Use of Z-mat with Abaqus

Z-set group

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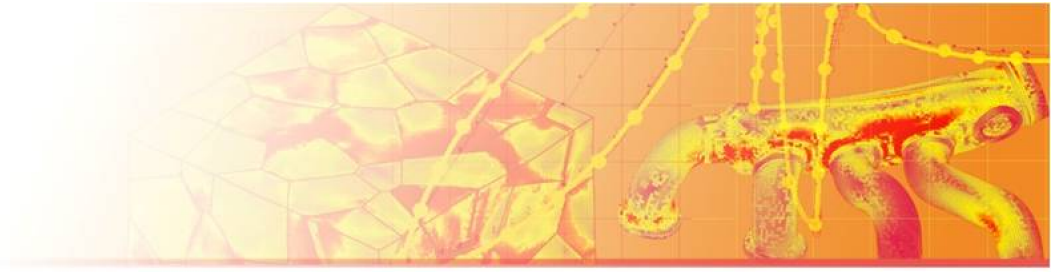
Plan



1. Use of Z-mat with Abaqus
2. Post-treatment of Abaqus results files with Zmaster/Z-post
3. Links with Zsopt for calibration

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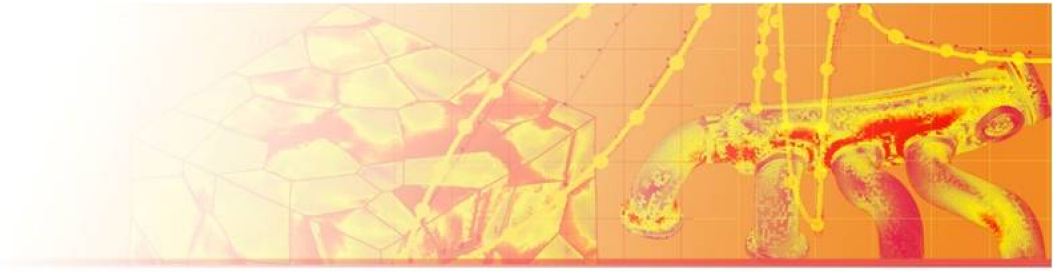

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Modifications to the Abaqus input file

Abaqus input file:

cyclic_abaqus.inp

```
*NODE ...
*SOLID SECTION,ELSET=EALL,MATERIAL=fz
*MATERIAL,NAME= fz
*DEPVAR
   19
*USER MATERIAL,CONSTANTS=1
0.0
*STEP ..
```

Z-mat material file: fz

```
***material
*integration theta_method_a 1. 1.e-10 50
***behavior gen_evp
 **elasticity
  young 200000.
  poisson 0.300000
 **potential gen_evp ep
  *criterion mises
  *flow plasticity
  *isotropic nonlinear
   R0 300.000
   Q 100.000
   b 10.0000
  *kinematic nonlinear
   C 25000.0
   D 50.0000
***return
```

