CHARACTERIZING WOOD-PLASTIC COMPOSITES VIA DATA-DRIVEN METHODOLOGIES

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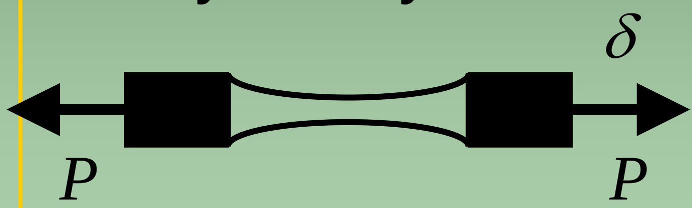
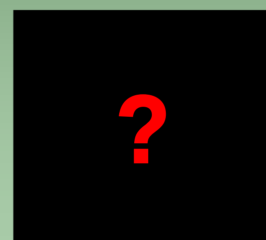
Operational Philosophy

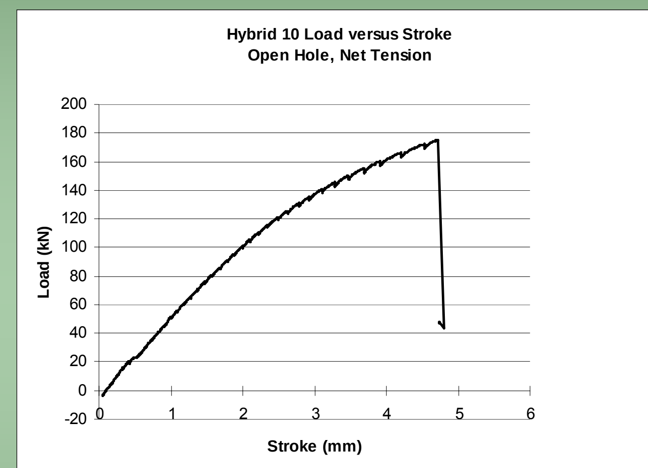
Physical World

External Appearance	Internal Appearance	Behavior Appearance

Physical System







P

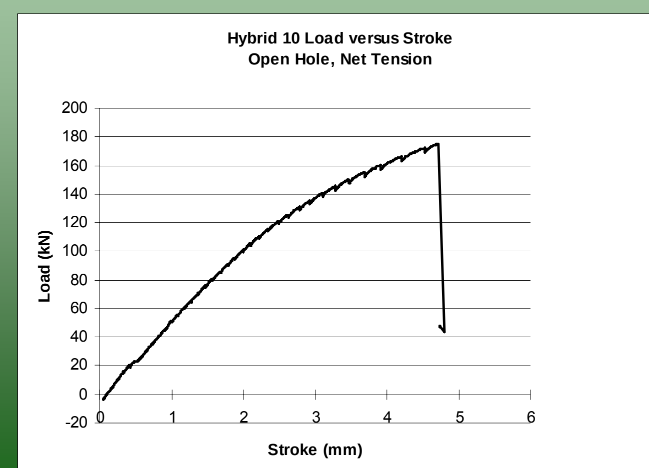
Conceptual World

Modeled System

$$R(P,\delta) = 0$$

$$P(\delta)$$

$$\delta(P)$$



Operational Philosophy

- Measure first, then Model (Data driven Modeling)
- Interpolate, NOT Extrapolate
- Locally flat Parameter Spaces (Continuity of parameters)
- Work only with commonly accepted composition rules
- Automate, then Apply

Operational Philosophy

Technology Pull

- Computational Technology
- Automation
- Computational Symbolic Math
- Automated Software Synthesis

Operational Philosophy

- Application Push
- Realistic Systemic Simulation/ Prediction
- Inexpensive Material Qualification/Certification
- Quick Material Insertion
- Rapid Prototyping and Production

