Strength of Materials Problem Exercises

Curated by James Lord, Jake Grohs, …

2024-01-05

Table of contents

Welcome to Demo Site

Welcome to this demonstration site of the Strength of Materials Open Problem Exercises companion to the Strength of Materials Open Textbook.

At this time, we are simply using this site as a demonstration and shell for our ongoing work. The intent is to demonstrate a more traditional static style problem exercise pack along with dynamic versions which allow students to quickly check answers and receive basic feedback, and/or to input their math in an interactive interface which will provide them with targeted feedback based on their atempted solution.

This work is still very much in progress and you may find bugs. We would welcome any input or feedback you have about this. Thanks!

Part I

List of Complete Problems

Problem 2.1

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

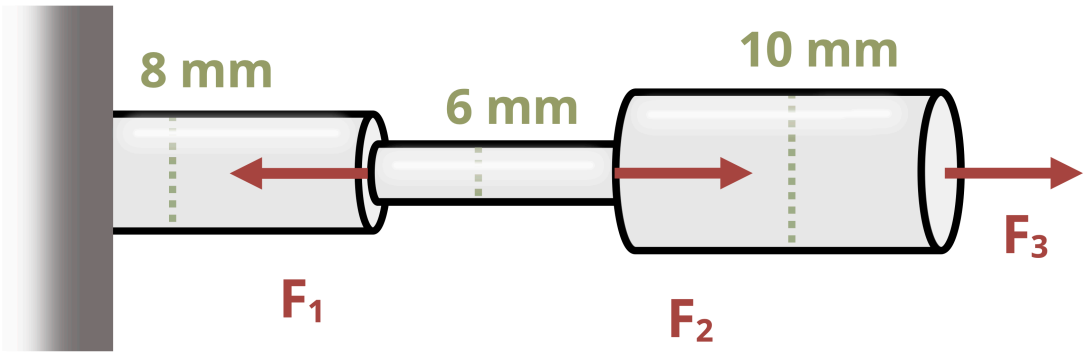


Figure 0.1: Figure 1: A series of solid circular bars are loaded with three loads

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
```

```
from pathlib import Path


def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="138"
F1=reactive.Value("__")
F2=reactive.Value("__")
F3=reactive.Value("__")
d1=8
d2=6
d3=10
attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of MPa", placeholder="Please enter your answ
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"A series of solid circular bars are loaded with three loads as s

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
        F1.set(random.randrange(50, 70, 1))
```

```
        F2.set(random.randrange(10, 30, 1))
        F3.set(F1()-F2())


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        # Calculate the instructor's answer and determine if the user's answer is correct.
        instr= (F1()/(math.pi*(d2/(1000*2))**2))/10**6

        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference in
        m = ui.modal(
            feedback,
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
```

