

# Material Parameter Calibration Services for Abaqus Non-linear Material Models

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DatapointLabs

Simulia Customer Conference 2011

# DatapointLabs

expert material testing

- **Physical properties of materials**

- ▶ Mechanical properties
- ▶ Thermal properties
- ▶ Flow properties

- **Globally available at**

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tensile  
compressive  
flexural  
stress-strain  
Poisson's ratio  
high strain rate  
bulk modulus  
fatigue  
visco-elasticity  
stress relaxation  
creep  
friction  
hyperelasticity  
thermal expansion  
thermal conductivity  
specific heat  
PVT  
rheology

# Customer base

- 800 companies
- 11 manufacturing verticals
- Product development / R&D

- Aerospace
- Automotive
- Appliance
- Biomedical
- Consumer products
- Electronics
- Industrial Goods
- Materials
- Petroleum
- Packaging

# Material testing expertise

- **Product development / R&D support**

- ▶ Over 1,000 materials tested each year
- ▶ All kinds of materials
- ▶ Over 200 kinds of physical properties

- Plastic
- Rubber
- Film
- Metal
- Foam
- Composite
- Cement
- Ceramic
- Paper
- Wire
- Fiber



# US test laboratory



# TestPaks: CAE Material Model Parameters for Abaqus

- FEA of Non-linear materials
  - ▶ Rubber
  - ▶ Plastic
  - ▶ Fiber filled plastics
  - ▶ Foam
  - ▶ Metal plasticity
- Crash/drop test simulation

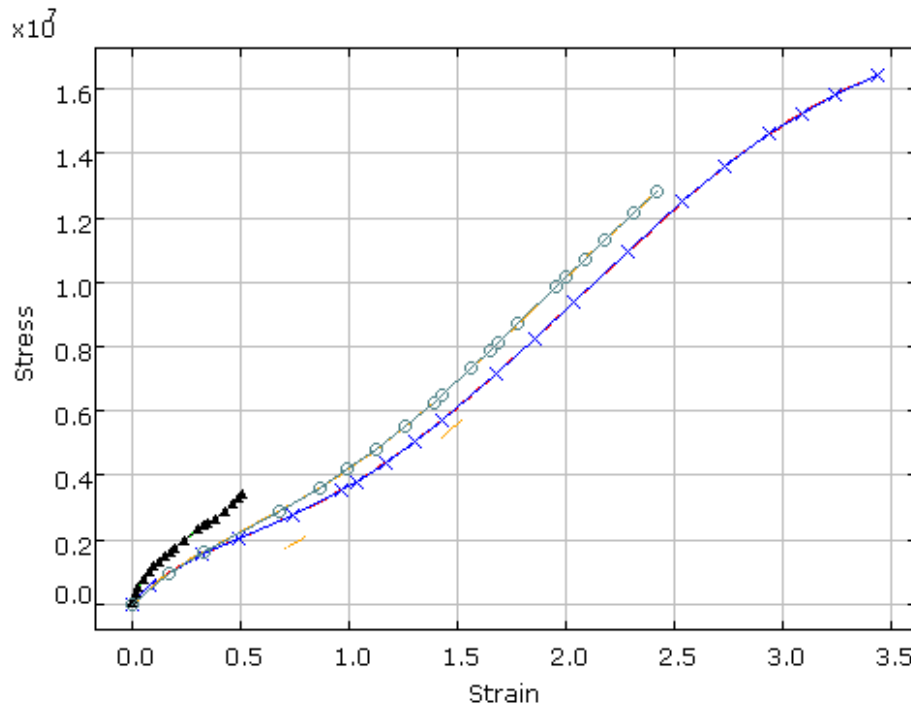
# Hyperelastic

- Tensile
- Compressive
- Planar
- Volumetric
- Range
  - ▶ pre-cycled or first pull
  - ▶ -50 to 200 C
  - ▶ rate dependency



# Hyperelastic export to Abaqus

\*HYPERELASTIC, POLYNOMIAL, N=2, TEST DATA INPUT



Edit Points

Legend

- Uniaxial Data ■
- Uniaxial Export ×
- Biaxial Data ■
- Biaxial Export ▲
- Planar Data ■
- Planar Export ○



