

Optimization with CalculiX

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Overview

There are a few ways to parameterize input files for the various tools in the Open Engineering Suite. Gmsh's input file format naturally incorporates parameters, but the CalculiX file formats do not. For this reason, the Open Engineering Suite's translation tools provide a mechanism to do this.

The `translate` command has an option to translate Abaqus input to CCX input. This includes the `*PARAMETER` keyword. This tool can be used to embed the parameterization into any text file as long as the keyword parameter conventions are followed.

The implementation of Python in `*PARAMETER` in this translator is more extensive than the Abaqus implementation. The parameter section supports all the Abaqus functionality and more. All functions in the Python math library are supported, any one line Python command can be used in the parameter block (not just variable assignments), and the variable usages in the rest of the deck can include any one line Python command (not just variable names).

More information about the `*PARAMETER` can be found in the Abaqus and Python documentation.

Parameterization of CCX Input

A trivial example of the parameter usage in an Abaqus input deck fragment:

```
*PARAMETER
width = 12.7
height = width*2
*BEAM SECTION, SECTION=RECT, ELSET=elset_name, MATERIAL=mat_name
<width>, <height>
```

To expand the parameters and view in CCX, you could run the following batch file with this command: `ccxp jobname`

ccxp.bat

```
translate -abq %1.inpp -ccx %1.inp
ccx %1
```

This assumes that the parameterized input deck has the extension `inpp`.

The previous trivial fragment would be written as:

```
*BEAM SECTION, SECTION=RECT, ELSET=elset_name, MATERIAL=mat_name
12.7, 25.4
```

Parameterization of CGX Input

The Abaqus translator in the extended version for Windows can be used to embed Python code into an FBD file to get the parameterization functionality available in Abaqus input decks. An FBD file can be modified like the following example:

arc.fbdp

```
*PARAMETER
centx = 0.0
centy = 0.0
radius = 3.0
theta = 45.0*pi/180.0
centPt = "PCENTER"
**end parameter section
PNT <centPt> <centx> <centy> 0
PNT !P002 <centx> <centy+radius> 0
PNT !P003 <centx+radius*cos(theta)> <centy+radius*sin(theta)> 0
LINE LA001 %P002 %P003 <centPt> 12
```

All of the text between the *PARAMETER and the **end is parsed as Python code, as are the characters between the <>. Everything else in a non-INP formatted file would be unchanged. Note that this is much more flexible than the Abaqus use of parameters. If you use this in an INP file and want the file to be Abaqus compliant you must only have parameter names in the <>. I have also implemented more math functions than Abaqus supports.

To expand the parameters and view in CGX, you could run the following batch file with this command: `cgxp arc`

cgxp.bat

```
translate -abq %1.fbdp -ccx %1.fbd
cgx -b %1.fbd
```

The FBD file created and opened with CGX in the build mode:

arc.fbd

```
**end parameter section
PNT PCENTER 0.0 0.0 0
PNT !P002 0.0 3.0 0
PNT !P003 2.12132034356 2.12132034356 0
LINE LA001 %P002 %P003 PCENTER 312
```