```
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.2

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

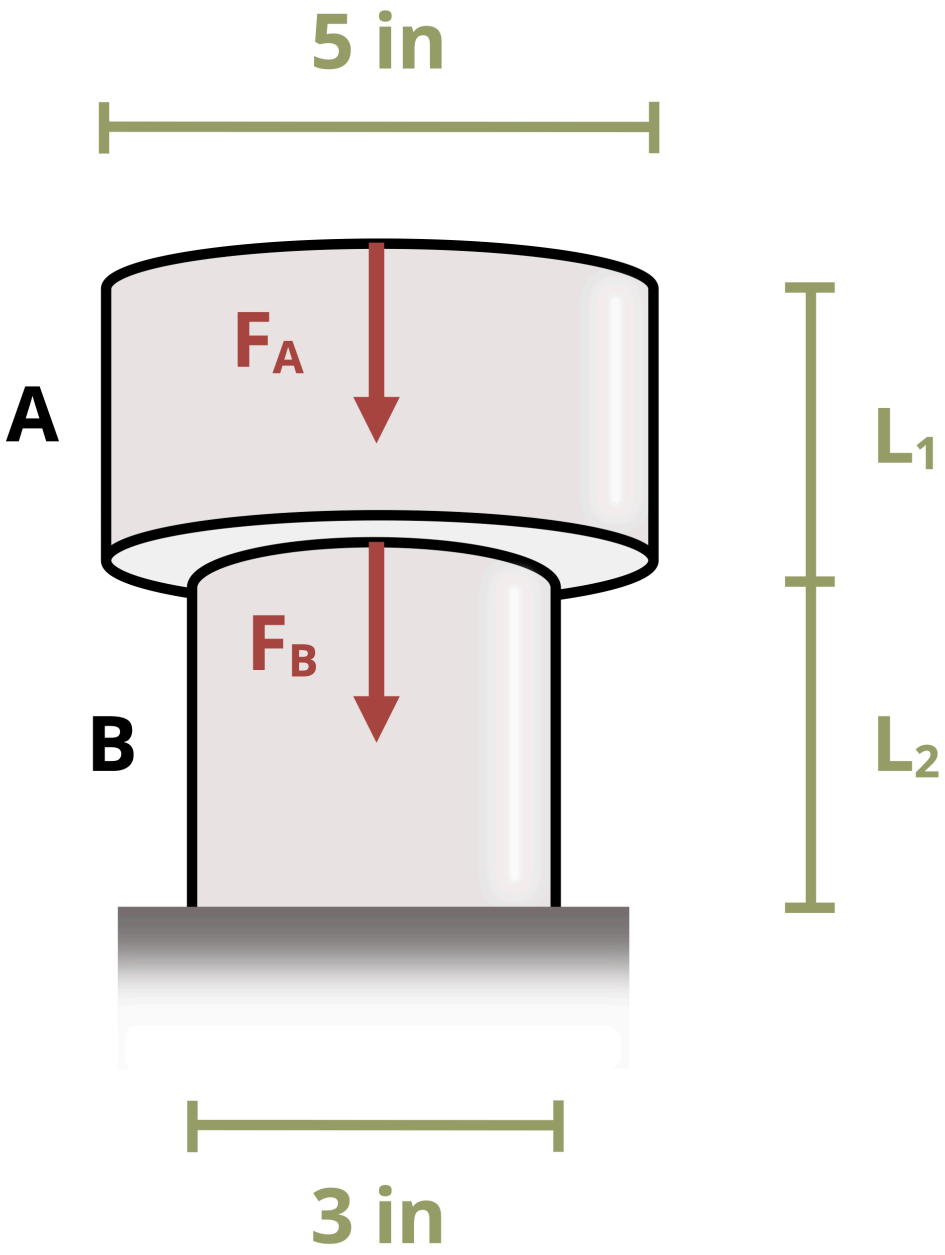


Figure 0.2: Figure 1: Two sylinders are stacked on top of each other.

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path

def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="139"
L1=reactive.Value("__")
L2=reactive.Value("__")
FA=reactive.Value("__")
FB=reactive.Value("__")
E = 30*10**6

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of inches", placeholder="Please enter your a
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)
```

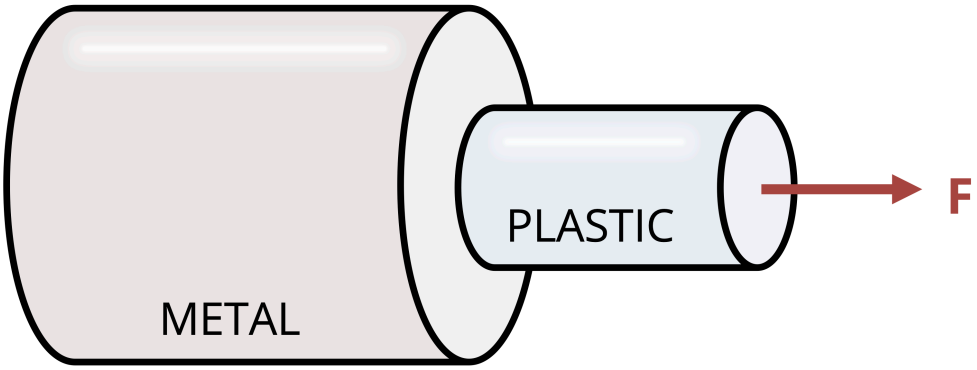
```
@output
@render.ui
def ui_problem_statement():
    return[ui.markdown(f"Two cylinders are stacked on top of one another and two forces a

@reactive.Effect
@reactive.event(input.generate_problem)
def randomize_vars():
    random.seed(input.ID())
    FA.set(random.randrange(300, 700, 10))
    FB.set(random.randrange(100, 300, 10))
    L1.set(random.randrange(2, 7, 1))
    L2.set(L1() * 1.3)


