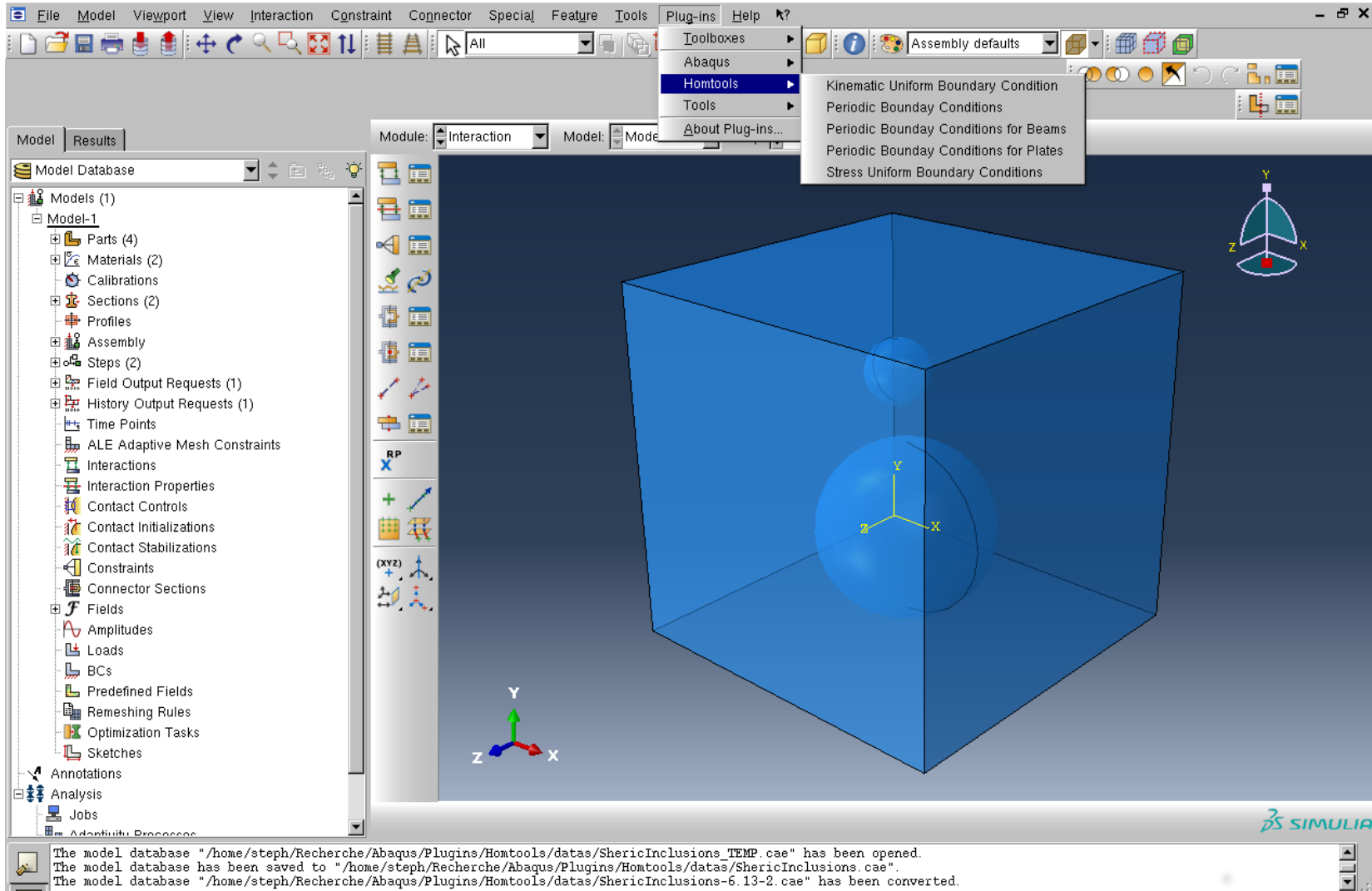


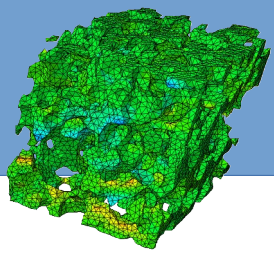


HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 5 : Homtools is available from the plug-ins menu in the interaction module.