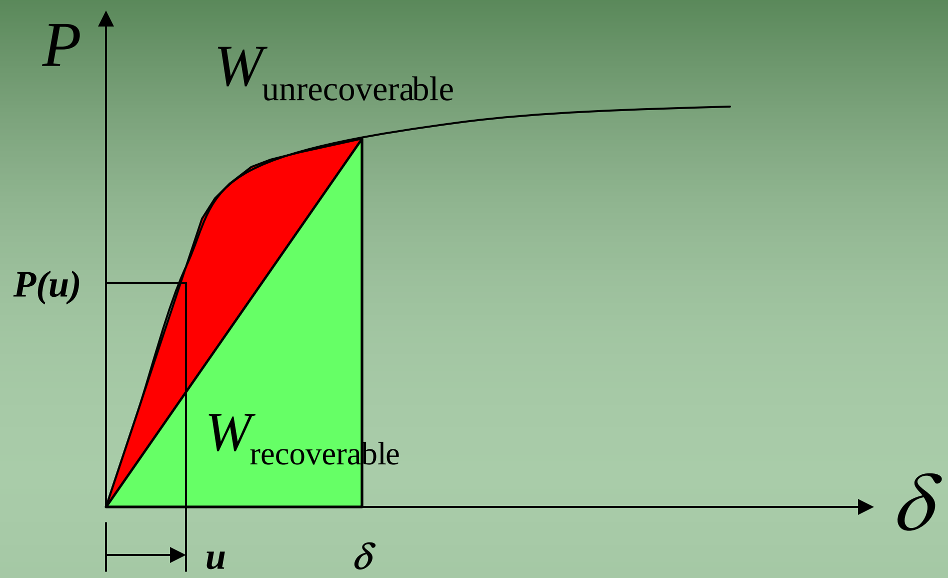
Motivation (Producer's View):

- Rapid and inexpensive characterization of new materials
- Utilization of existing material behavior databases constructed from massive automated testing
- Automated synthesis of material behavior theories and finite element models for structures of interest
- Studies of material/structural behavior as a function of operational system requirements

Motivation (Producer's View):

- Optimization of structural design and final prototype manufacturing based on interactive concept formation processes by the users
- To encapsulate physical reality in the form of errorless predictive models of WPC behavior.
- To package these models in useful products in the form of synthetic simulation environments for domain experts to apply their expertise in an enhanced mode for solving realistic problems.

Dissipated Energy Computation



$$W_{\text{Total}}(\delta) = \int_0^{\delta} P(u)du$$

$$W_{\text{recoverable}} = \frac{1}{2} P(\delta)\delta$$

$$W_{\text{unrecoverable}}(\delta) = W_{\text{total}}(\delta) - W_{\text{recoverable}}(\delta)$$

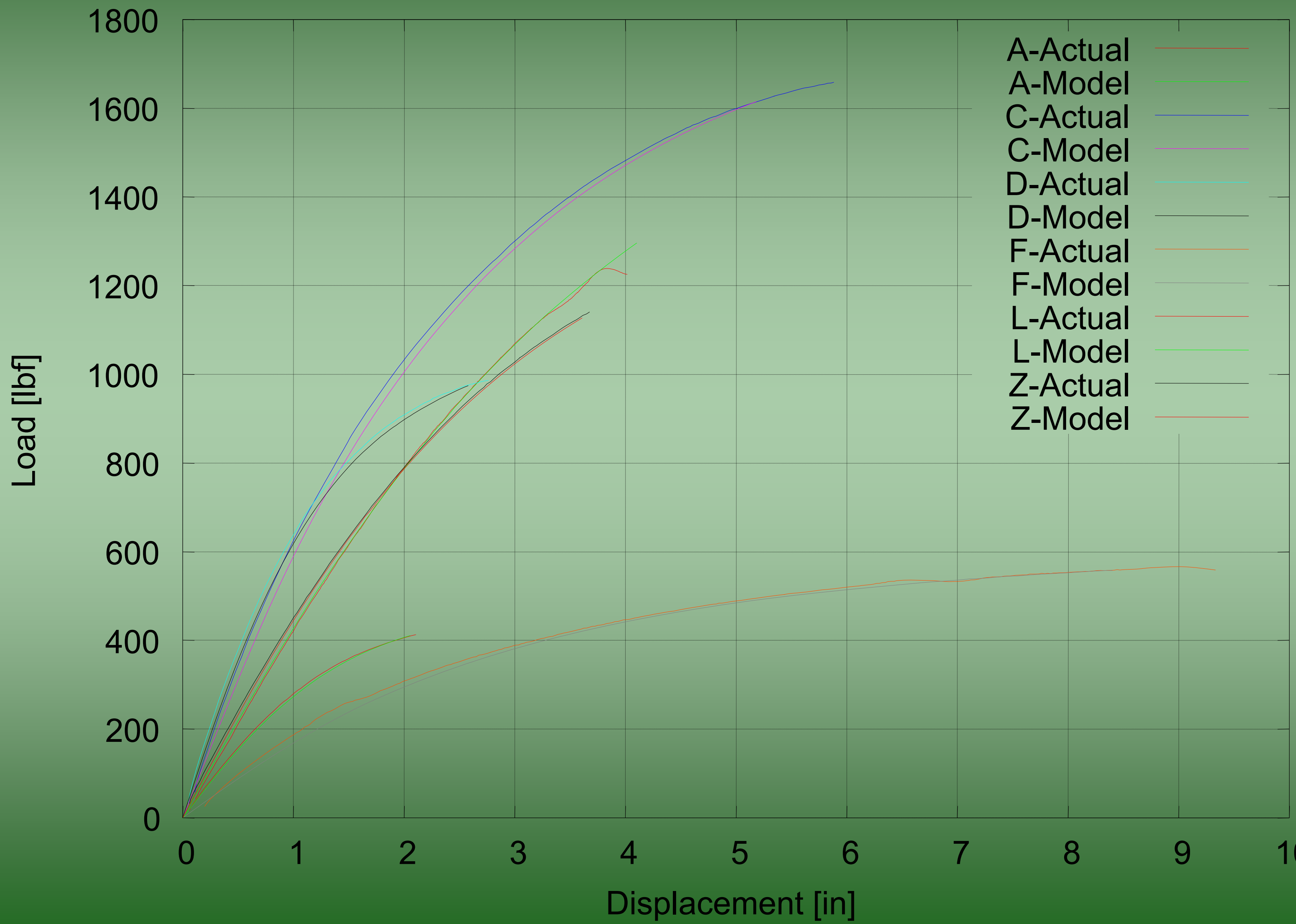
$$W_{\text{unrecoverable}}(\delta) = \int_0^{\delta} P(u)du - \frac{1}{2} P(\delta)\delta$$