@reactive.Effect
@reactive.event(input.submit)
def _():
    attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

    instr= (FA()*L1())/((math.pi*(5/2)**2)*E) + (FB()*L2())/((math.pi*(3/2)**2)*E)
    if math.isclose(float(input.answer()), instr, rel_tol=0.001):
        check = "*Correct*"
        correct_indicator = "JL"
    else:
        check = "*Not Correct.*"
        correct_indicator = "JG"

    # Generate random parts for the encoded attempt.
    random_start = generate_random_letters(4)
    random_middle = generate_random_letters(4)
    random_end = generate_random_letters(4)
    encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

    # Store the most recent encoded attempt in a reactive value so it persists across sub
    session.encoded_attempt = reactive.Value(encoded_attempt)

    # Append the attempt data to the attempts list without the encoded attempt
    attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

    # Show feedback to the user.
    feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference i
```

```
        m = ui.modal(
            feedback,
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.3

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image



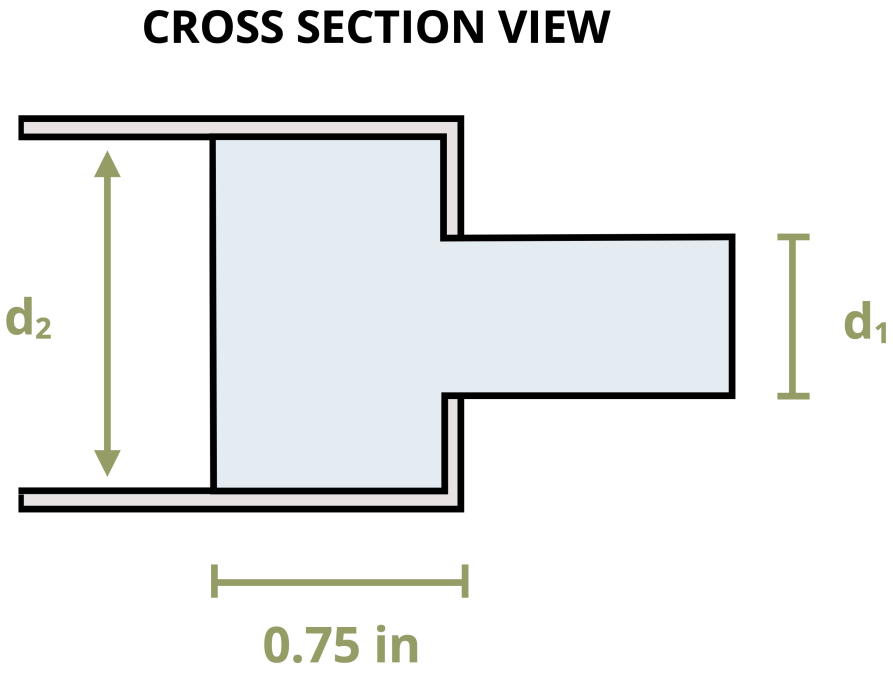


Figure 0.3: Figure 1: A plastic cylindrical peg is constrained by a metal cap

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path

def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="144"
F=reactive.Value("__")
d1=reactive.Value("__")
d2=reactive.Value("__")

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of psi", placeholder="Please enter your answ
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
```

```
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"A plastic cylindrical peg is constrained by a metal cap as show

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
        F.set(random.randrange(20, 80, 5))
        d1.set(random.randrange(3, 8, 1)/10)
        d2.set(round(d1() * 1.6, 2))


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s
        instr= F()/(math.pi*((d1()/2)**2))
        #check=math.isclose(float(input.answer()),instr,rel_tol=0.001)

        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference in
        m = ui.modal(
```

```
            feedback,
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.4