Refresh

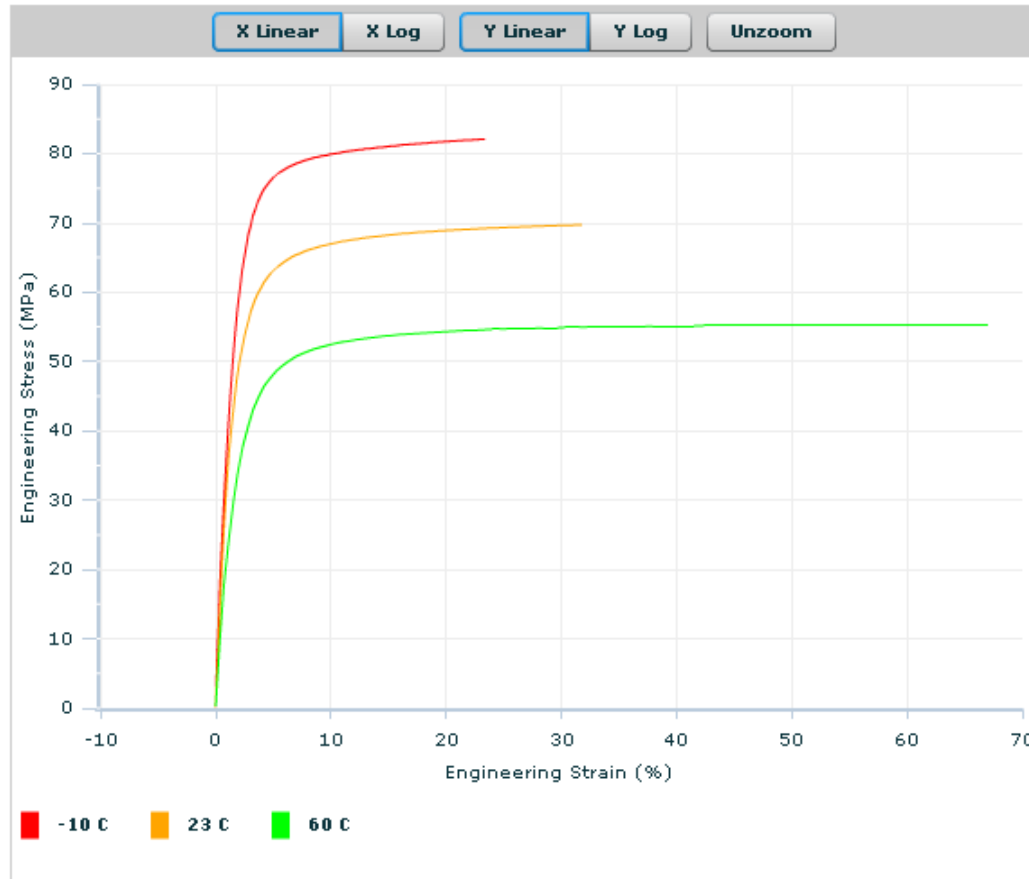
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** output generated by Matereality
** Abaqus Hyperelastic Model
*MATERIAL, name=EPDM60Durometer
*HYPERELASTIC, POLYNOMIAL, N=2, TEST D
*UNIAXIAL TEST DATA
0.1594814, 0.0211042
0.3208162, 0.07203753
0.5474399, 0.1571316
0.7312444, 0.2297227
0.8018367, 0.263645
0.941079, 0.3318102
1.014725, 0.3639037
1.123375, 0.4291126
1.193063, 0.4623924
1.310755, 0.5281718
1.367727, 0.5610719
1.431055, 0.5924231
1.487432, 0.6228672
1.602884, 0.6875517
1.653628, 0.7200964
1.818384, 0.8170168
1.875023, 0.8502936
1.987376, 0.912495
2.043667, 0.9434061
2.119651, 0.9921576
*BIAXIAL TEST DATA
0.1378403, 0.0117455
0.3916698, 0.04177969
0.613751, 0.07112567
0.766247, 0.1032959
0.8820472, 0.1369487
1.0618925, 0.208224
1.1487646, 0.2435821
1.3103990, 0.3091004
1.4695978, 0.371739
1.5424144, 0.4123548
1.6063792, 0.4610693
1.6547366, 0.5104992
1.7133399, 0.5499286
1.7799146, 0.5867600
1.8463172, 0.6187684
1.9111035, 0.6484157
1.9673220, 0.6767286
2.0603721, 0.7216054
2.1107518, 0.7463254
2.1592589, 0.770474
*PLANAR TEST DATA
0.2034791, 0.0125749
0.417682, 0.03775836
    
