Modeling Soft Materials for Non-linear NVH Applications

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DatapointLabs
expert material testing

Mechanical properties

Thermal properties

Flow properties

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

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DatapointLabs
expert material testing

- Established 1995
- 1000 materials tested/yr
- 800 clients
- 11 manufacturing verticals
- ISO 17025 Quality System
- Globally available at

  www.datapointlabs.com

  visit | browse | buy | download

plastics
rubber
foam
metals
films
fiber
adhesives
composites
paper

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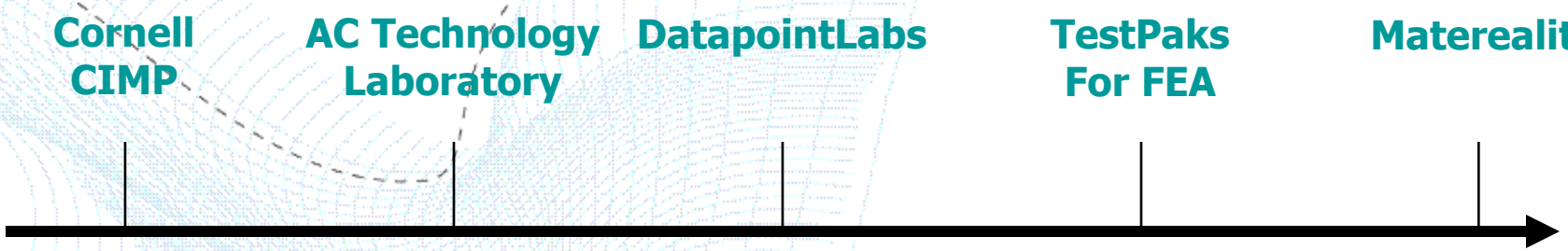
Our history



University research

Commercial lab delivers analysis-ready Data for C-MOLD

Commercial lab delivers data for process simulation

Pre-packaged tests deliver material model parameters

Material data and models stored and deployed

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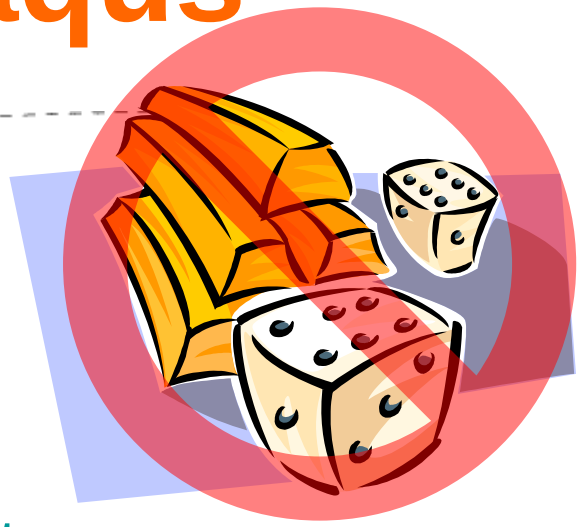
TestPaks® for Abaqus



- Simple to order
- Globally available
- Testing to Abaqus requirements
- Calibration of Abaqus material models
- Download via Matereality for Abaqus/CAE

no gamble

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Latest Innovations

- High strain rate properties to 100/s
- Non-linear elastic + plastic model-FeFp
- Equi-biaxial testing for rubber, films, foils
- 37C saline testing for *in-vivo* CAE
- Non-linear visco-elastic data for NVH
- Validated material model calibrations

The NVH problem

- Causes noise and vibration from resonance modes
  - Noise: 20 Hz – 20KHz
  - Vibration: Lower frequencies
- Structure borne or air borne
- Interaction between components

Real life NVH mitigation

- Use of damping components
  - bushings, seals, blankets, gaskets
- Materials are non-linear
  - rubber, felt, foam
- Materials are highly deformed
  - large strain

small components-big effects

Why non-linear NVH

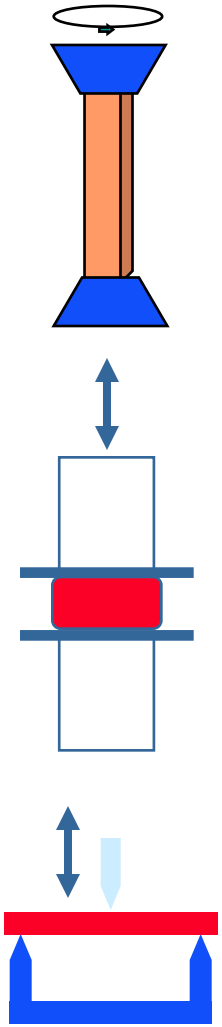
- NVH is traditionally a linear problem
- NVH mitigation components not modeled
  - Small components> big effect
- Need
  - complex material models (visco-elasticity)
  - advanced simulation (AMS+SSD)