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

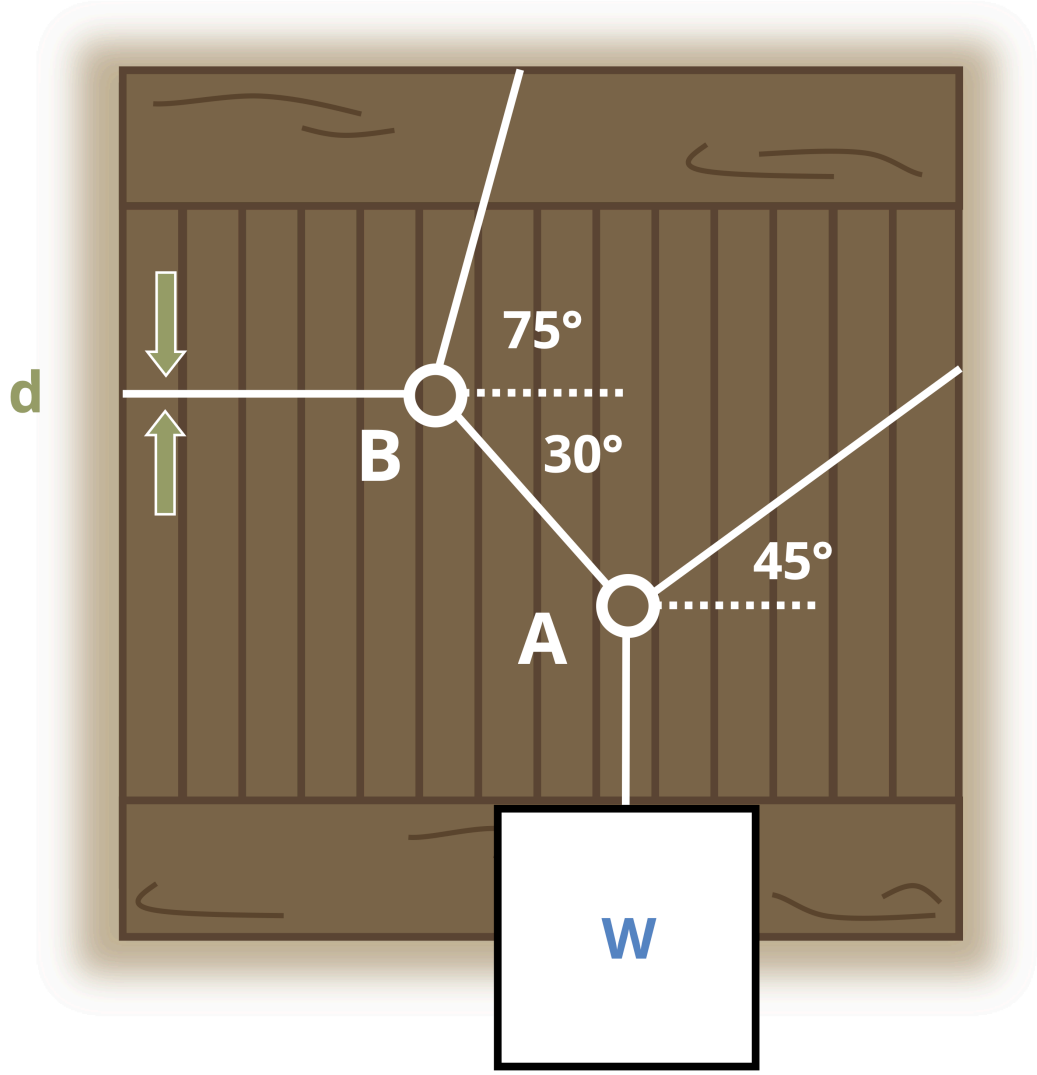


Figure 0.4: Figure 1: A crate is suspended by a set of cables

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]
```

```
from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path


def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="146"
W=reactive.Value("__")
d=reactive.Value("__")
angle1=math.radians(45)
angle2=math.radians(30)
angle3=math.radians(75)

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of GPa", placeholder="Please enter your answ
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
    @render.ui
    def ui_problem_statement():
```

```
        return[ui.markdown(f"A crate weighing {W()} kN is suspended by a set of cables. The c

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
        W.set(random.randrange(30, 90, 1))
        d.set(random.randrange(20, 90, 1)/10)


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        R1 = W()/(((math.cos(angle1)/math.cos(angle2))*math.sin(angle2))+math.sin(angle1))
        instr= (R1*10**3/(math.pi*((d()/(1000*2))**2)))/10**9
        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference in
        m = ui.modal(
            feedback,
            title="Feedback",
            easy_close=True
```