```



# Plastics non-linear stress-strain

Engineering Tensile Stress-Strain Curves

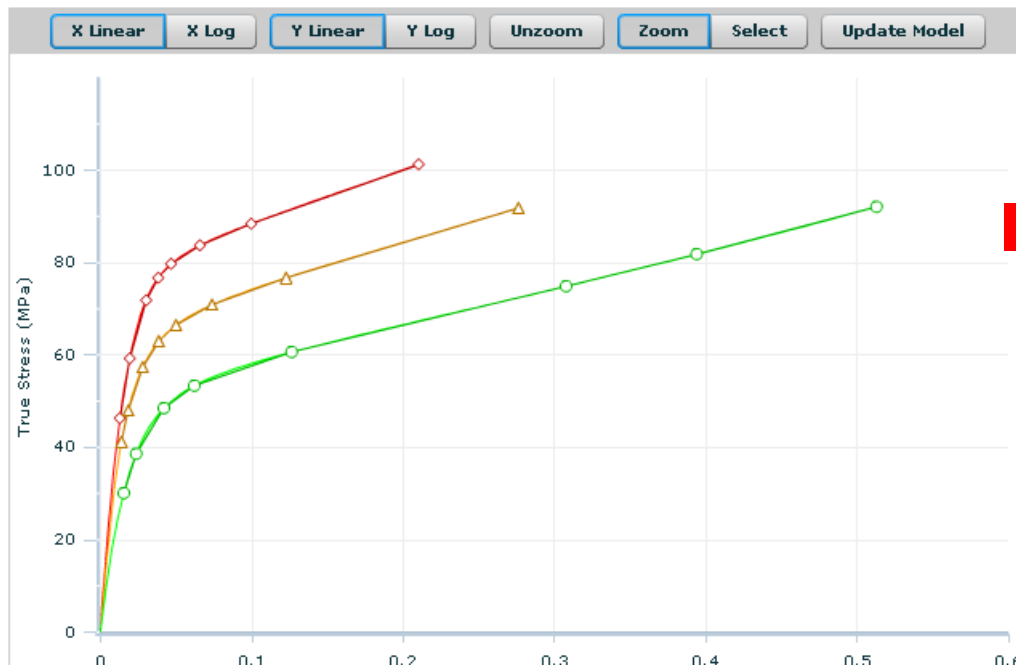


# Post-processing and output

\*Elastic

Temperature (C)	Modulus (MPa)	Poisson's Ratio
-10	3607.59123689013	0.2413
23	3183.7938807461	0.323571664399527
60	2174.59568965032	0.39415

\*Plastic Plot

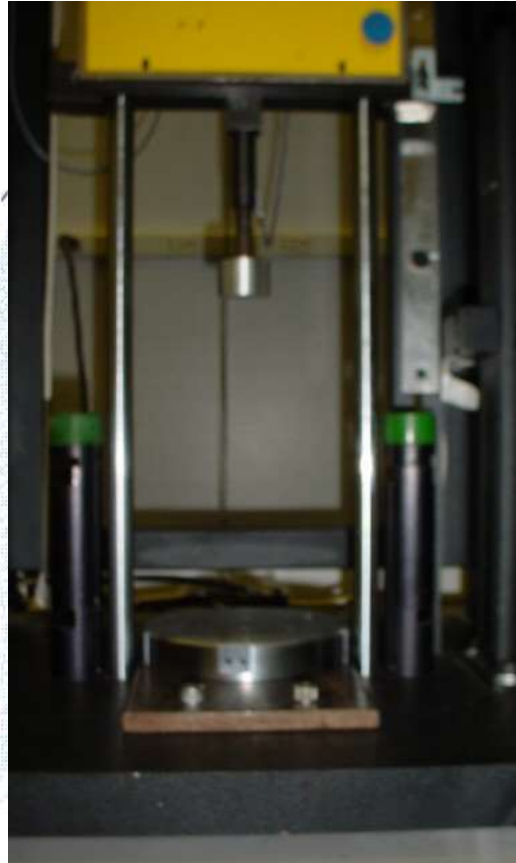


