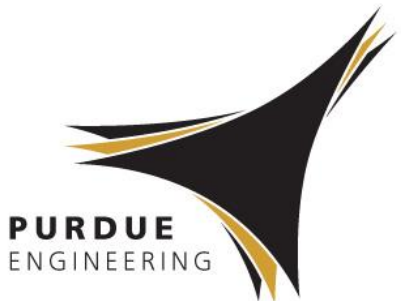


Lecture 3: Shear stress and strain

Lecture Book: Chapter 3

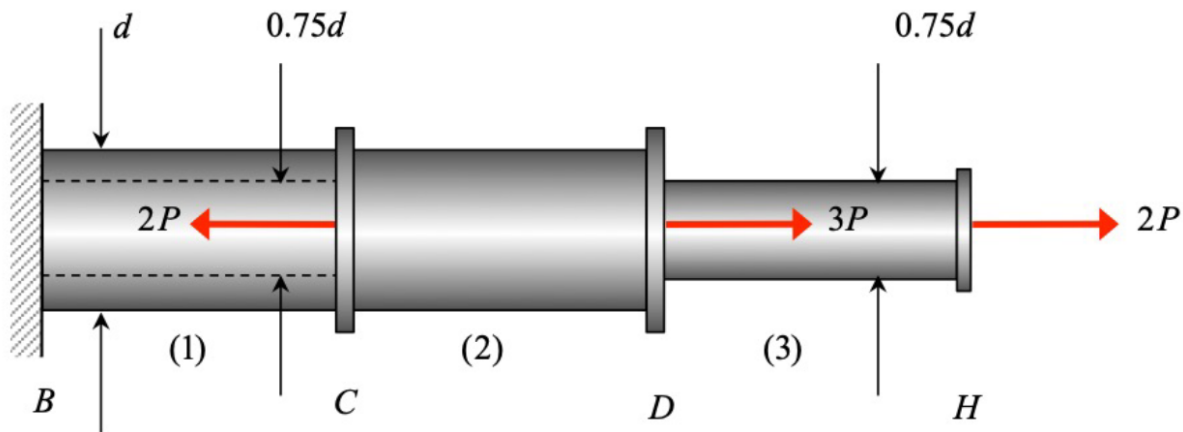
Joshua Pribe

Fall 2019



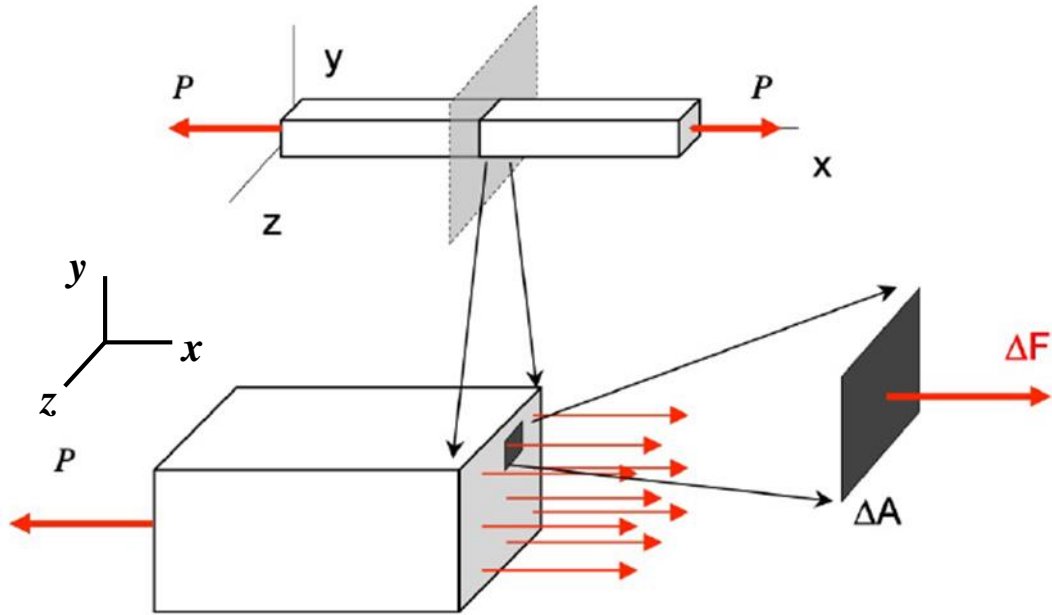
Review of last class

- Average normal stress: $\sigma_{ave} = P/A$
- Extensional strain: $\varepsilon = \Delta L/L_0$
- Mechanical properties (for linear elastic materials under uniaxial loading)
 - Young's modulus E : relates axial stress and strain, $\sigma_x = E\varepsilon_x$
 - Poisson's ratio ν : relates axial strain to transverse strain, $\varepsilon_y = \varepsilon_z = -\nu\varepsilon_x$
- Follow-up on Example 2.7:



Extension of last class: State of stress

Use a “stress element” to represent the state of stress at a point on the cross section



Course website reminder

The screenshot shows the course website for ME 323: Mechanics of Materials at Purdue University. The left sidebar contains navigation links for course materials, exams, homework, lecture material, and examples. The main content area features two blog posts: 'ME323 - SYLLABUS' and 'WELCOME!'. Annotations with arrows point to specific links in the sidebar and their corresponding content in the main area.

ME 323: Mechanics of Materials 🔍

Purdue University

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Site Admin
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COURSE MATERIALS

- Animations and demos
- Course Information
- Exams
 - Exam 1
 - Exam 2
 - Final Exam
- Homework
 - Homework Problems
 - Homework Submission
- Lecture Material
 - 11:30 section
 - 12:30 section
 - 2:30 section
 - 4:30 section
- Lecturebook examples
 - Additional examples
 - Conceptual examples
 - Solution videos

UNCATEGORIZED

ME323 - SYLLABUS

🕒 AUGUST 19, 2019 👤 KEJIE ZHAO 💬 LEAVE A COMMENT ✎ EDIT

GENERAL

WELCOME!

🕒 AUGUST 11, 2019 👤 KROUSGRI 💬 LEAVE A COMMENT ✎ EDIT

Welcome to the ME 323 blog for the Fall 2019 term. This blog will be used to deliver all online material for the course (see links in the sidebar) along with providing a forum for the discussion of homework problems and other course issues. Check back often for new material and to see what your colleagues and friends are saying in the course.

Homework assignments (red arrow pointing to Homework Submission)

Gradescope (homework submission) instructions (blue arrow pointing to Homework Submission)

Syllabus, slides for class, and links to pre-week videos and quizzes (green arrow pointing to 4:30 section)

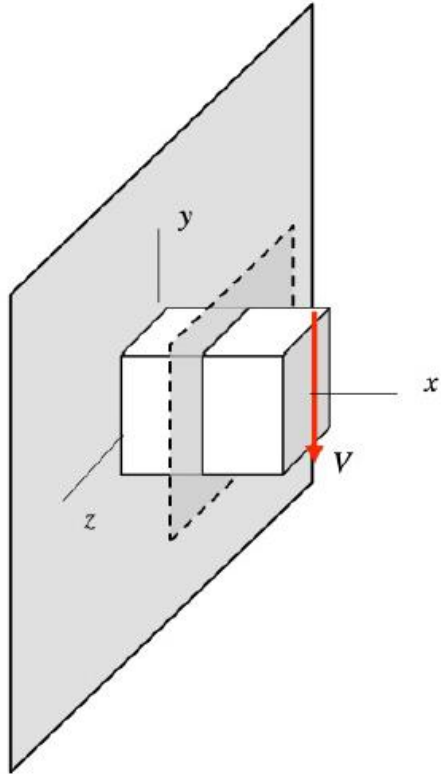
Solution videos for almost all examples in Lecture Book and "Additional Examples" (red arrow pointing to Solution videos)

Objectives

- Define shear stress and shear strain
 - When does a state of direct shear exist in a material?
 - Single shear vs. double shear for pinned/bolted connections
- Relate shear stress and shear strain
- Calculate normal and shear components of stress