```
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.47

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

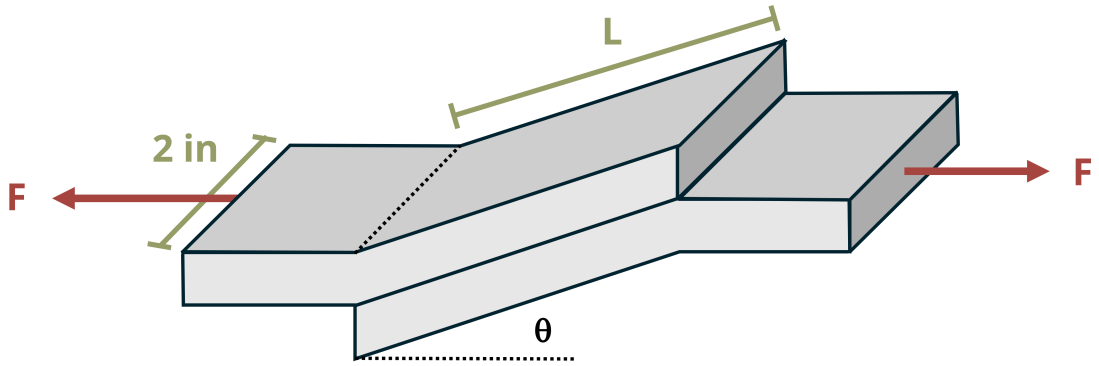


Figure 0.5: Figure 1: Two slanted brackets are glued together

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path
```

```
def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="153"
F=reactive.Value("__")
L=reactive.Value("__")
θ=reactive.Value("__")

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of psi", placeholder="Please enter your answ
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"Two slanted brackets are glued together as shown. If F = {F()} l

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
        F.set(random.randrange(200, 800, 10))
        L.set(random.randrange(20, 80, 1)/10)
        θ.set(random.randrange(15, 30, 1))


    @reactive.Effect
```

```
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        instr= (F()*math.sin(math.radians(θ()))/(L()*2))
        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference ir
        m = ui.modal(
            feedback,
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"
```

```
        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.48

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

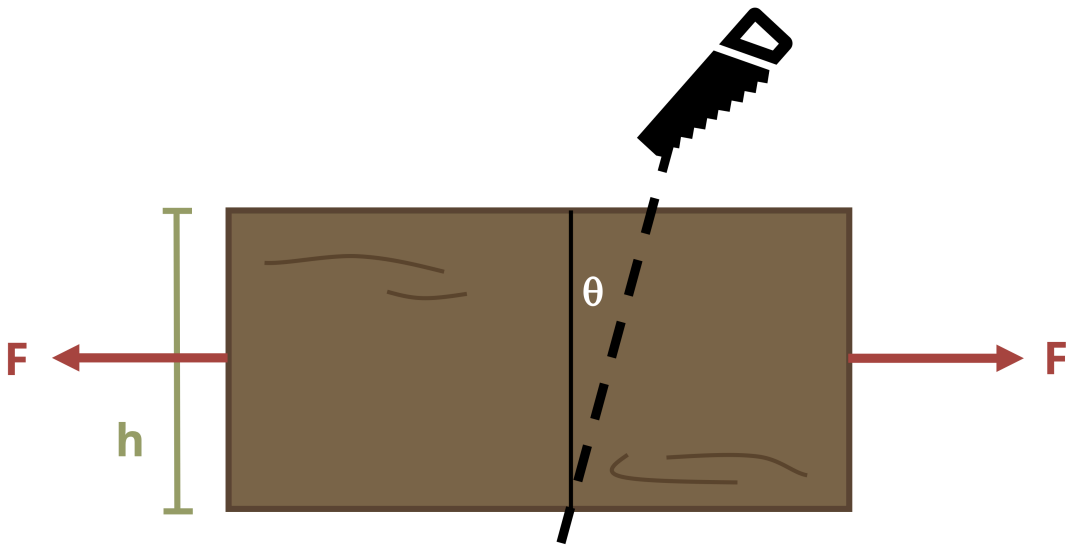


Figure 0.6: Figure 1: A 2 inch thick board is cut and then glued back together along a line

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
```

```
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path

def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="156"
F=reactive.Value("__")
h=reactive.Value("__")
θ=reactive.Value("__")

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of psi", placeholder="Please enter your answ
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"A 2 inch thick board is cut and then glued back together along a