```

** Output generated by Matereality
** Abaqus Plastic Model
*MATERIAL, name=Delrin8753K13
*ELASTIC
3607.59123689013, 0.2413, -10
3183.7938807461, 0.323571664399527, 23
2174.59568965032, 0.39415, 60
****
*PLASTIC
46.381708640637, 0, -1.000E+01
59.3182190072696, 0.0028490427305577354, -1.000E+01
71.8736400512504, 0.01017006174294555, -1.000E+01
76.7156702762688, 0.016802750802138691, -1.000E+01
79.8204244473178, 0.0246331420035193, -1.000E+01
83.7520014704219, 0.042400203020399568, -1.000E+01
88.44580120706, 0.07511425176203515, -1.000E+01
101.286187380666, 0.18221125102592156, -1.000E+01
**
1.2027474277636, 0, 2.300E+01
1.0138087197766, 0.0021790259049776321, 2.300E+01
57.359137021248, 0.00867790936047107, 2.300E+01
62.9873556601982, 0.017373626682723388, 2.300E+01
66.4967793306663, 0.027568865979447788, 2.300E+01
70.9009392980115, 0.05004465060490744, 2.300E+01
76.72575710626, 0.096883146480115784, 2.300E+01
91.876816291205, 0.24545717623947155, 2.300E+01
**
30.11774647629, 0, 6.000E+01
38.66825030697, 0.0039035831184979289, 6.000E+01
48.5300393483556, 0.017108653508792655, 6.000E+01
53.3730143012474, 0.03494428420354867, 6.000E+01
60.661535633334, 0.095585277502911209, 6.000E+01
74.9317547325, 0.26978649975467672, 6.000E+01
81.885009651224, 0.35258702479111464, 6.000E+01
92.151413540012, 0.46612695216059519, 6.000E+01
**
    
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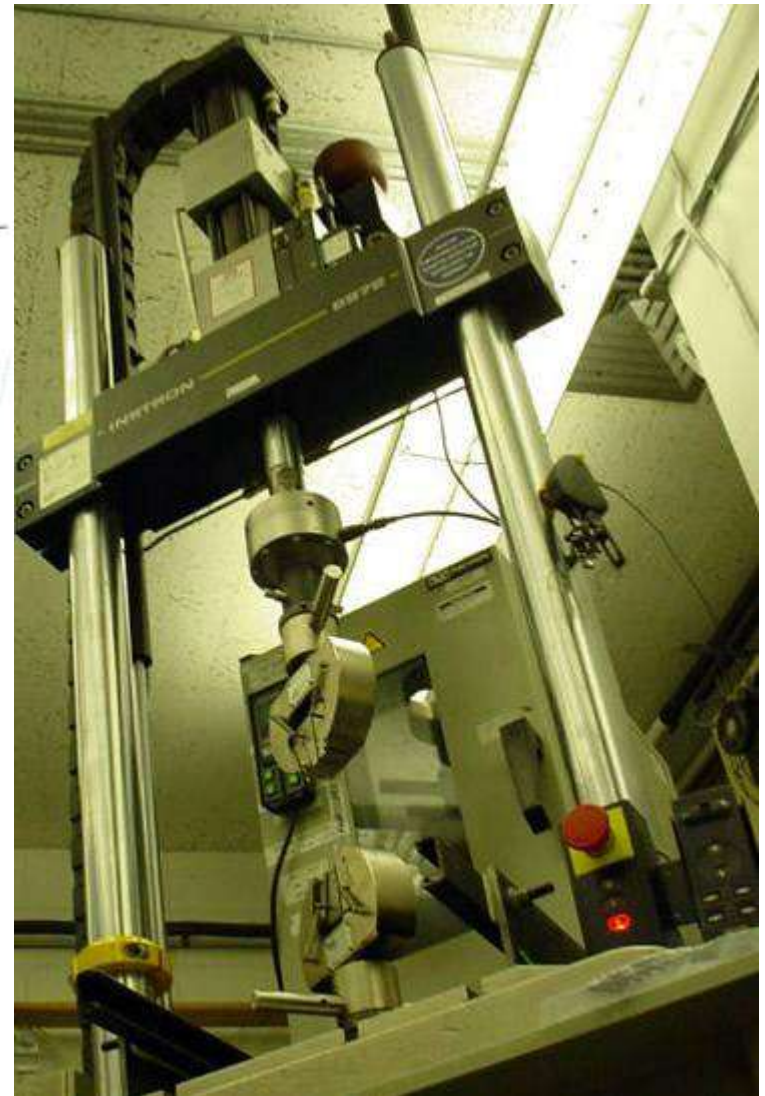


