Applus DatapointLabs

Material Testing and Calibration Strategies for Material Models of Polymers, Foams, and Composite Materials

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TestCart

TestPaks

CAETestBench

EST 1995

ISO 17025 Quality

OpenRadioss™

Applus, DatapointLabs & Materials Characterization

Applus Overview: **€1,558B** revenue | **23,387 staff** | **70+ countries** [2020]

Relevant Divisions:

Product Development & Validation

LABORATORIES DIVISION	IDIADA DIVISION (AUTOMOTIVE)
• Testing • Engineering • Product/System Certification • Multidisciplinary Laboratories	• Design & Engineering • Data Analysis & Simulation • Homologation Services • Testing & Proving Ground

Relevant Partner Laboratories:

Materials Characterization & Quality Assurance


USA | Ithaca


Spain | Barcelona


France | St. Etiènne


Norway | Bryne


USA | Detroit


Spain | Illescas


Germany | Bremen


China | Shanghai

DatapointLabs Summary Overview (I)

Applus DatapointLabs

- Experience
  - 27 years of experience in materials testing and characterization
  - ISO 17025:2017 accredited, operating on an end-end digital platform
  - Nadcap accredited [Aerospace / Defense] (Metallic/Non-Metallic Materials Testing)

Nadcap
Administered by PRI
ACCREDITED
Certificate# 17231205927
Non Metallic Materials Testing

- Operations
  - Testing 2000+ materials per year
  - Standard 5-day turnaround
  - Comprehensive one-stop testing capability
    - 168 unique tests: all aspects of mechanical, thermal and rheological characterization

ISO
ISO 17025

DatapointLabs Summary Overview (II)

- Capabilities
  - Materials: plastics, composites, foam, rubber, metals, additive materials, films, adhesives
  - May be characterized over a wide range of temperature and environmental conditions (elevated/cryogenic, heat aging, moisture conditioning, weathering, fluid exposure, in-vivo)
  - Characterize non-linear and post-yield behavior, dynamic situations (drop, crash, impact), hyperelasticity (rubber, foams), time-based behavior (creep, stress relaxation, viscoelasticity)

- Clientele
  - Global clientele of more than 1,800 companies in 49 countries
  - Market leader in materials testing for CAE simulation
  - Recognized as accredited materials test lab by leading OEMs

Materials Testing for Product Development

Applus+ DatapointLabs

TestCart

Comprehensive online catalog and order system for 168 unique tests characterizing physical, thermal and flow properties of materials for use in R&D and product development

metals, plastics, composites, rubber, foam, rubber, films

[redacted]

TestPaks®

Material testing and material parameter conversion to generate 179 material cards for 36 simulation (CAE) programs, including finite-element analysis, crash and drop-test simulations, injection-molding and other process simulations

[redacted]

CAETestBench™

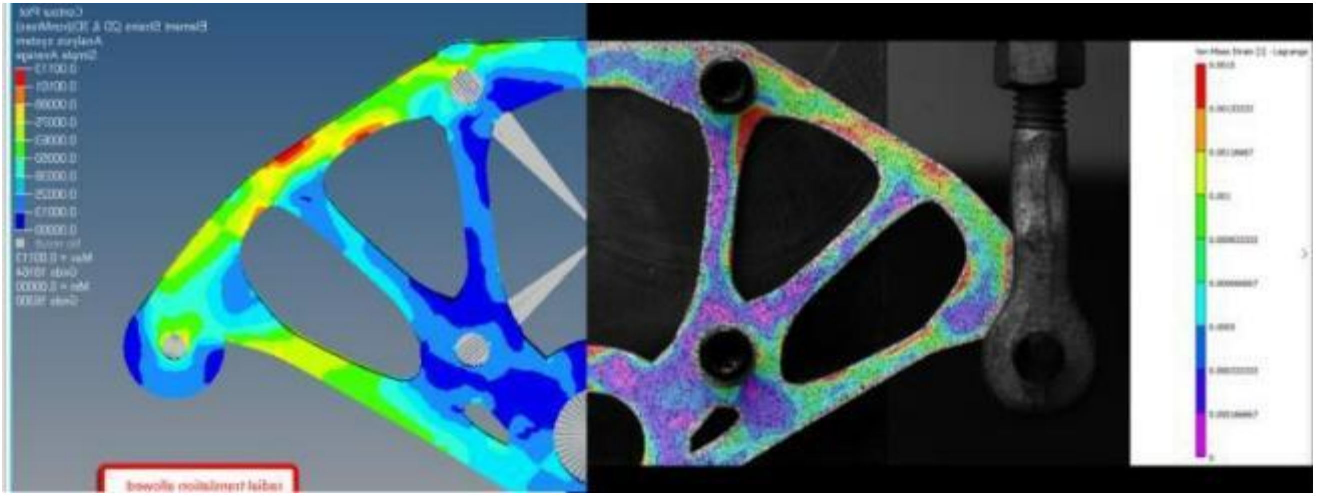
Validate your simulation against a physical part, created and tested using a rigid protocol, which can be accurately replicated in your solver – probe simulation accuracy and quantify its ability to replicate the test