Uniaxial Material Characterization

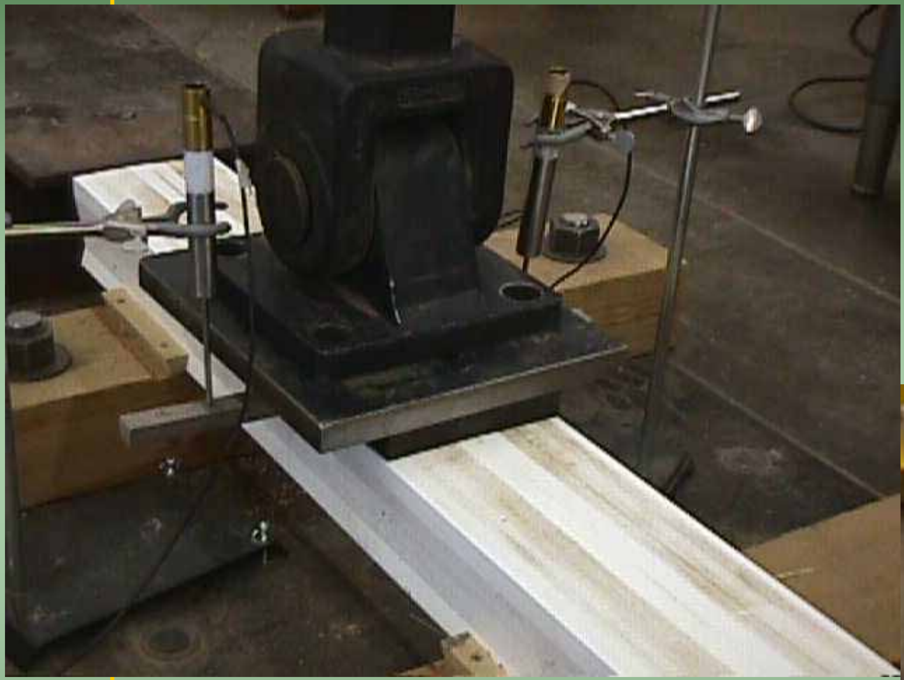
Specimens:

- Compression
- Tension
- Flexure
- V-notch
- Torsion

Uniaxial Results



Uniaxial Results



Design Load = 88964 N

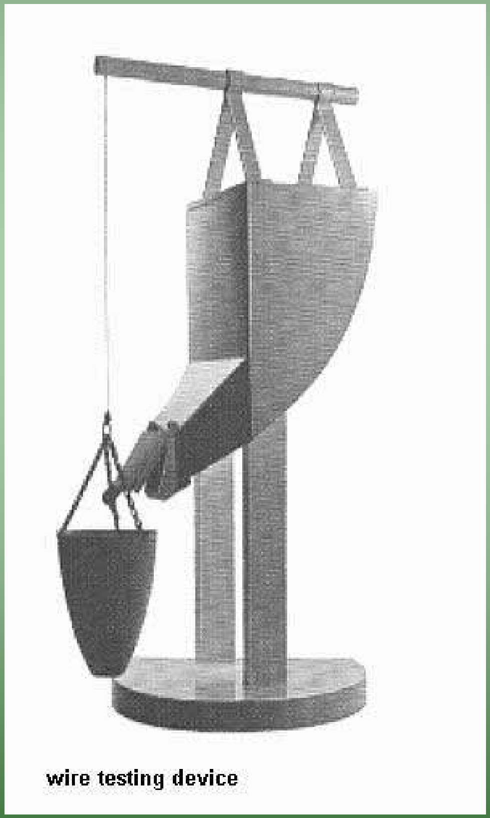
Actual Load = 88995 N

COV = 3.6%

3 DOF Implementation

Leonardo da Vinci (1452-1519)

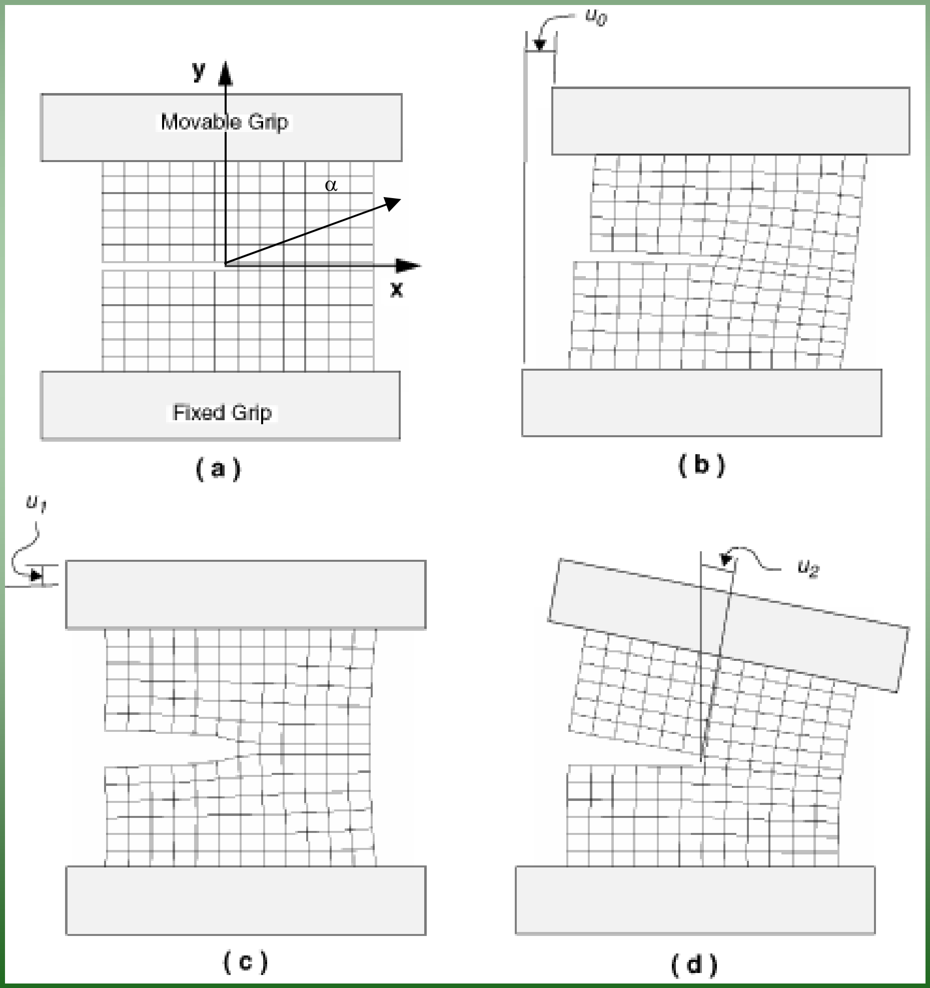
"Testing the Strength of Iron Wire of Various Lengths"