Command: $ Zmat cyclic_abaqus

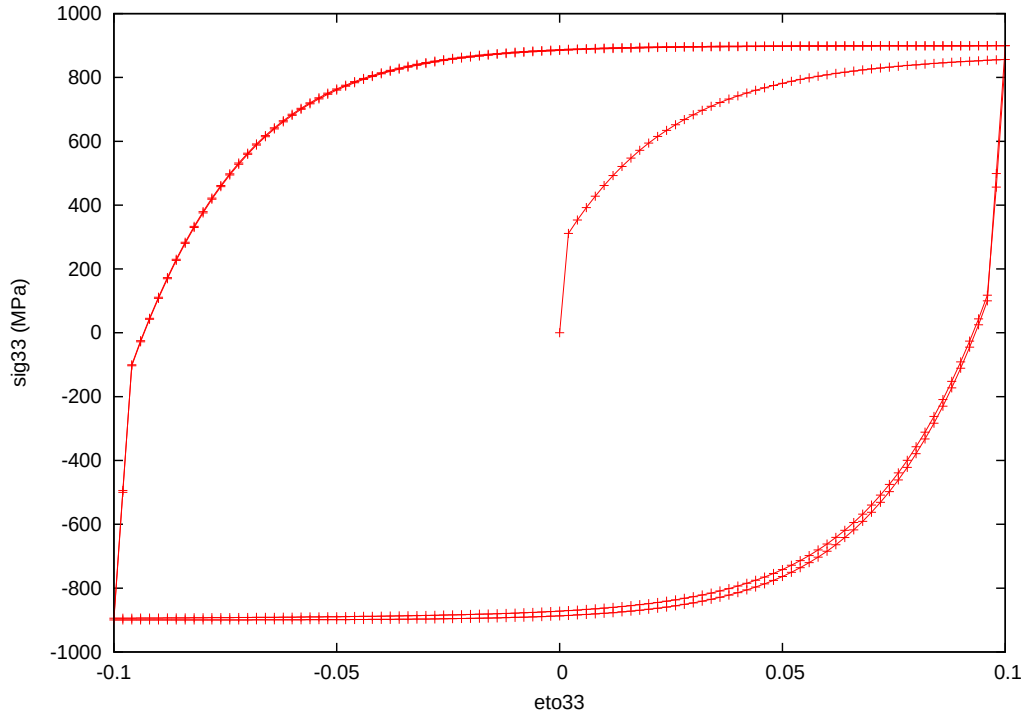
Zpreload utility

- Checks the behavior definition
- Printouts the names and number of SDVs needed by the Z-mat model
- Command: $ `Zpreload zf`
- 3D default output, for 2D use `Zpreload -d 2 ...`

```
Reading behavior in file: zf
============================================
..
var_int Name:
  eel11(sdv1) eel22(sdv2) eel33(sdv3) eel12(sdv4) eel23(sdv5)
  eel31(sdv6)
  epcum(sdv7)
  al111(sdv8) al122(sdv9) al133(sdv10) al112(sdv11) al123(sdv12)
  al131(sdv13)

var_aux Name:
  epi11(sdv14) epi22(sdv15) epi33(sdv16) epi12(sdv17) epi23(sdv18)
  epi31(sdv19)
============================================
done with material file reading...
```

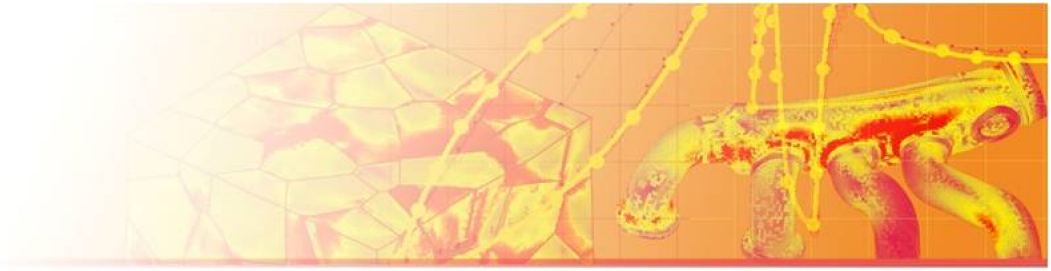
Example: strain-controlled symmetric cyclic test



