ESS 411/511 Geophysical Continuum Mechanics Class #2

Highlights from Class #1 – Zoe Kraus
Today's highlights on Monday? – Maleen Kidiwela

Warm-up question (break-out) – Traffic on Interstate 5 as a continuum problem

- suggest a value for averaging length *r*
- Why?

Class-prep answers (break-out)

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For Monday class

- Read Raymond Notes Ch 2, (2.3 – 2.8).
- (Focus on the 1-D model descriptions, not the Earth properties yet)

I am also preparing a short CR/NC writing assignment (1 point) in Canvas (Assignment Group - Pre-class prep).

- It will be due in Canvas at the start of class.
- I anticipate the whole thing will be around ~half a page.
- The goal to help us get into the topic, and the points from this and similar exercises will contribute to class participation grades.
- The writing assignment should help you to be prepared to discuss what you see as the key feature of a spring, and of a dashpot, and to be prepared to discuss stress, strain, and elastic behavior.

- I will send another message when it is posted in Canvas.

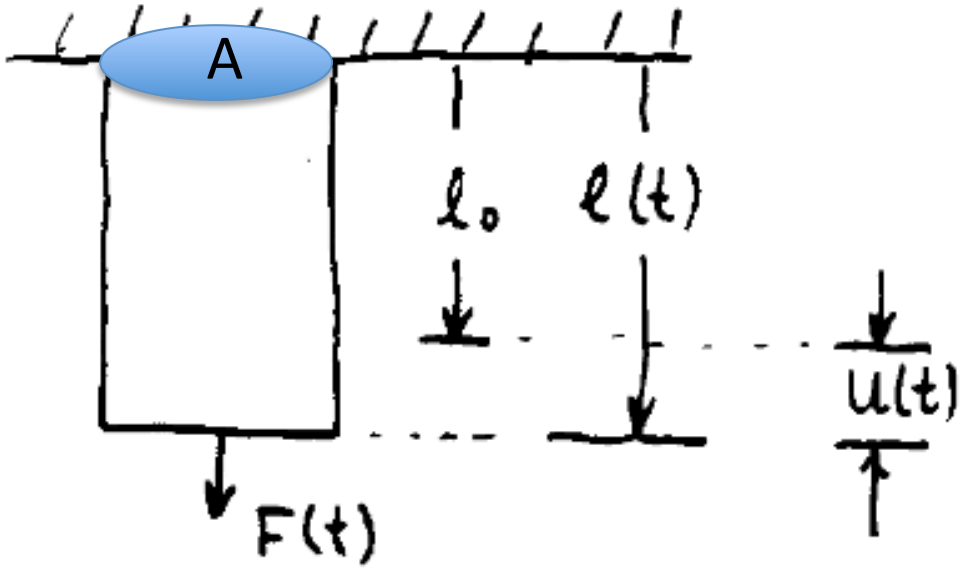
Dealing with a continuum

Environment	**The continuum**	**How it responds**
• Temperature T	Material properties	Constitutive properties
• Pressure *P*	• density ρ	• thermal conductivity
• Force ***F***	• charge state E	• electrical conductivity
• Electromagnetic ***H,B,E***	• magnetization state	• elastic constants
		• Viscosity
		• magnetic permeability

Force *vs* stress in 1-D

- $F(t)$ applied force
- l_0 initial length
- $l(t)$ deformed length
- $u(t)$ elongation