NVH Simulation

- Mode-based FEA
  - natural vibration frequencies
  - specific vibration patterns of the structures
- Frequencies: up to 300Hz
- Abaqus recommends
  - automatic multilevel substructuring (AMS) eigensolver
  - steady state dynamic (SSD) analysis

Visco-elasticity

- Small strain theory
- Modulus is strain independent
- Can be superposed in time and temperature
- Valid to the non-linear visco-elastic limit



Non-linear visco-elasticity

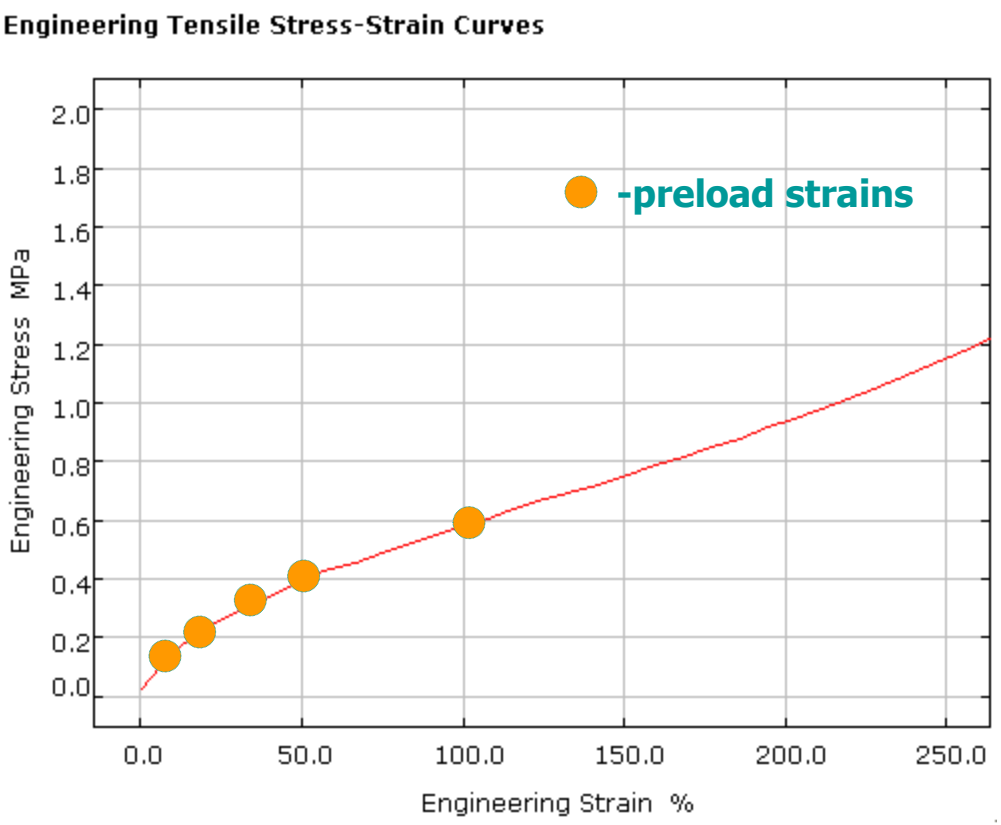
- Beyond the non-linear elastic limit
- Modulus is strain level dependent
- Linear visco-elastic theory may not apply
- Localized small strain visco-elastic solutions are possible
  - Visco-elastic data at each strain (Preload)

Simplifying assumptions

- Small dynamic strains
- Localized solutions
- Limited extrapolation capability
  - No Prony series
  - No TTS