- FE mesh with a single element (c3d8)
- 2 cycles applied in 8 Abaqus steps

▸ Zmat -fg cyclic_abaqus ▸ Edit .inp ▸ Edit .sta ▸ Viewer ▸ Open terminal

Plan



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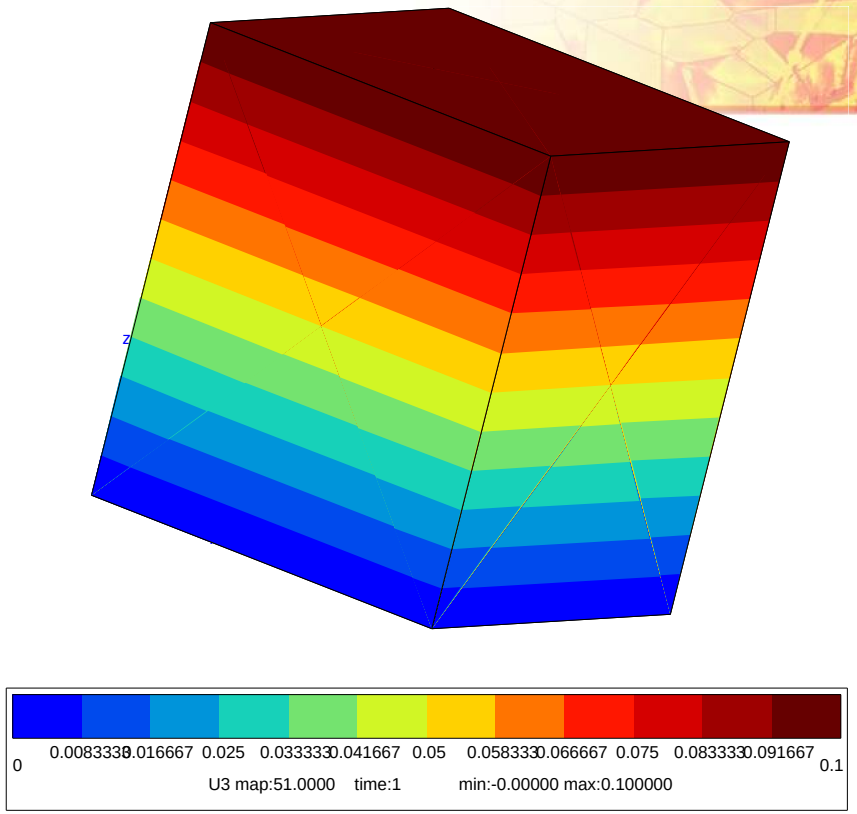
Reading odb files with the Zmaster GUI



- Alternative to abaqus viewer
- Basic graphical post-treatment operations
- Preserve Z-mat's SDV names
- Iso-contours at integration points

▸ Zodb -G cyclic_abaqus.odb

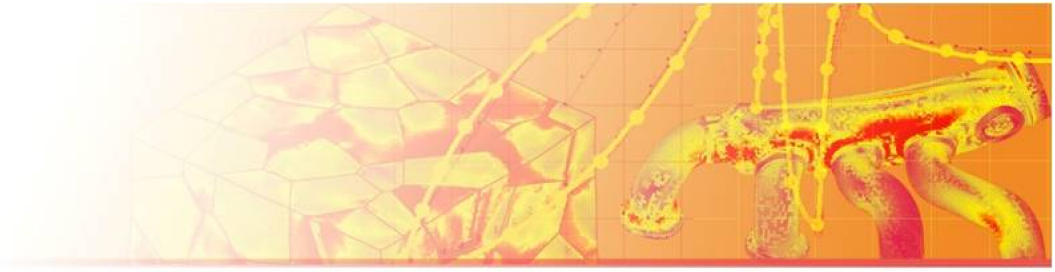
Running Z-post on odb files

- General batch post-processing
- Damage post-processing
- Reading/Writing of odb files

```
****post_processing
 ***data_source odb
  **open cyclic_abaqus.odb
 ***data_output odb
  **problem_name zpost_for_abaqus
 ***local_post_processing
  ...
  **process range
   *var sig
****return
```

▸ Zodb -pp zpost_for_abaqus ▸ Viewer ▸ Open terminal

Plan



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Single element Abaqus vs Z-sim

- Common material file for model calibration and FE analysis
- Definition of the cyclic test using Z-sim
- Driving of Abaqus in SimOpt using external simulations
- Advantages of Z-sim for calibration:
  - easy definition (no mesh, boundary conditions, steps etc..)
  - very fast (mandatory for automatic optimization)

▸ Zsopt cyclic ▸ Open terminal