Shear stress

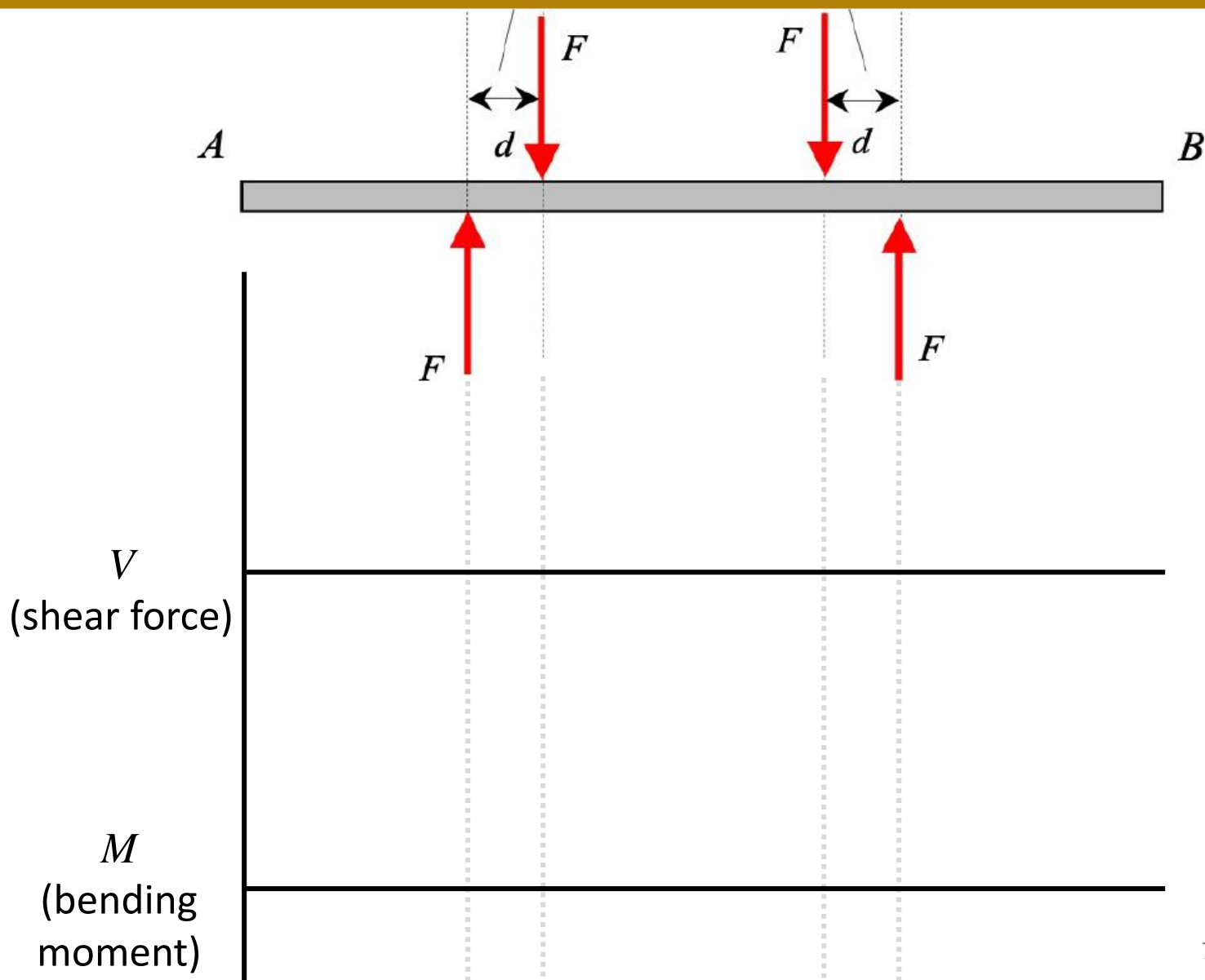
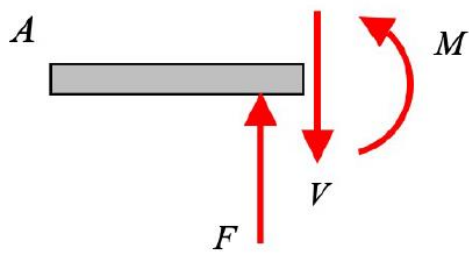
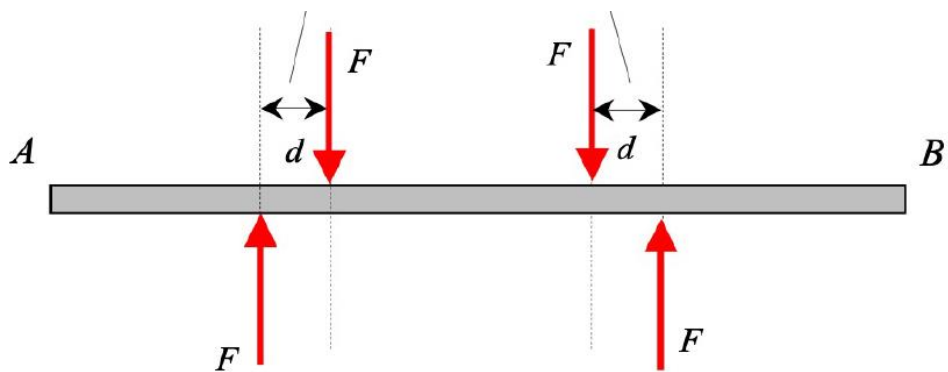
Apply a shear force V to a short, stubby member



Internal resultants and shear stress:

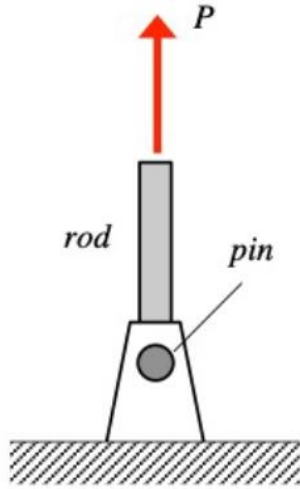
Direct shear

What happens to the shear force and bending moment between the pairs of applied forces as $d \rightarrow 0$?