# Testing of foams



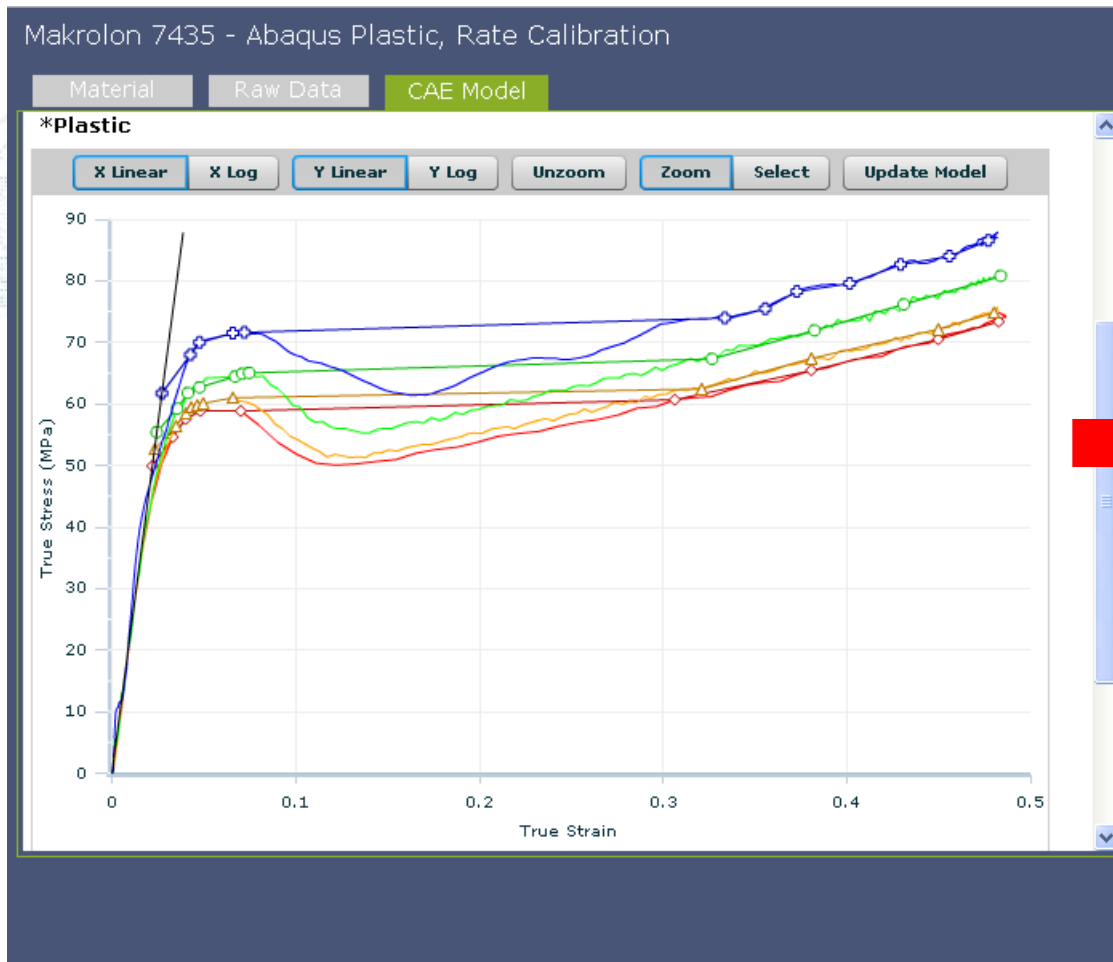
# High speed testing

- **Instron servo-hydraulic**
  - ▶ Dynamic load cell
  - ▶ Strain rate range
    - 0.01, 0.1, 1, 10, 100/s
  - ▶ Test modes
    - tensile
    - compressive
    - flex





# High strain rate tensile properties



```

** Output generated by Matereality
** Abaqus Plastic, Rate Model Model
*MATERIAL, name=Makrolon7435
*ELASTIC
1967.00039820387, 0.4, 23
*PLASTIC
51.752289574966554, 0
54.6276232428106, 0.0053670185121656756
57.5761189597426, 0.010870599287081697
58.8714171822015, 0.018310873449855561
58.8514324430007, 0.040340514042735108
59.5595744806121, 0.26601479715390969
63.0211931618155, 0.3132768472443474
67.2674249265918, 0.3703233668514665
71.8640275879173, 0.42772510624792442
**
*PLASTIC, Rate=6.929E-02
51.752289574966554, 0
54.6276232428106, 0.0053670185121656756
57.5761189597426, 0.010870599287081697
58.8714171822015, 0.018310873449855561
58.8514324430007, 0.040340514042735108
59.5595744806121, 0.26601479715390969
63.0211931618155, 0.3132768472443474
67.2674249265918, 0.3703233668514665
71.8640275879173, 0.42772510624792442
**
**
*PLASTIC, Rate=2.665E-01
54.575141733601086, 0
56.4072143469709, 0.0061455537705760455
58.4816451099972, 0.010562001367414208
59.4275580191473, 0.01304673337896798
59.791233060358, 0.016003911661294026
60.102496106527, 0.019173170417494036
61.0198938453632, 0.034742530631047888
    
```



# Visco-elastic testing

- **Instruments**

- ▶ Rheometrics ARES
- ▶ Bose Enduratec
- ▶ Instron Servo
- ▶ Perkin Elmer DMA 7e