DMA test protocol

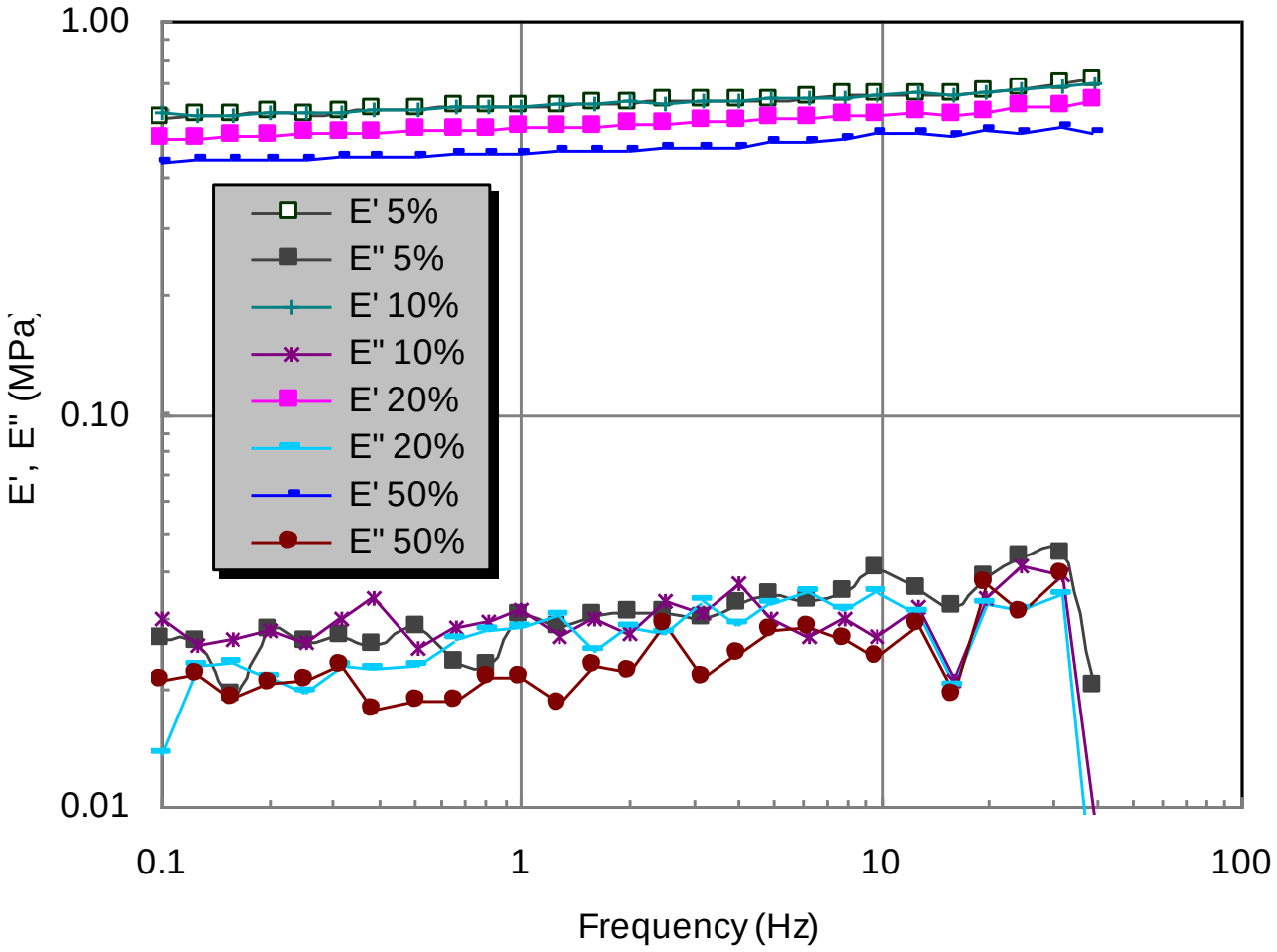
- DMA testing
  - tensile or compressive
  - uniaxial preload strain
  - frequency sweeps at each preload strain
  - dynamic strain levels are fixed
  - temperature is fixed
- Obtain E',E" f(ω,ε)