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
```

```
        random.seed(input.ID())
        F.set(random.randrange(2000, 6000, 100))
        h.set(random.randrange(50, 150, 1)/10)
        θ.set(random.randrange(10, 20, 1))


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        instr= (F()/(2*h()))*(math.cos(math.radians(θ()))**2)
        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference in
        m = ui.modal(
            feedback,
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
```

```
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 4.37

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

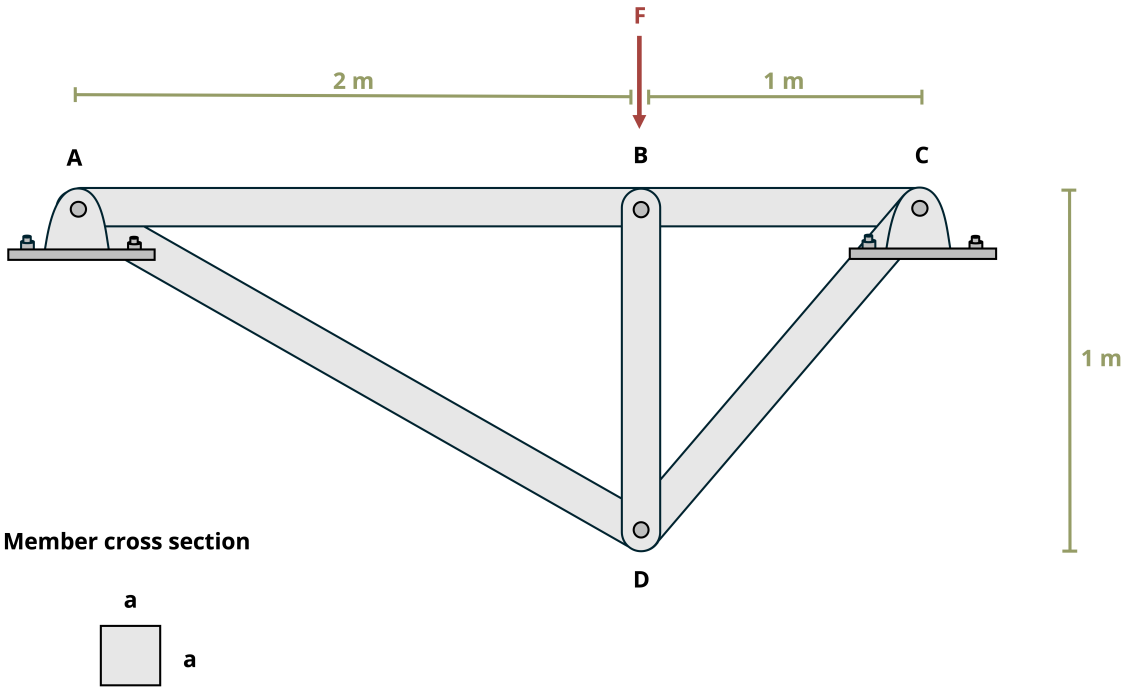


Figure 0.7: Figure 1: A small truss is constructed with solid square wood members

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]
```

```
from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path

def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="157"
F=reactive.Value("__")
FS=reactive.Value("__")
 fail=reactive.Value("__")

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of centimeters", placeholder="Please enter y
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"A small truss is constructed with solid square wood members and

    @reactive.Effect
```

```
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
        F.set(random.randrange(15, 50, 1))
        FS.set(random.randrange(15, 40, 1)/10)
         fail.set(random.randrange(40, 60, 1))


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        dl = FS()*F()
        A = (dl/( fail()*10**3))*100*100
        instr= math.sqrt(A)
        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference i
        m = ui.modal(
            feedback,
            title="Feedback",
            easy_close=True
        )
```

```
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writ
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.21