Validations range from simple tensile modes to more complex, multi-axial modes, impact and failure

[redacted]

Why material models matter

- Tailored material models are essential to ensure simulation results closely match real-world material behavior
- Untailored models can lead to inaccurate predictions → costly design failures or over-engineering
- Reduced need for physical testing → faster product development

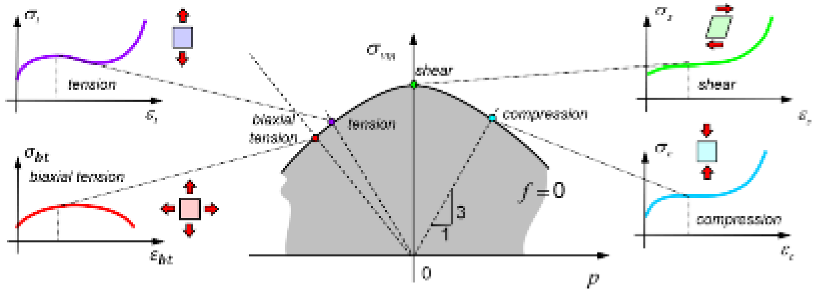


The Three Material Classes

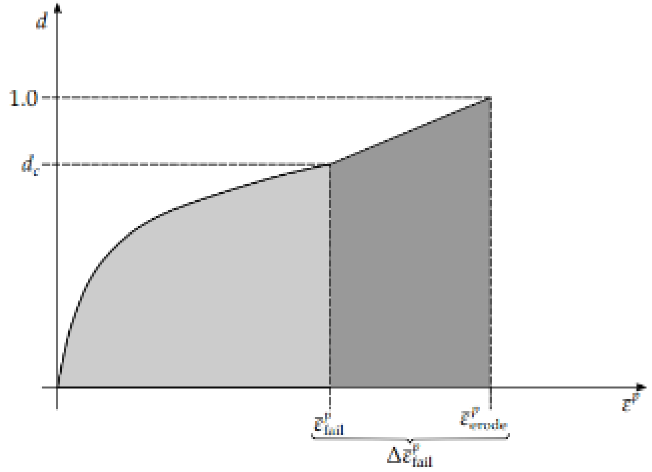
Material	Key properties	Simulation Challenges	Applications
Polymers 	Lightweight Ductile Viscoelastic Temperature Strain-rate sensitive	Nonlinear deformation Strain-rate dependency Damage evolution	Car bumpers, packaging, medical devices
Foams 	Compressible Energy-absorbing Elastic region Plateau region Densification region	Capturing large Deformations Rate sensitivity Low Poisson's ratio	Helmet padding, vehicle interiors
Composites 	Anisotropic High strength-to-weight ratio Layered structure Brittle failure	Multi-directional stiffness Damage progression Delamination	Aircraft fuselages, drone arms, blades