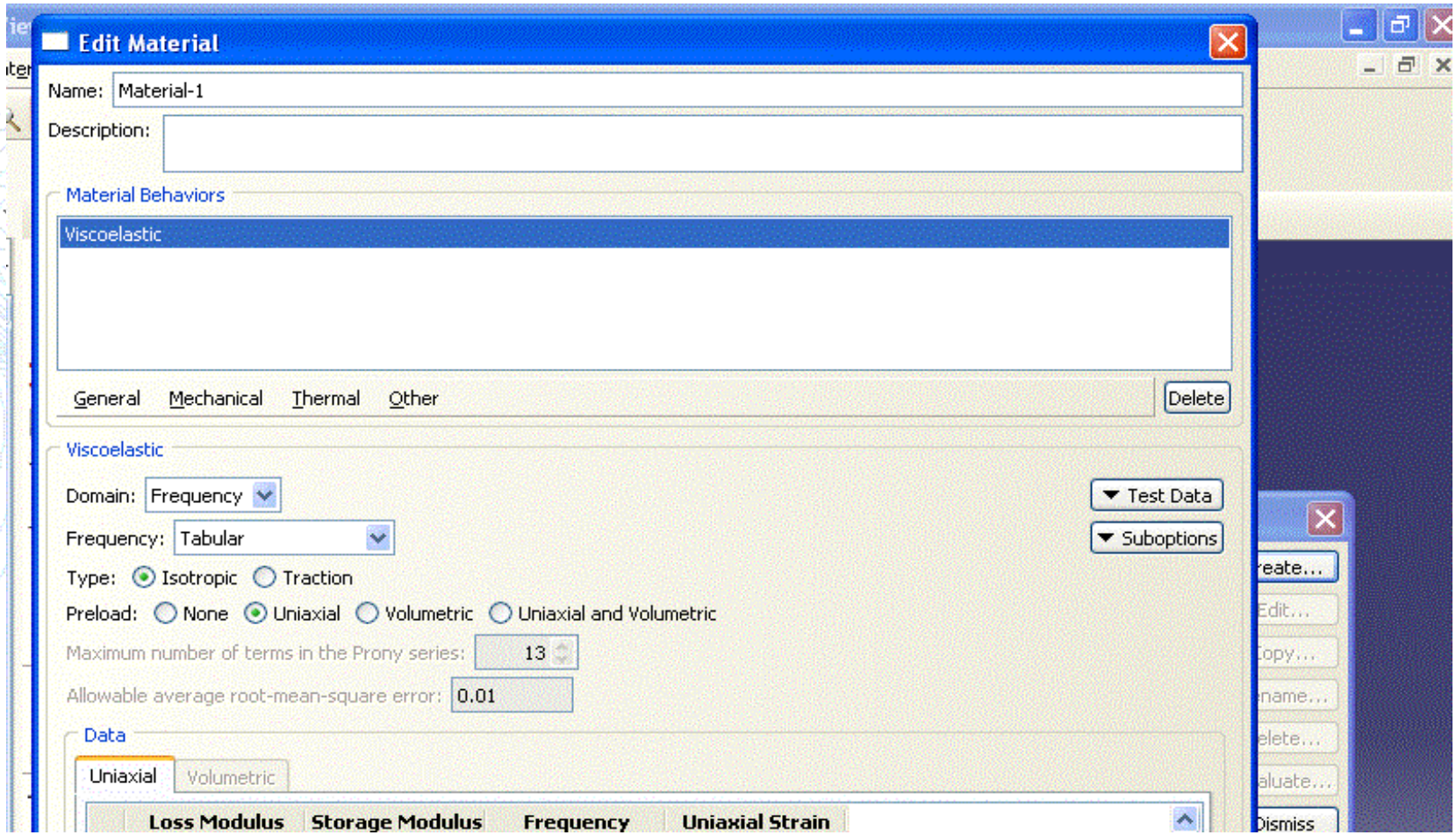
DMA Instrument

- Bose
- Tensile or compressive
- Static Strain: 5 to 100%
- Dynamic strain: 5%
- Frequency range: 0.1-100 Hz
- Temperature: -40 to 150C