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

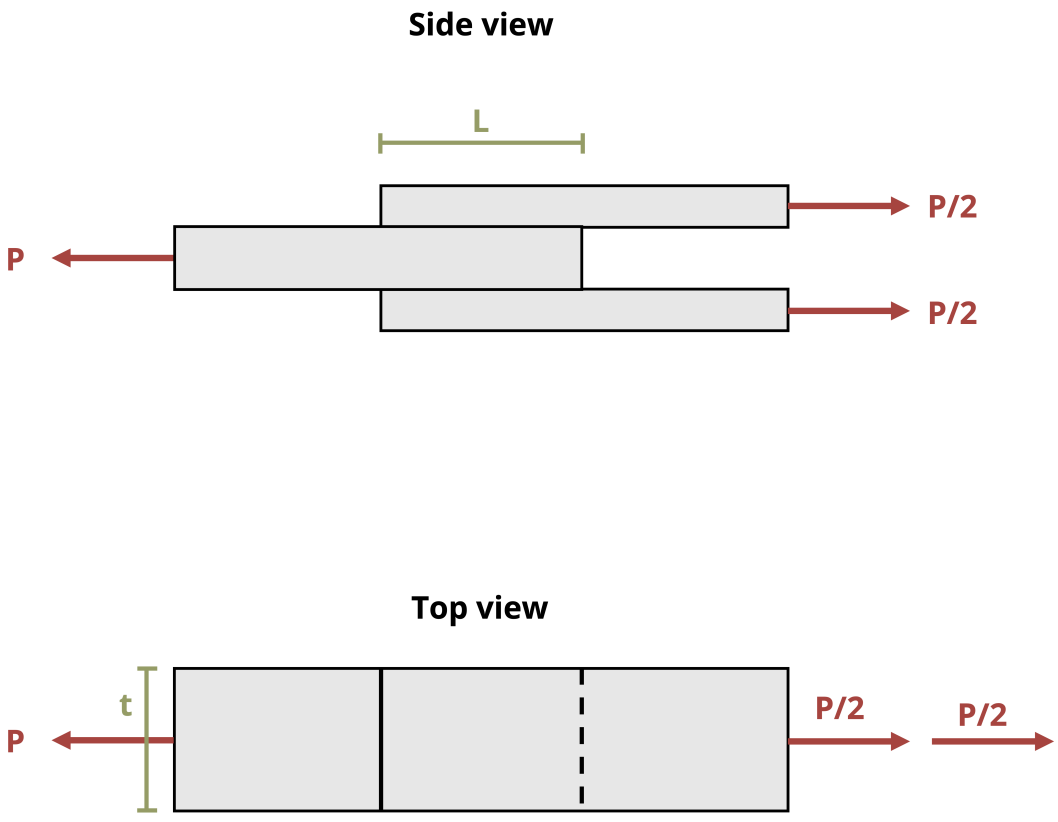


Figure 0.8: Figure 1: A double lap joint is glued together

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path

def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="164"
 fail=reactive.Value("__")
L=reactive.Value("__")
t=reactive.Value("__")

attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of kips", placeholder="Please enter your ans
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
```

```
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"A double lap joint is glued together using glue with a shear str

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
         fail.set(random.randrange(7000, 9000, 100))
        L.set(random.randrange(40, 100, 1)/10)
        t.set(random.randrange(40, 100, 1)/10)


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        A = L()*t()*2
        instr= ( fail()*A)/1000
        if math.isclose(float(input.answer()), instr, rel_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference in
        m = ui.modal(
```

```
            feedback,
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writt
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.22

This is a dynamic rendering of the problem with dynamic variables based on the username entered.