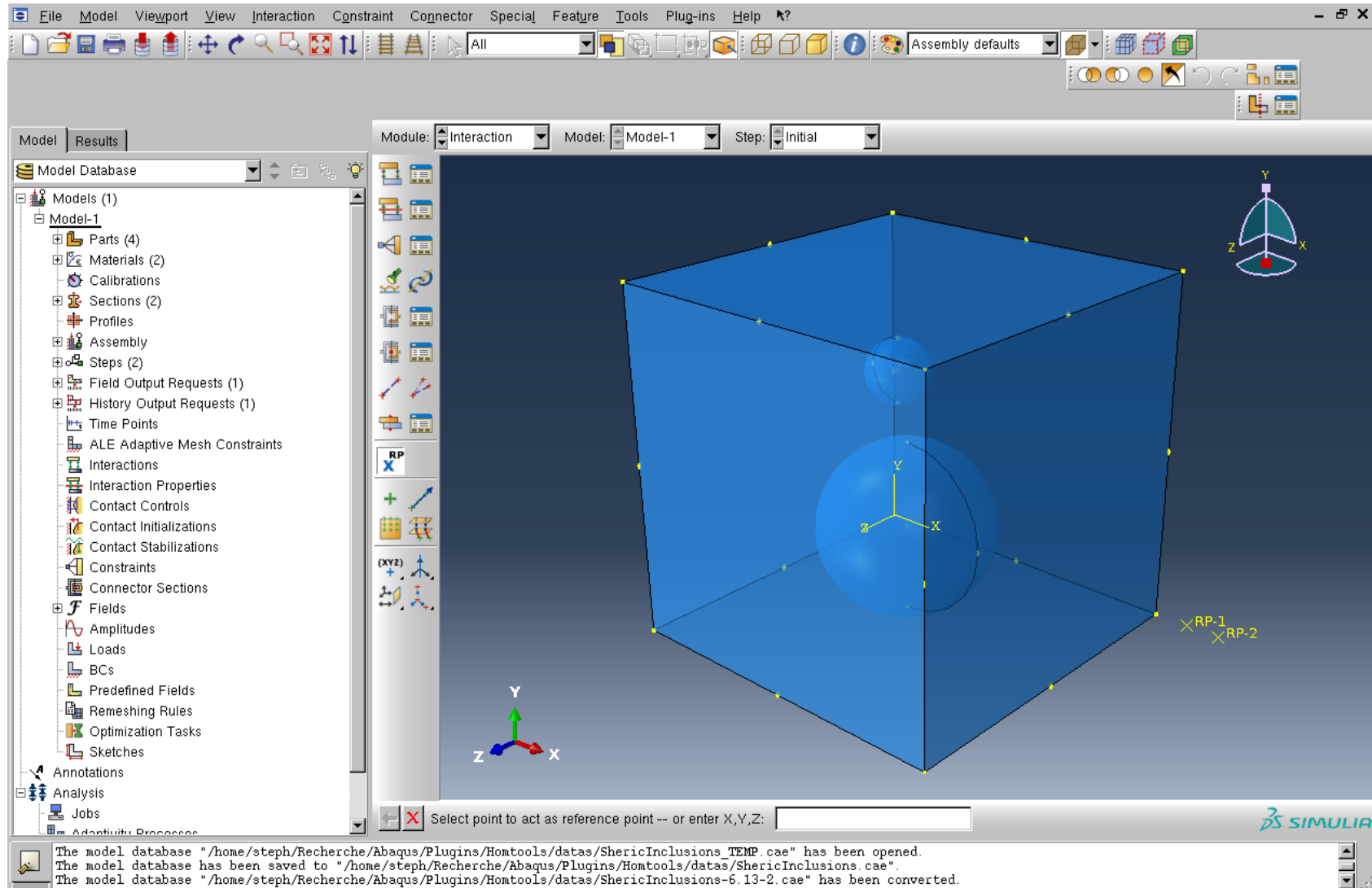


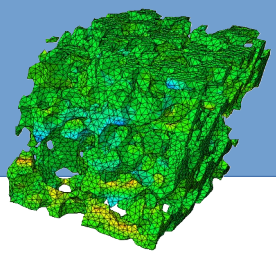


HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 5 : Reference points creations for macro stress or strain (two ref points are needed in the case of small strain)





HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 5 : Choice of a homogeneisation method : in this case Kinematic Uniform Boundary Conditions (KUBC)

Linear displacements on the boundary

Formulation: Small strain

Macro Nodes

Select the first RefPoint (E11,E22,E33)

Select the second RefPoint (GAMMA12=2xE12,GAMMA13=2xE13,GAMMA23=2xE23)

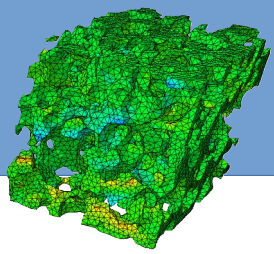
Select the third RefPoint (Unused)

Boundary Sets

Select the Faces

Select point to act as reference point -- or enter X,Y,Z:

The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions_TEMP.cae" has been opened.
The model database has been saved to "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions.cae".
The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions-6.13-2.cae" has been converted.



HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 5 : The two ref points are selected and 6 faces of the cube define the boundary sets

Linear displacements on the boundary

Formulation: Small strain

Macro Nodes

Select the first RefPoint (E11,E22,E33)

Select the second RefPoint (GAMMA12=2xε12,GAMMA13=2xε13,GAMMA23=2xε23)

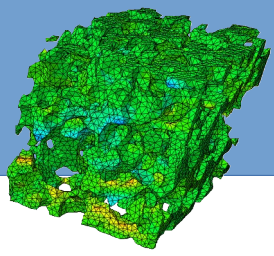
Select the third RefPoint (Unused)

Boundary Sets

Select the Faces

Select Faces

The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions_TEMP.cae" has been opened.
The model database has been saved to "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions.cae".
The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions-6.13-2.cae" has been converted.



HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 5 : Homtools generates the constraint equations (linear relations between ref nodes and boundary nodes) on the boundary sets

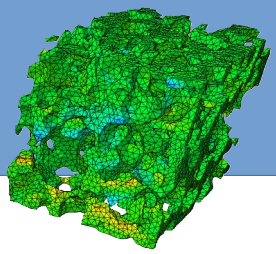
The screenshot displays the Abaqus CAE interface. The main window shows a 3D model of a blue cube with two spherical inclusions. The **Constraint Manager** dialog is open, listing 16 constraint equations. The **Edit Constraint** dialog is also open, showing the details for 'Constraint-1-Num1'.

Name	Type
Constraint-1-Num1	Equation
Constraint-1-Num2	Equation
Constraint-1-Num3	Equation
Constraint-1-Num4	Equation
Constraint-1-Num5	Equation
Constraint-1-Num6	Equation
Constraint-1-Num7	Equation
Constraint-1-Num8	Equation
Constraint-1-Num13	Equation
Constraint-1-Num14	Equation
Constraint-1-Num15	Equation
Constraint-1-Num16	Equation

	Coefficient	Set Name	DOF	CSYS ID
1	1	Num1	1	(global)
2	1.1	RefMacro1	1	(global)
3	-0	RefMacro2	1	(global)
4	-0.5	RefMacro2	2	(global)

The status bar at the bottom shows the following messages:

- The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions_TEMP.cae" has been opened.
- The model database has been saved to "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions.cae".
- The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions-6.13-2.cae" has been converted.



HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 6 : Macro strains (resp. stresses) are defined from displacement boundary conditions (resp. cload condition) specified at the ref nodes. In this case (3D small strains) at ref node 1 we have E_{11}, E_{22}, E_{33} and $2E_{12}, 2E_{13}, 2E_{23}$ at ref node 2.

Model Database

Models (1)

Model-1

Edit Boundary Condition

Name: BC-1

Type: Displacement/Rotation

Step: Step-1 (Static, General)

Region: Set-2405

CSYS: (Global)

Distribution: Uniform $f(x)$

U1: 1.0

U2: 0

U3: 0

UR1: radians

UR2: radians

UR3: radians

Amplitude: (Ramp)

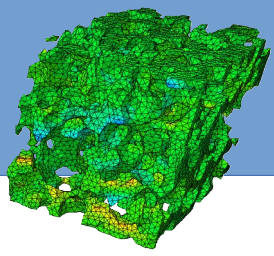
Note: The displacement value will be maintained in subsequent steps.

OK Cancel

Fill out the Edit Boundary Condition dialog

THE SIMULIA

The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions_TEMP.cae" has been opened.
The model database has been saved to "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions.cae".
The model database "/home/steph/Recherche/Abaqus/Plugins/Homtools/datas/ShericInclusions-6.13-2.cae" has been converted.



HOMTOOLS : An homogeneisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 7 : Job submission and local results, nothing special compare standard results

Module: Visualization Model: /home/steph/KUBC_SphericInclusion.odb

Session Data

- Output Databases (1)
- Model Database (1)
- Spectrums (7)
- XYPlots
- XYData
- Paths
- Display Groups (1)

View Cut Manager

Show	Name	Model
<input type="checkbox"/>	X-Plane	<input checked="" type="checkbox"/>
<input type="checkbox"/>	Y-Plane	<input checked="" type="checkbox"/>
<input checked="" type="checkbox"/>	Z-Plane	<input checked="" type="checkbox"/>

Allow for multiple cuts

Motion of Selected Cut

Translate

Position: 0.5

Sensitivity: 1

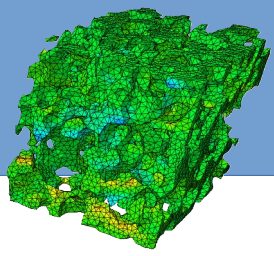
E, E12 (Avg: 75%)

- +2.728e+00
- +2.255e+00
- +1.783e+00
- +1.311e+00
- +8.389e-01
- +3.667e-01
- 1.055e-01
- 5.777e-01
- 1.050e+00
- 1.522e+00
- 1.994e+00
- 2.466e+00
- 2.939e+00

ODB: KUBC_SphericInclusion.odb Abaqus/Standard 6.14-2 Mon Nov 17 16:10:28 CET 2014

Step: Step-1
Increment 1: Step Time = 1.000
Primary Var: E, E12
Deformed Var: U Deformation Scale Factor: +1.091e-01

Job KUBC_SphericInclusion: Analysis Input File Processor completed successfully.
Job KUBC_SphericInclusion: Abaqus/Standard completed successfully.
Job KUBC_SphericInclusion completed successfully.



HOMTOOLS : An homogenisation toolbox for Abaqus CAE

1st example: rigid spherical inclusions in an elastic media

step 7 : Macro stress/strain relationship is easily obtained by creating xydata from odbfield at reference points. Macro strain correspond to variable U, macro stress correspond to variable RF at ref nodes.