Material Models

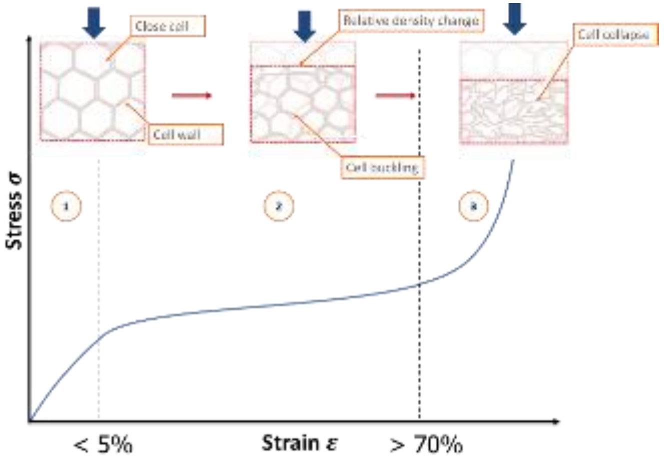
LAW76 SAMP



Yield surface as function of pressure

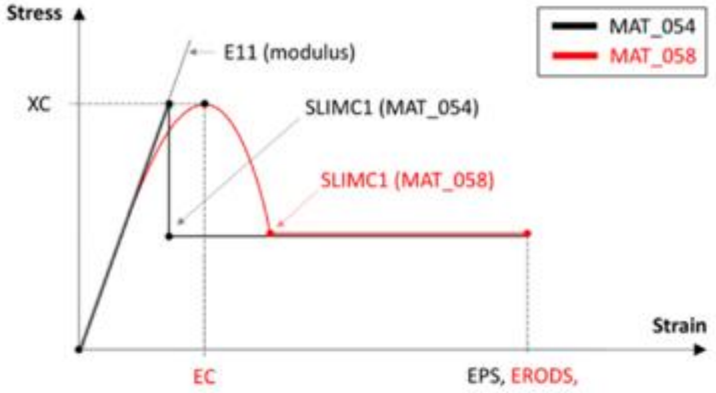


LAW70 Foam_Tab



Compression response of foam materials

MAT058 model for CFRP*



Damage evolution of MAT058 vs MAT054

*LSDYNA model

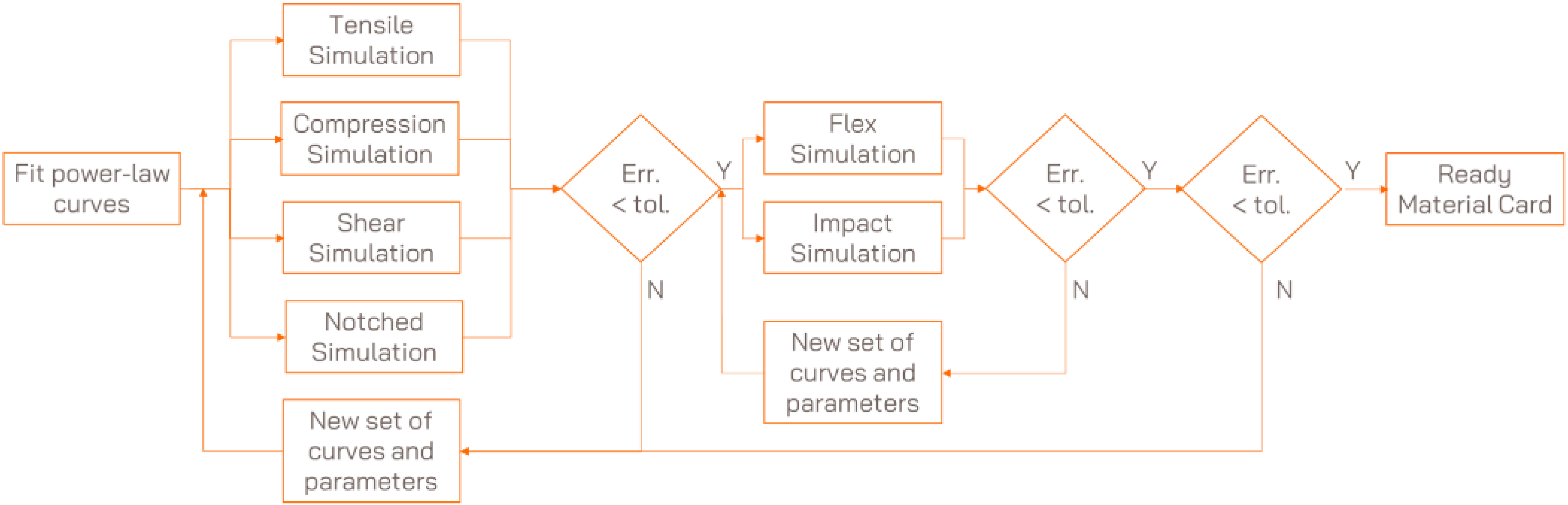
Calibration workflow: Polymers

Optimization process required

Strain-rate Model

Calibration of the yield surface

Material card formatting

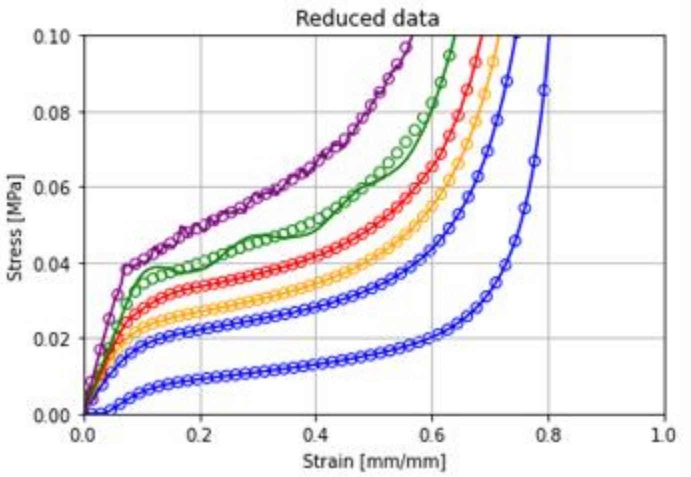


For more details about this work, please visit
https://www.knowmats.com/Post/View/1206