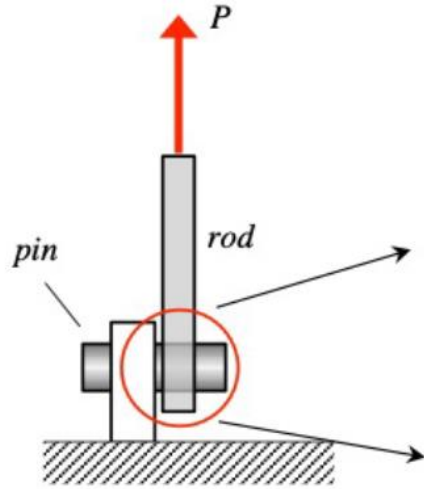


Single and double shear connections

Single shear:



side view

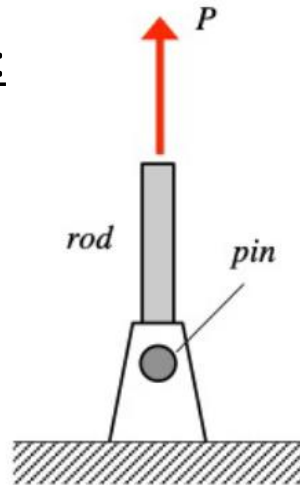


edge view

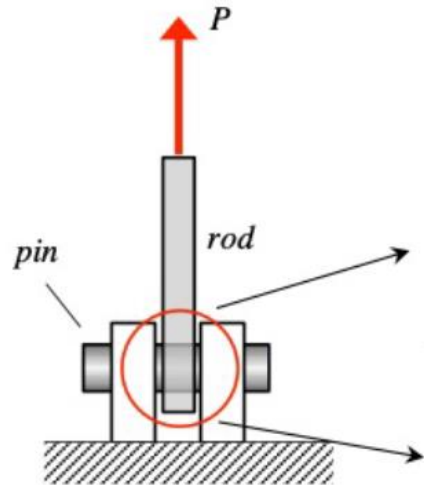
FBD of pin

shear stress

Double shear:



side view



edge view

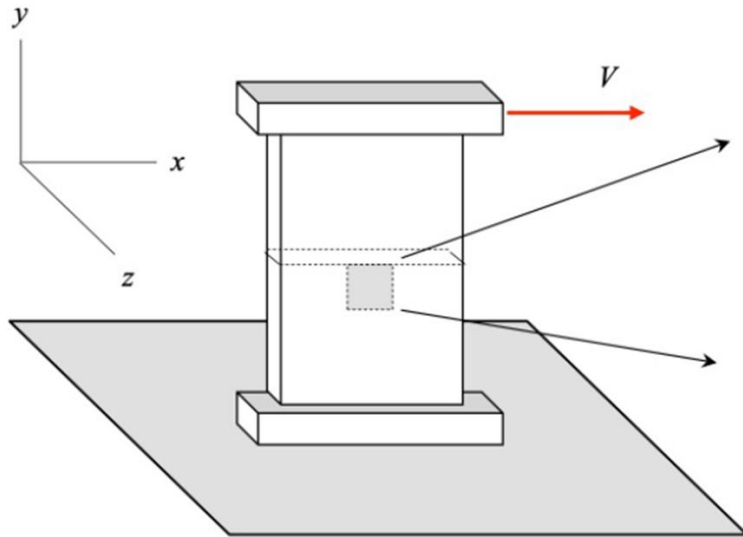
FBD of pin

shear stress

Shear stress and strain; shear modulus

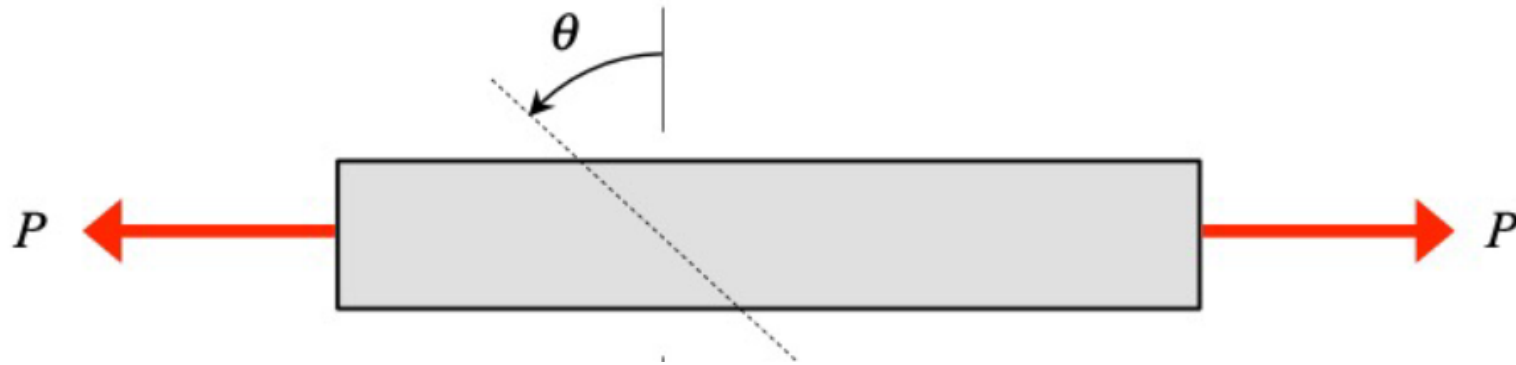
For the applied shear force V :

- How do we represent the shear stress on a stress element?
- What is the shear strain?
- How are shear stress and strain related?



Example: Stress on an inclined plane

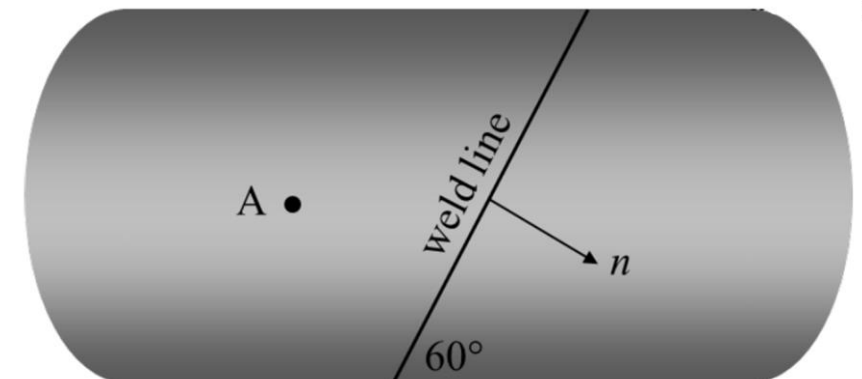
For the axially loaded rectangular bar, what are the normal and tangential components of the stress acting on the plane given by the angle θ ?



Motivation: Metals typically fail due to *shear* stress

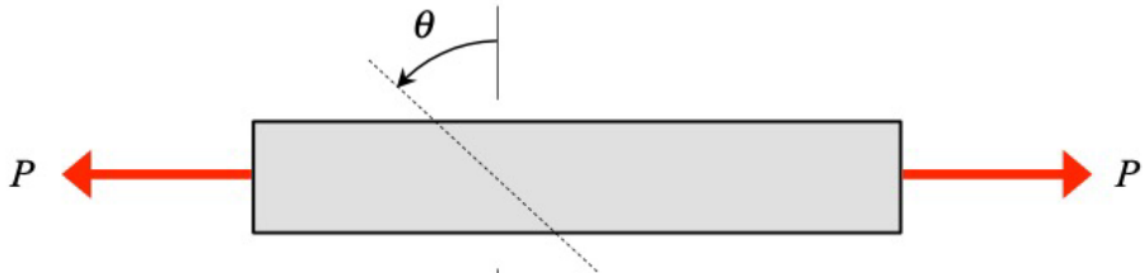


Motivation: Axial member with a weld line



Example: Stress on an inclined plane

For the axially loaded rectangular bar, what are the normal and tangential components of the stress acting on the plane given by the angle θ ?



Summary

- Average shear stress: $\tau_{ave} = V/A$
- Shear strain: $\gamma = \pi/2 - \theta^* \approx \delta_s/L_s$
- Shear modulus relates shear stress and strain: $\tau = G\gamma$
 - Calculate shear modulus from E and ν : $G = \frac{E}{2(1-\nu)}$
- Direct shear: shear forces without bending moments or normal forces
- Single vs. double shear

- Pre-week videos: design of deformable materials, general states of stress, and axial deformation