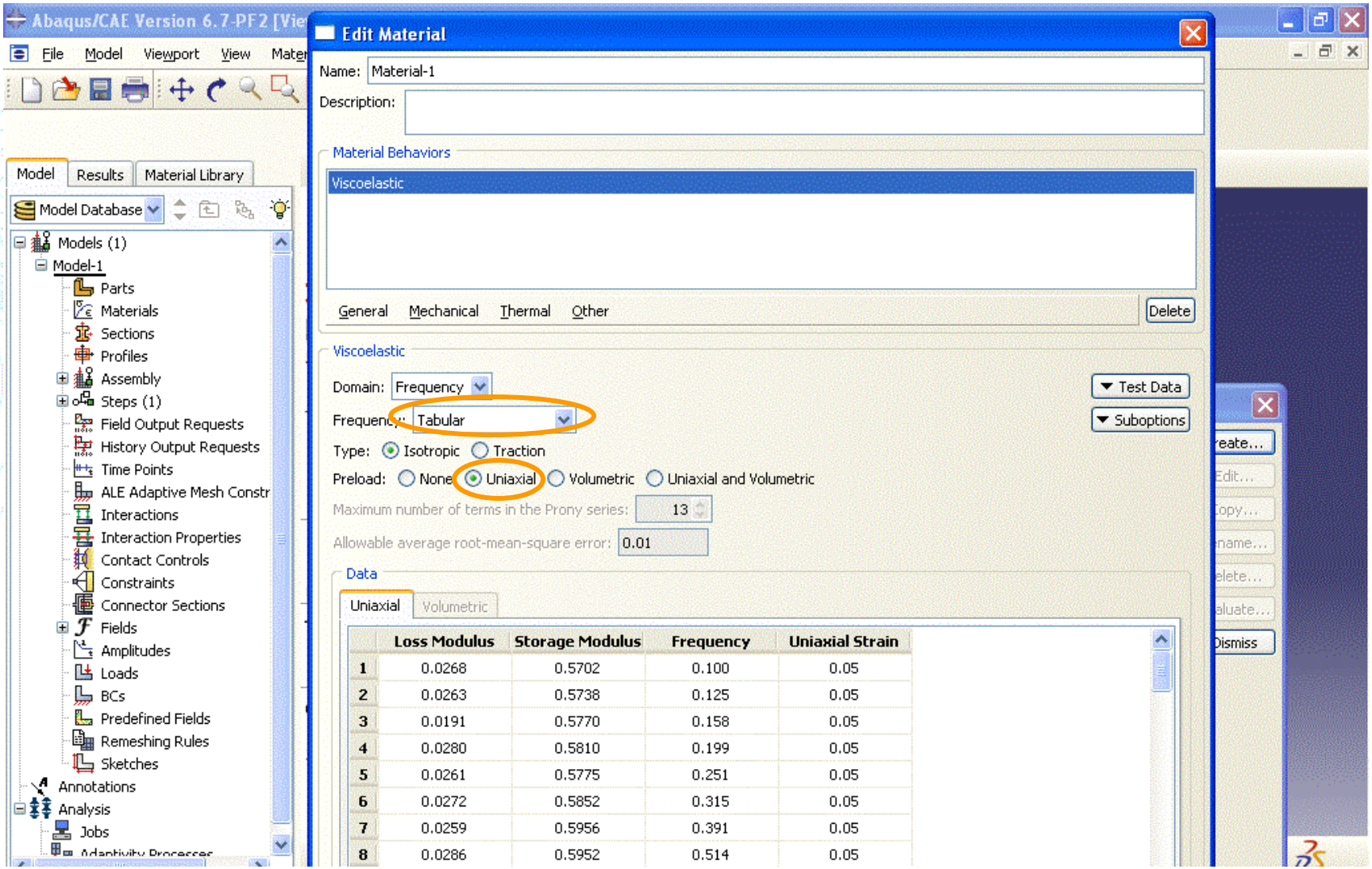
Non-linear viscoelasticity



Abaqus/CAE setup



Upload to Abaqus/CAE



More info: testpaks.com

- CAE centric materials web-site
- Focus on material modeling
- Testing for CAE / simulation
- Supported by
  - DatapointLabs
  - CAE vendors
  - Expert users

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Summary

- Major commitment to the CAE community
- Expansion into properties of all materials
- ABAQUS in-house for technical support
- Strong testing development program
  - Foam modeling
  - Biaxial film modeling
  - Crash and drop test modeling
  - Plasticity, damage, cyclic loading