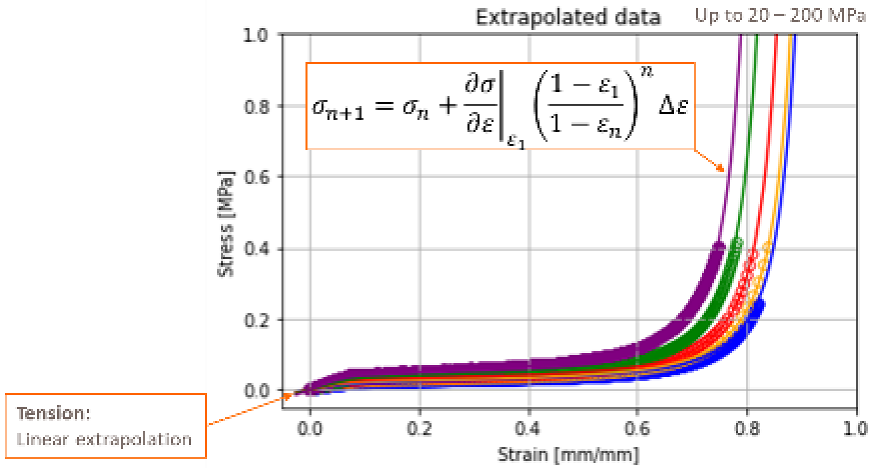
OpenRadioss™

Calibration workflow: Foams

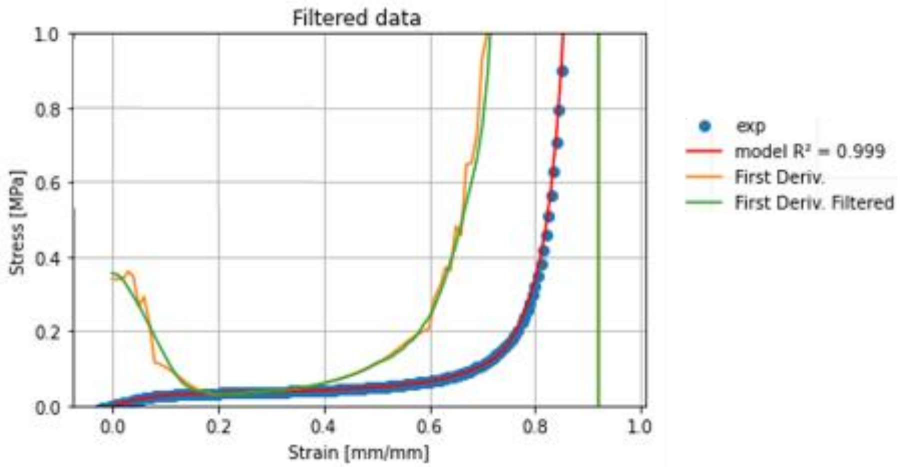
Reduce the data



Extrapolation



Filtering the first derivative



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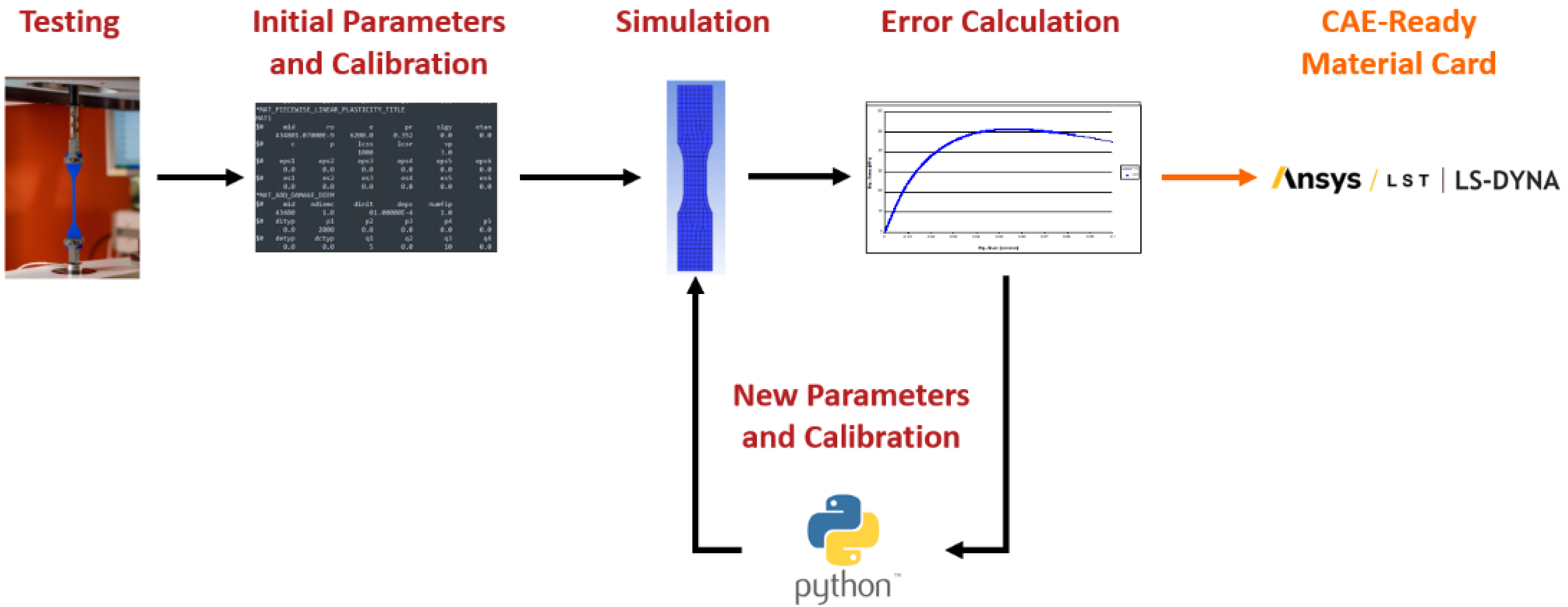
Calibration workflow: Composites