- A cross-sectional area



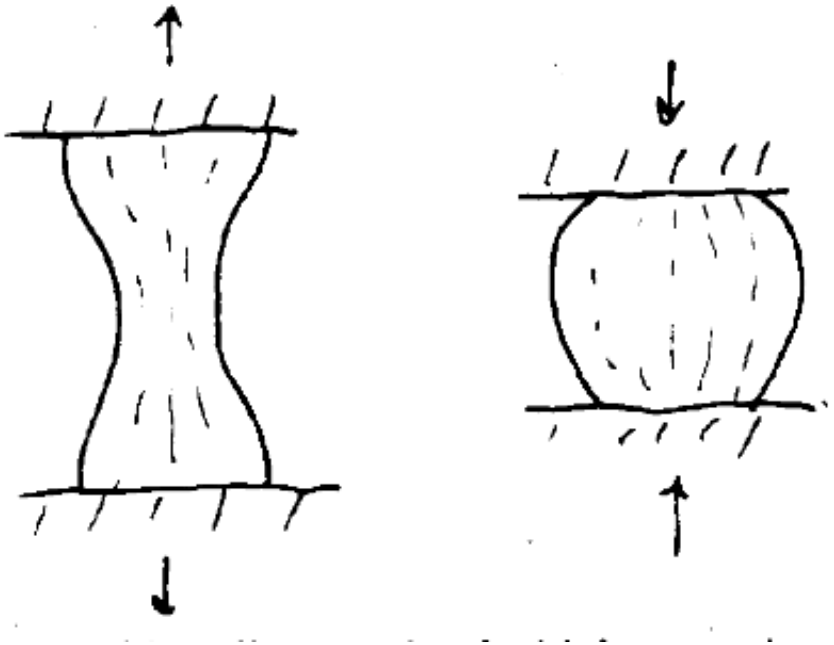
We want to discover relationship between force and response (shape change) independent of the geometry.

- **Stress** is force per unit area $\sigma(t) = \mathbf{F}/A$
- **Strain** is *fractional* elongation $e(t) = u(t)/l_0$

- Goal is to relate σ and e independent of geometry

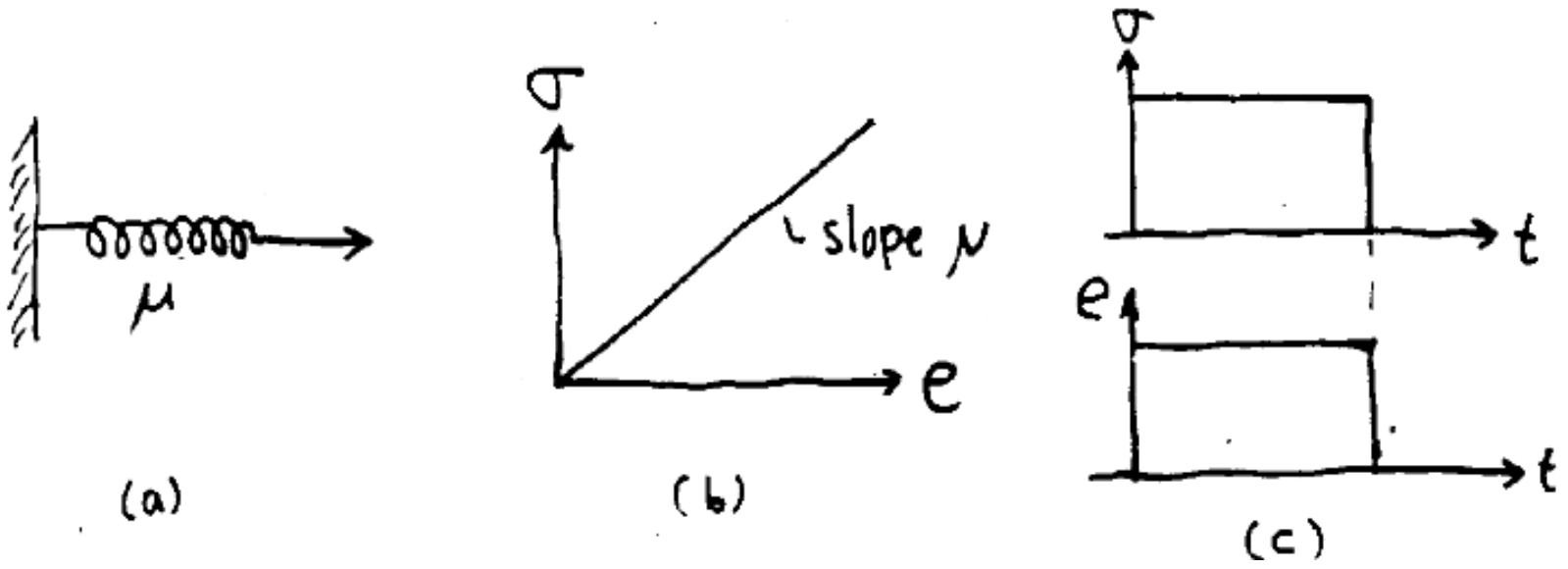
Issues

- Large strains – necking (no, not that necking)
- Silly-putty demo
- What happens to total force in the neck?
- What happens to stress in the neck?