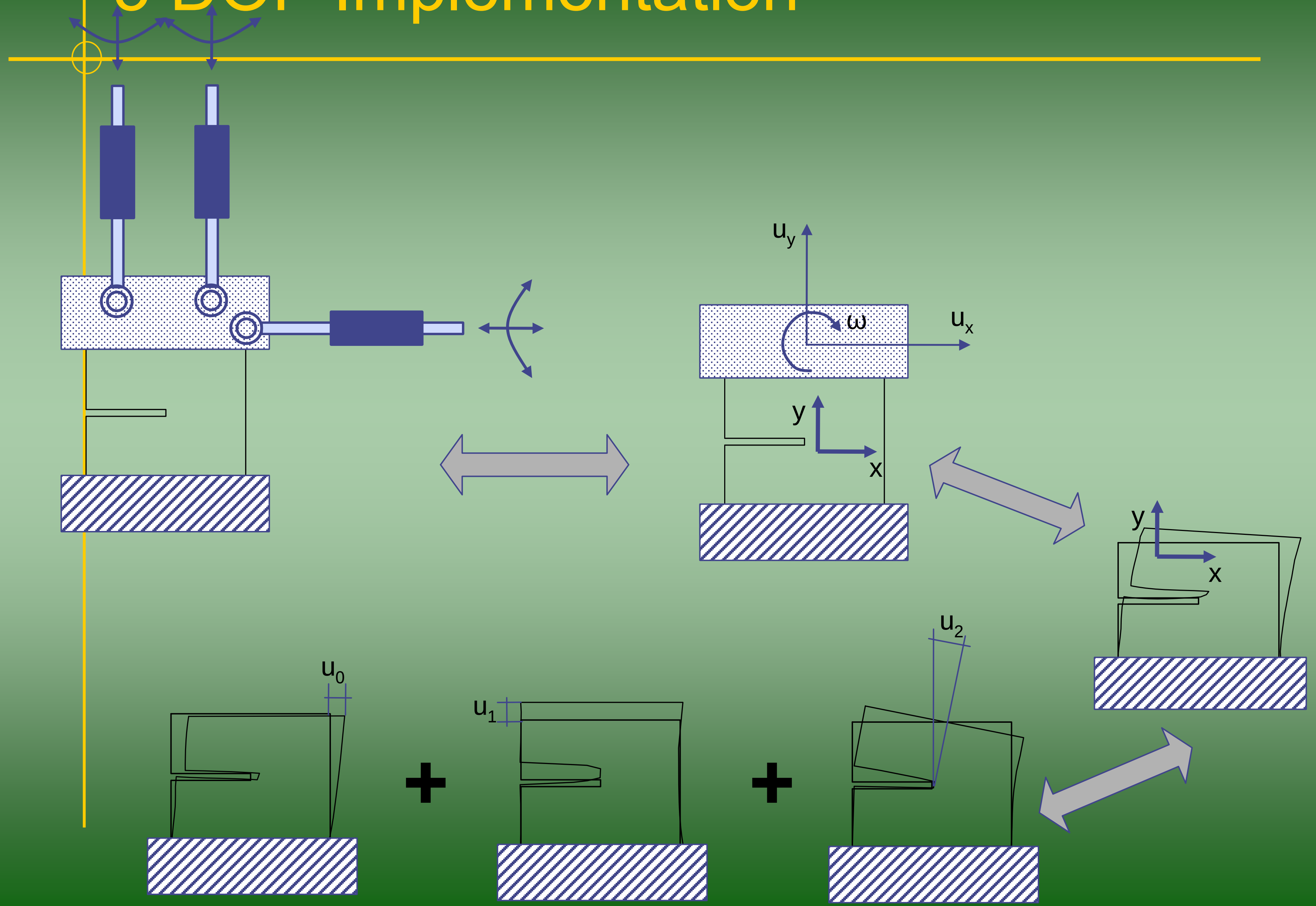
from Timoshenko, "History of Strength of Materials"