Optimization process required



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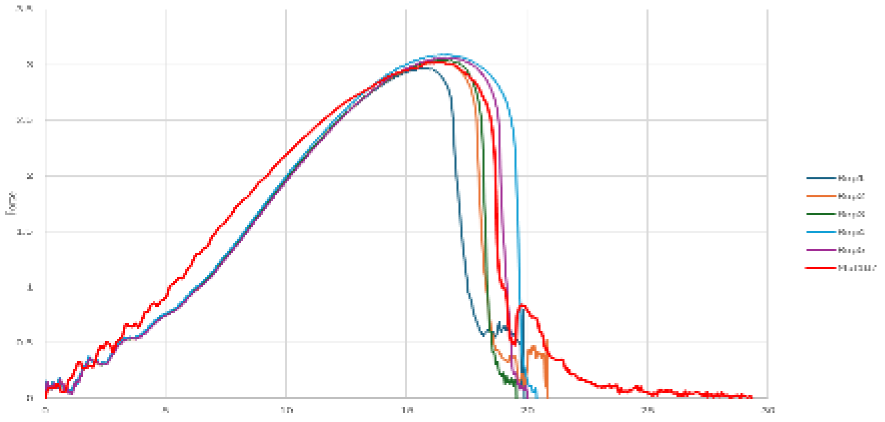
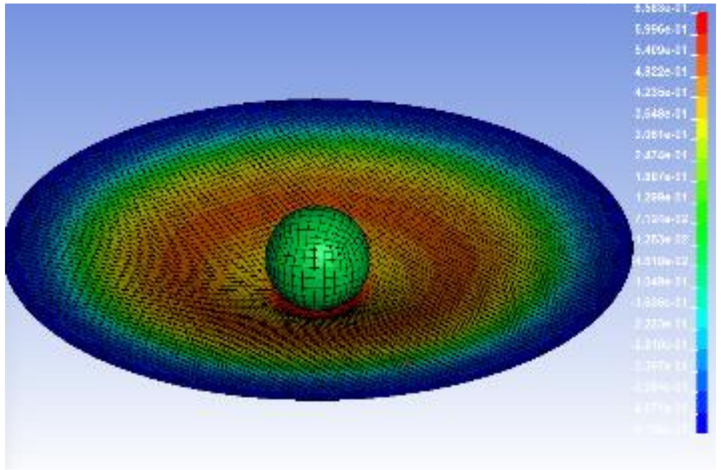
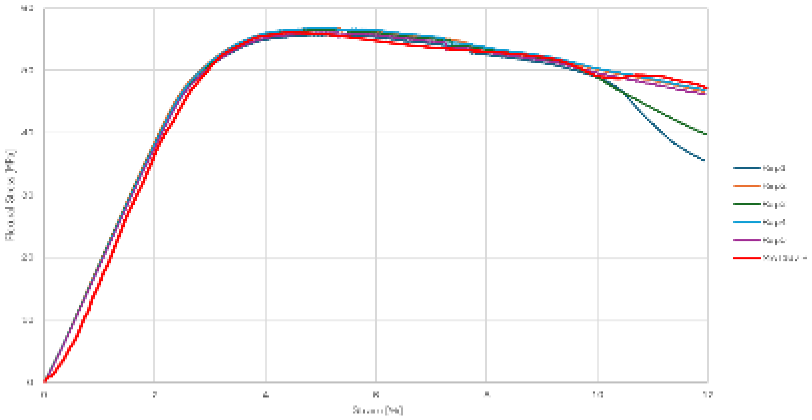
Validation: Polymers