Linear Elastic Behavior – Hookean solid (an idealization)

$$\sigma(t) = \mu\, e(t)$$



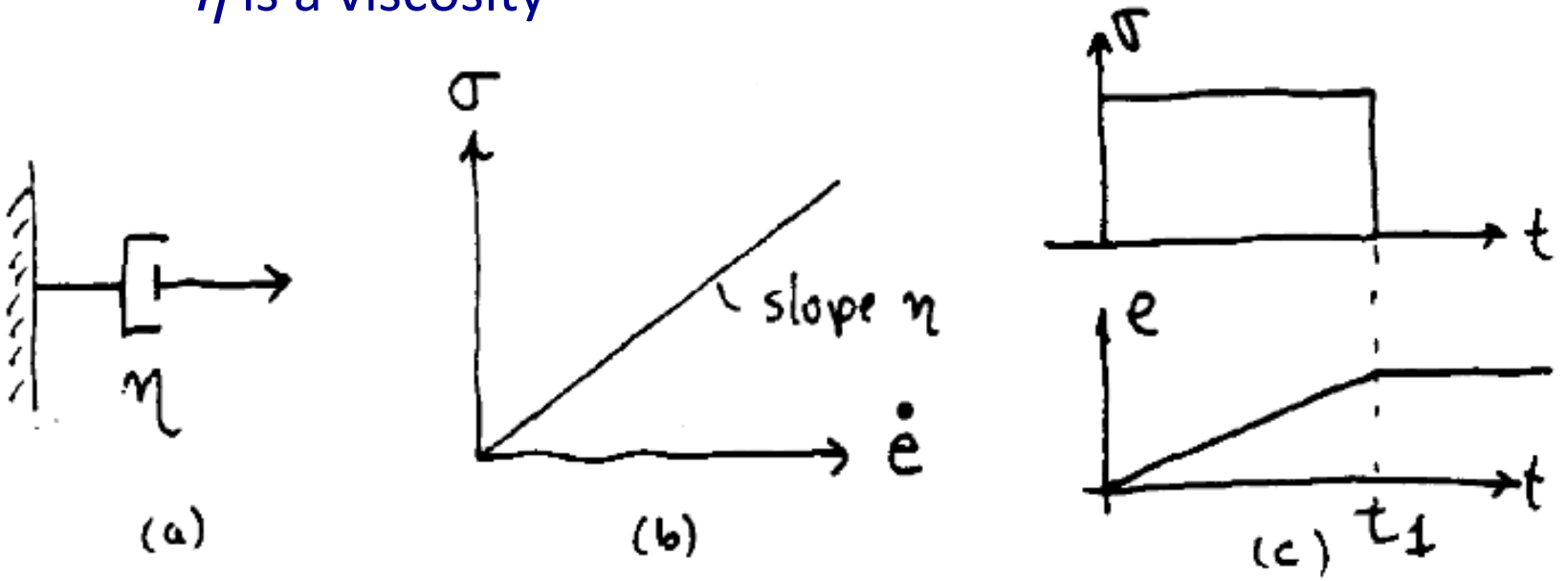
Linear viscous Behavior – Newtonian fluid (an idealization)