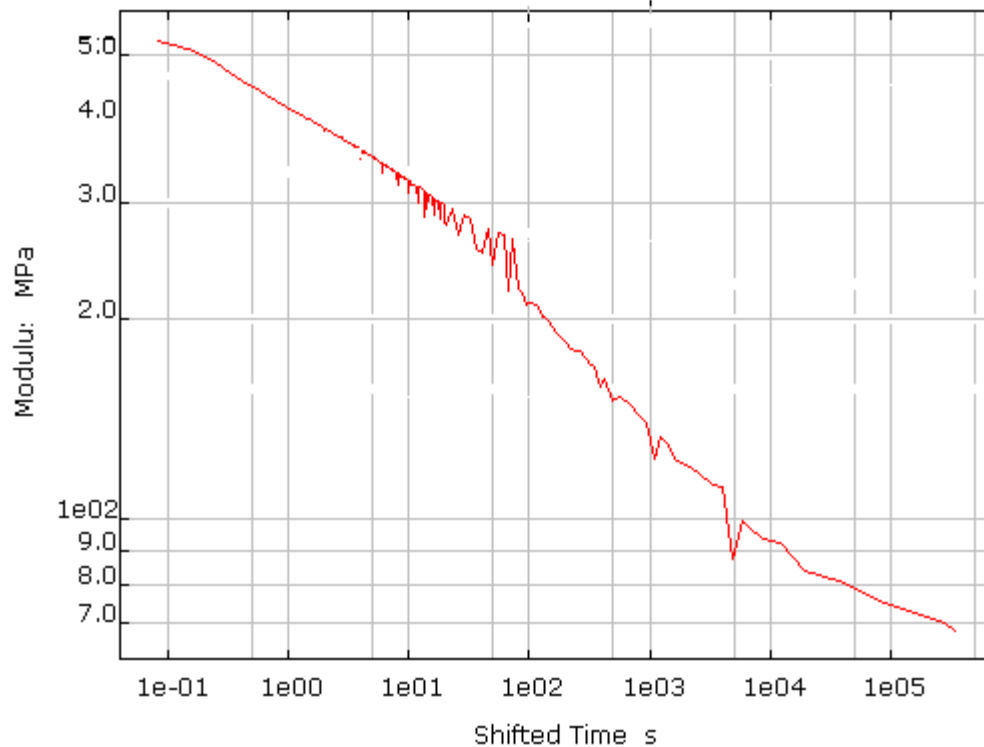
- **Test Modes**

- ▶ Stress relaxation
- ▶ Creep
- ▶ Frequency



# UHMWPE mastercurve

Modulus v. Time Mastercurve

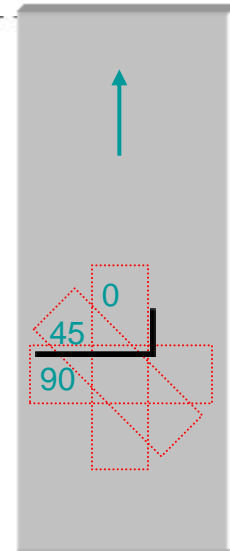


# Metal plasticity

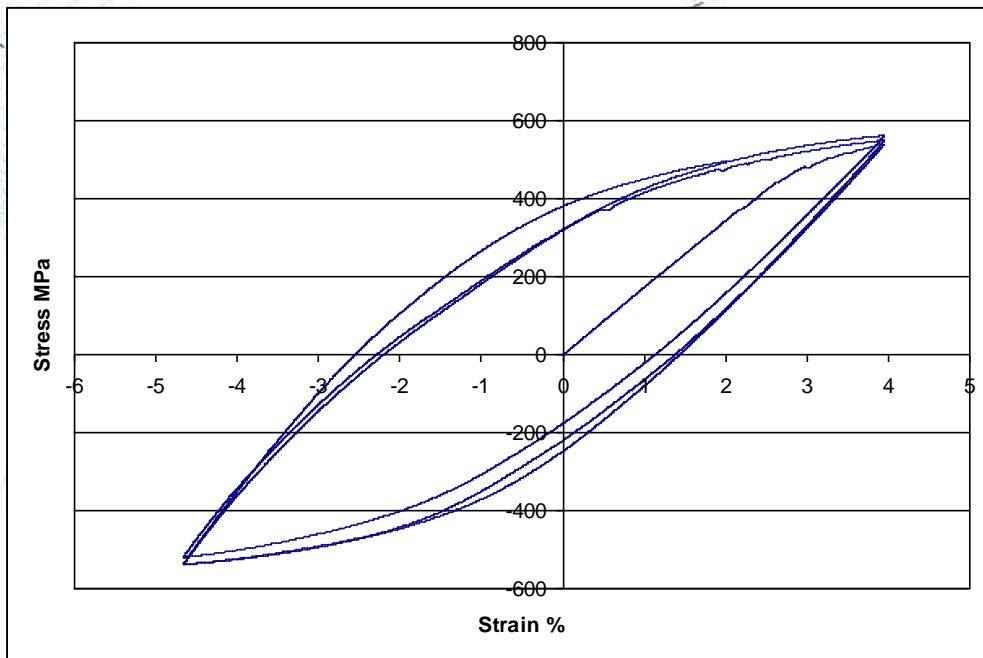
- Abaqus Metal Forming
- (\*ELASTIC \*CREEP, OPTION=POTENTIAL)

- ▶ **TestPak : G-708**

- Tensile stress-strain tests in 0, 90, 45° direction
- Poisson's ratio
- Lankford parameters



# Cyclic plasticity





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### Highlights

- [Datapoint e-bulletin 17.1: New TestPaks, International Sales, Giving Back](#)
- DatapointLabs' [Giving Back](#) program is being diverted to support Japan earthquake relief efforts.
- [See You At CARHS Automotive CAE Grand Challenge - DatapointLabs will present a workshop on Testing and Material Modeling Software for Crash & Safety](#)
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