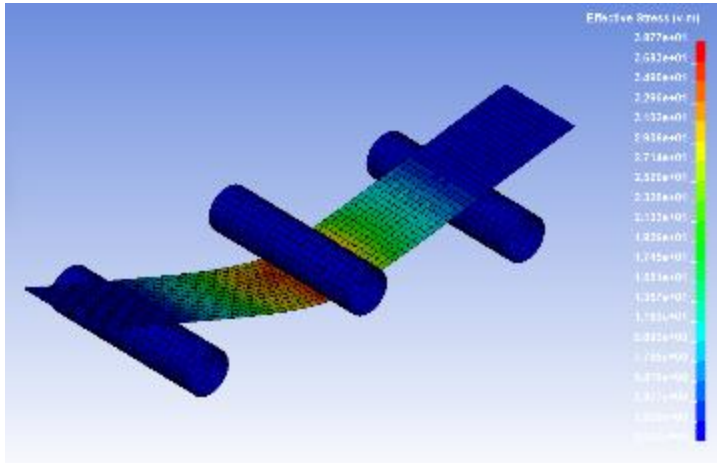
Impact Test





Flexural Test





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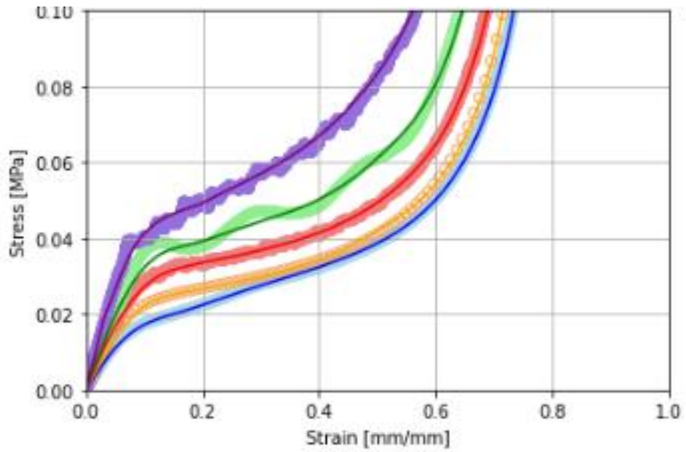
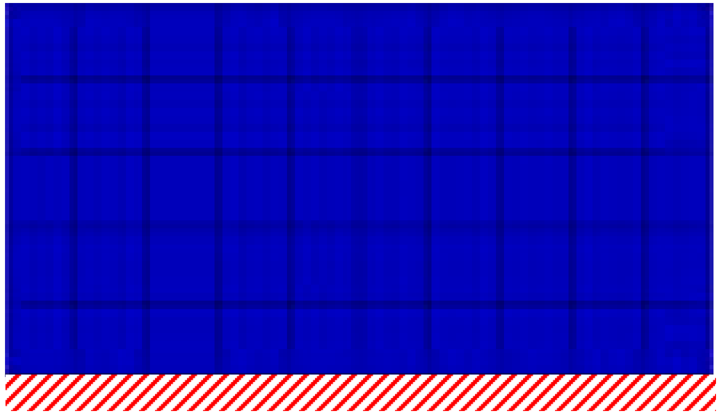
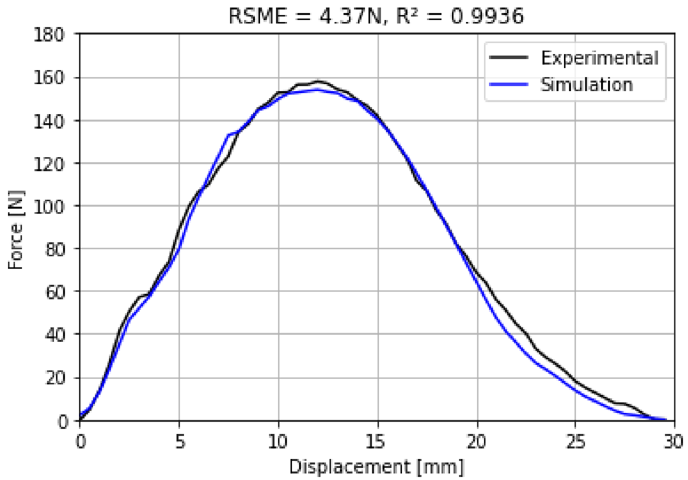
Validation: Foams