$$\sigma(t) = \eta \dot{e}(t)$$

The dot indicates a time derivative

$\dot{e}$ is a strain *rate*

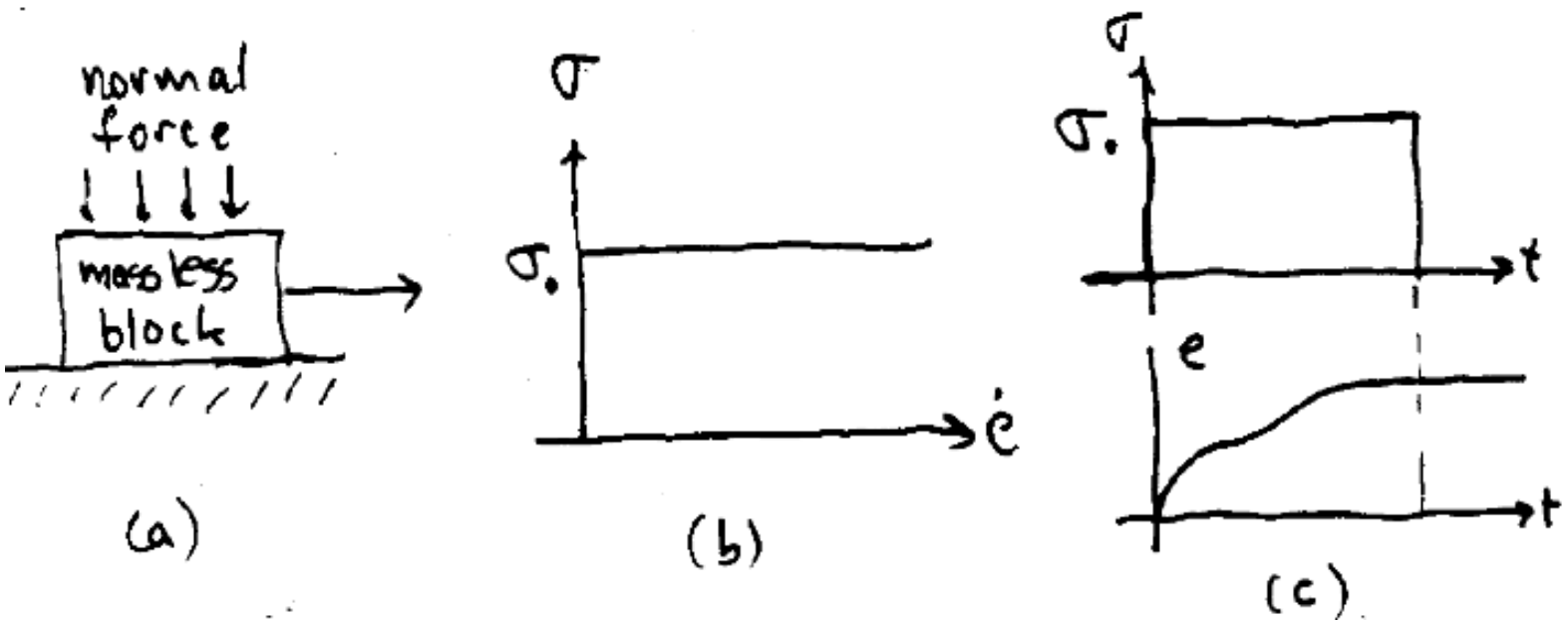
η is a viscosity



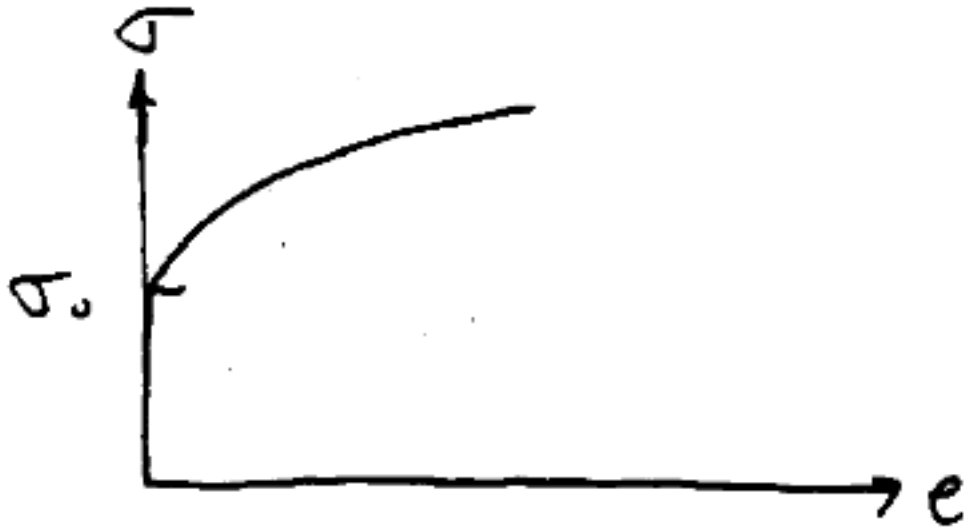
Failure (an idealization)

There is a critical stress σ_0 called the yield stress

- Below σ_0 there is no deformation
- At σ_0 the deformation can be anything
- Can be brittle failure, or perfect plasticity, or work hardening



Failure – A work-hardening plastic material



A more realistic model for real materials