3 DOF Implementation

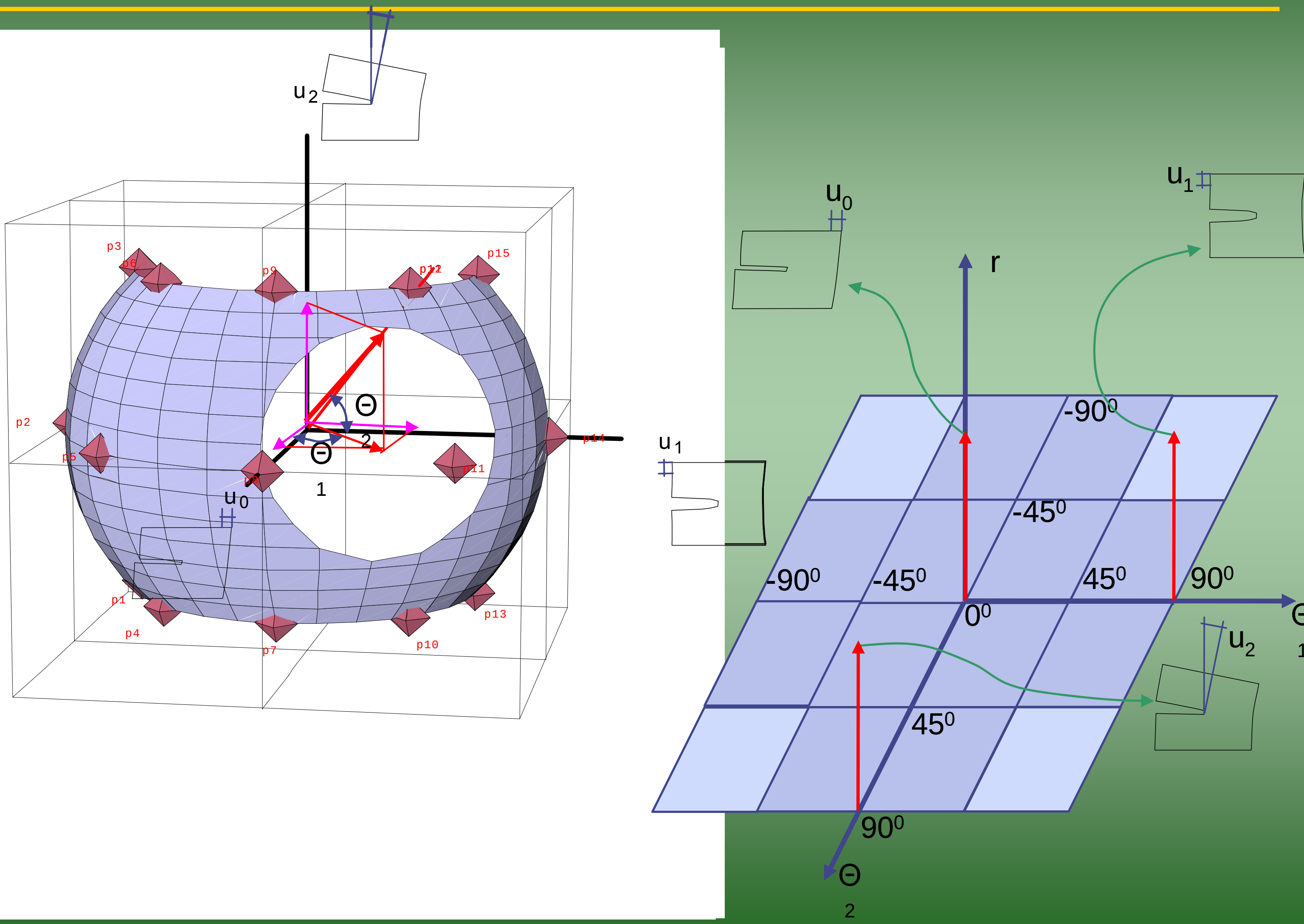
Systematic Material Identification, 3 DOF Motions:



3 DOF Implementation



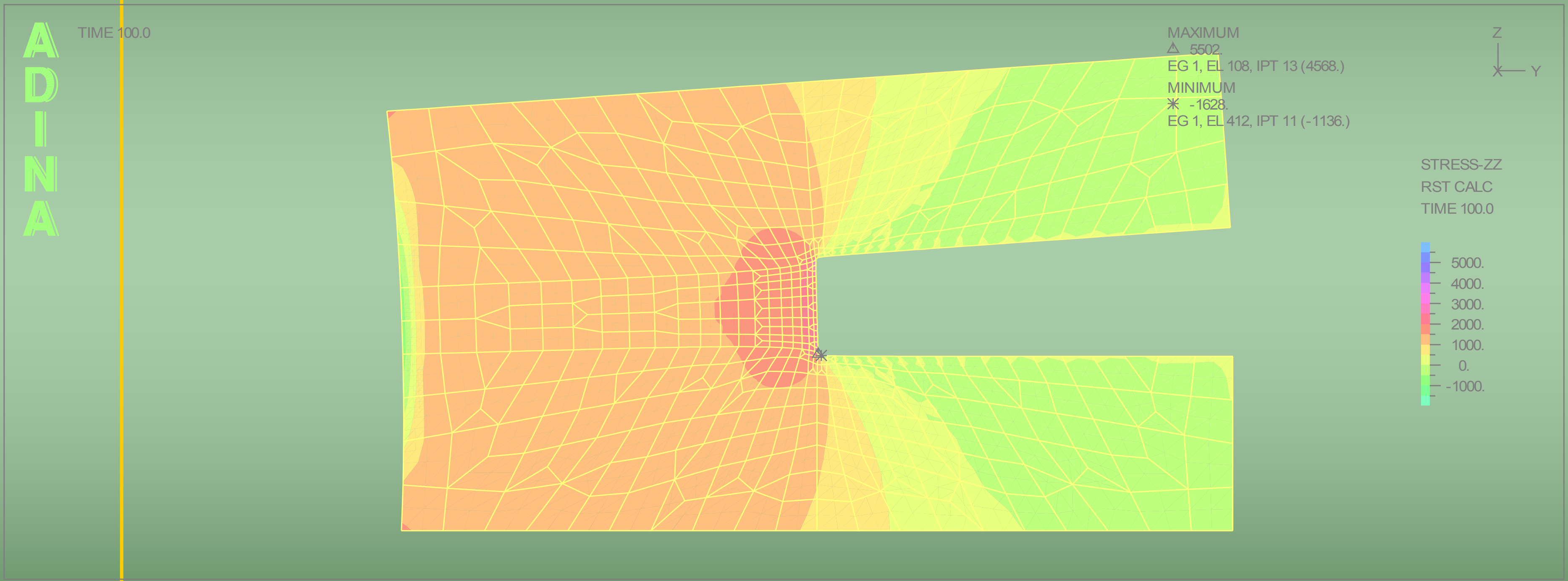
3 DOF Implementation



3 DOF Implementation

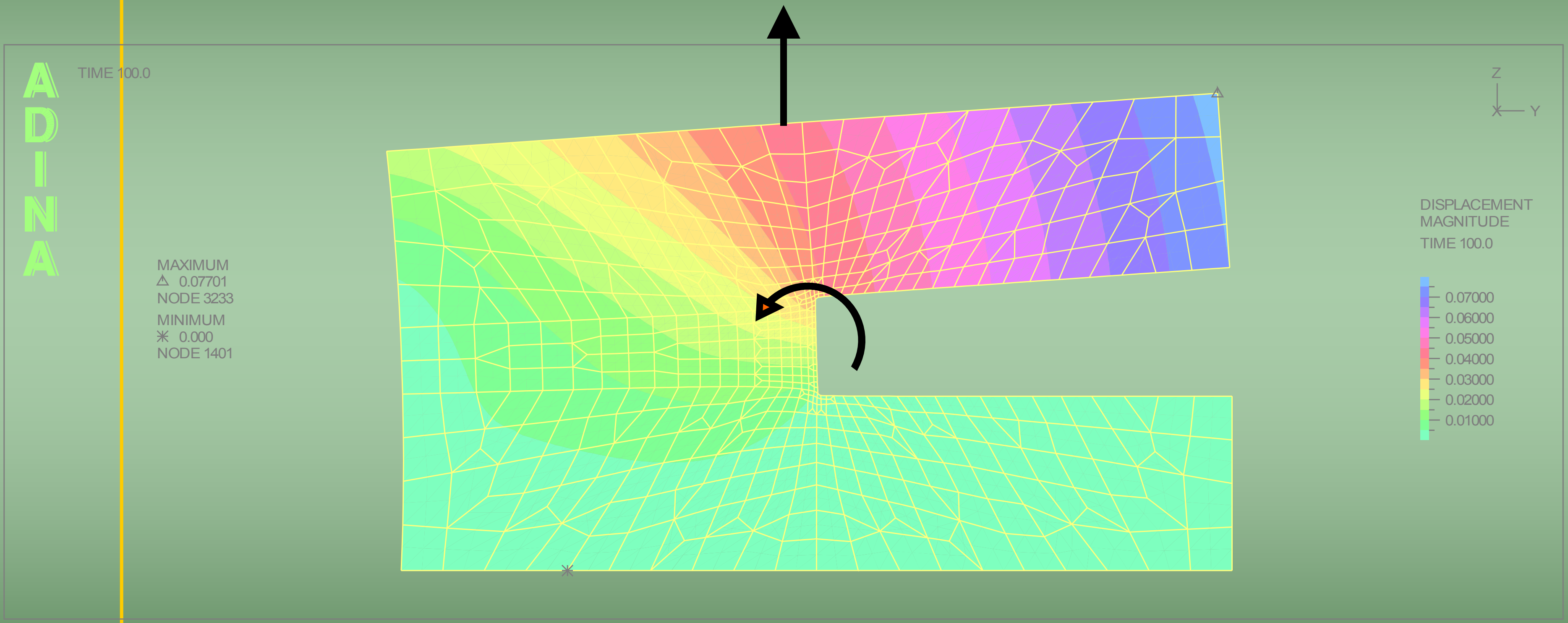
3 DOF Model

Stress in the vertical direction

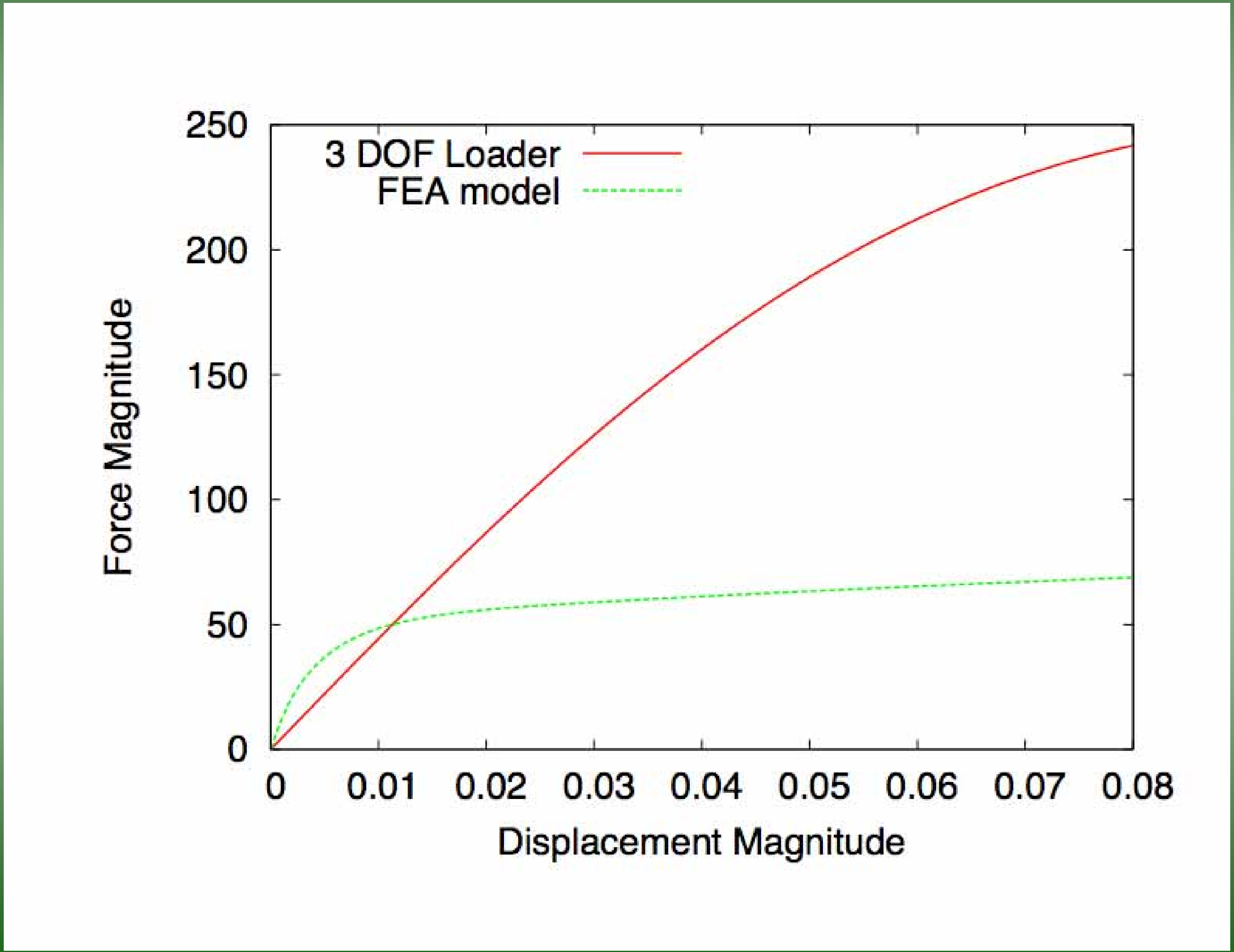


3 DOF Model

Displacement Magnitude



3 DOF Loader Results



6 DOF Loader

Conclusions

- Data driven methodology works extremely well when used to interpolate data.
- CANNOT be used to extrapolate
- Multiaxial states of strain is an extrapolation from uniaxial tests
- Testing hardware and software is being developed to determine the create data-driven information

Questions?

Nothing in Nature is random. ... A thing appears random only through the incompleteness of our knowledge.

Spinoza