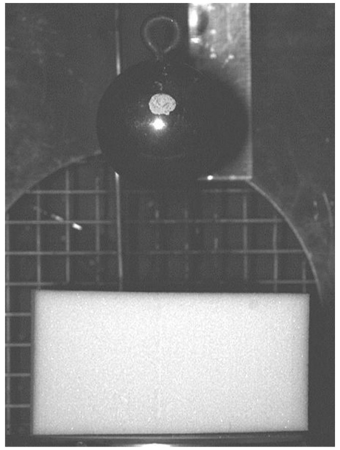
Compression Test

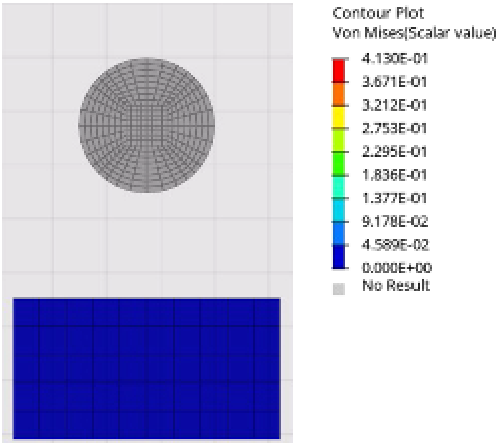




Impact Test







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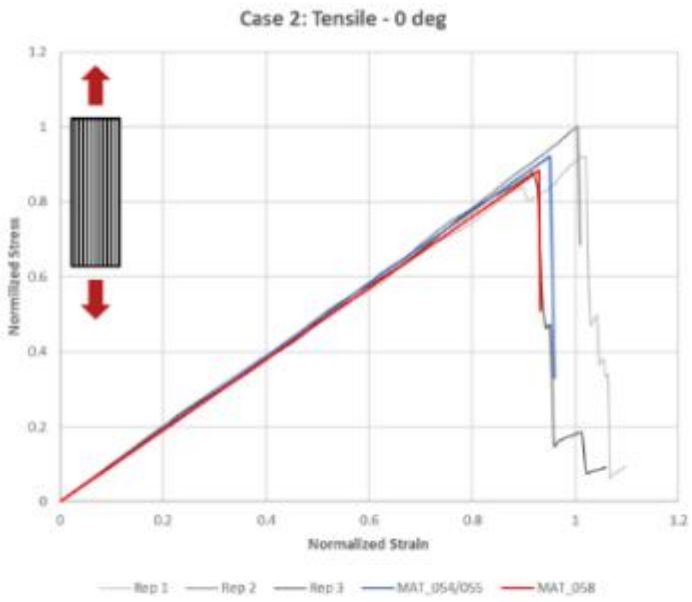
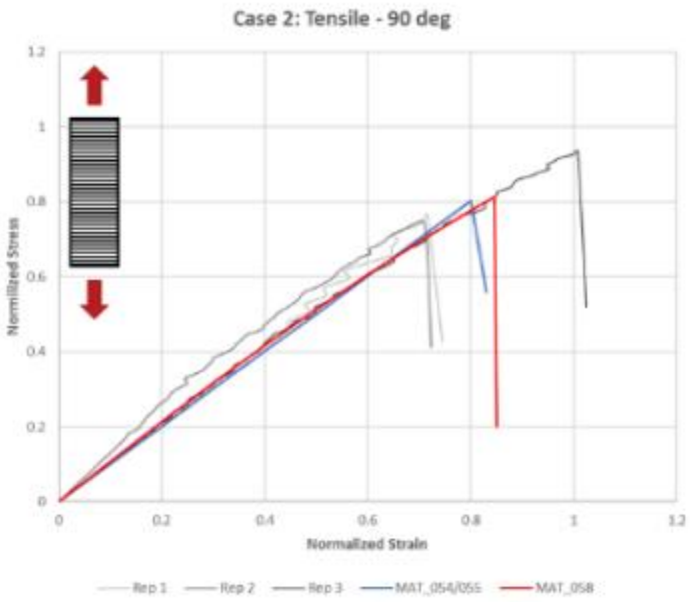
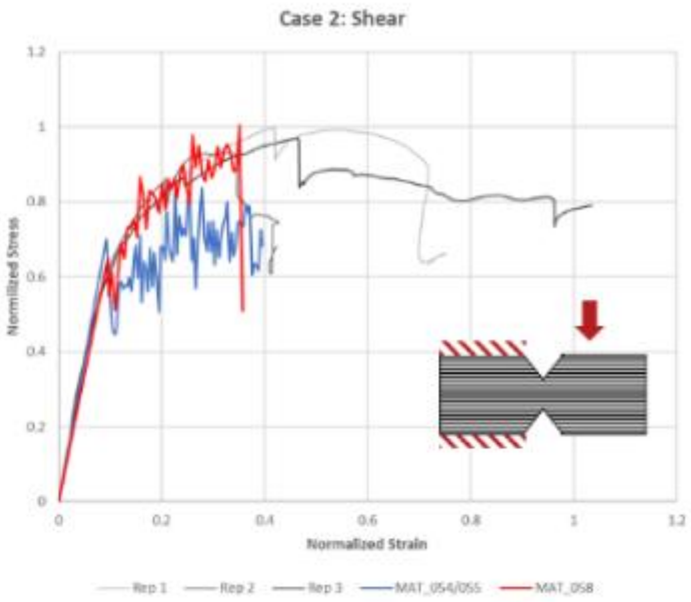
Validation: Composites

Pure modes validation for each orientation







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Summary of findings

Material	Key Calibration Challenges	Best Practices & Lessons Learned
Polymers 	Strong strain-rate dependence Damage evolves progressively Yield surface needs multi-axial data	Use DIC + high-speed cameras to capture full-field strain under dynamic load Include notched tests to define hydrostatic stress behavior Iteratively refine yield surface using inverse modeling
Foams 	Large deformations and densification behavior Rate sensitivity varies non-linearly Difficult to extract tension data	Focus on compressive and impact testing Fit rate-dependence with power/exponential laws Use extrapolation methods Use the first derivative filtering technic
Composites 	Anisotropic properties require directional testing Complex failure modes (fiber, matrix, delamination) Model needs ply-level & laminate-level accuracy	Perform tests in 0°, 90°, ±45° Use failure surface theories like Chang-Chang, Tsai-Wu Validate with impact & delamination-sensitive tests

Thank You!

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