Problem Image

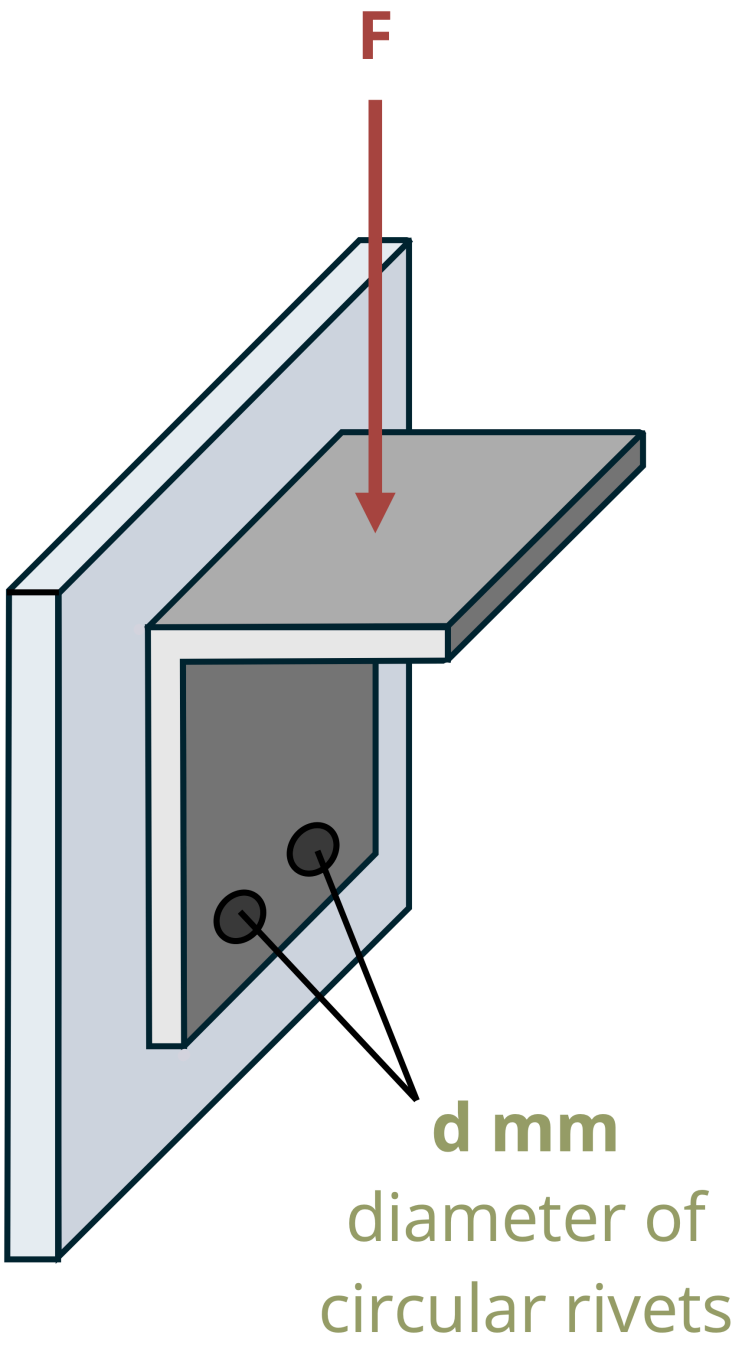


Figure 0.9: Figure 1: A bracket is attached to a wall with two circular rivets

```
#| standalone: true
#| viewerHeight: 600
#| components: [viewer]

from shiny import App, render, ui, reactive
import random
import asyncio
import io
import math
import string
from datetime import datetime
from pathlib import Path

def generate_random_letters(length):
    # Generate a random string of letters of specified length
    return ''.join(random.choice(string.ascii_lowercase) for _ in range(length))

problem_ID="165"
F=reactive.Value("__")
d=reactive.Value("__")


attempts=["Timestamp,Attempt,Answer,Feedback\n"]

app_ui = ui.page_fluid(
    ui.markdown("**Please enter your ID number from your instructor and click to generate you
    ui.input_text("ID","", placeholder="Enter ID Number Here"),
    ui.input_action_button("generate_problem", "Generate Problem", class_="btn-primary"),
    ui.markdown("**Problem Statement**"),
    ui.output_ui("ui_problem_statement"),
    ui.input_text("answer","Your Answer in units of MPa", placeholder="Please enter your answ
    ui.input_action_button("submit", "Submit Answer", class_="btn-primary"),
    ui.download_button("download", "Download File to Submit", class_="btn-success"),
)


def server(input, output, session):
    # Initialize a counter for attempts
    attempt_counter = reactive.Value(0)

    @output
```

```
    @render.ui
    def ui_problem_statement():
        return[ui.markdown(f"A bracket is attached to a wall with two circular rivets of dia

    @reactive.Effect
    @reactive.event(input.generate_problem)
    def randomize_vars():
        random.seed(input.ID())
        F.set(random.randrange(30, 100, 1))
        d.set(random.randrange(10, 40, 1))


    @reactive.Effect
    @reactive.event(input.submit)
    def _():
        attempt_counter.set(attempt_counter() + 1)  # Increment the attempt counter on each s

        A = math.pi*(d()/(1000*2))**2
        instr= ((F()/2)/A)/1000
        if math.isclose(float(input.answer()), instr, abs_tol=0.001):
            check = "*Correct*"
            correct_indicator = "JL"
        else:
            check = "*Not Correct.*"
            correct_indicator = "JG"

        # Generate random parts for the encoded attempt.
        random_start = generate_random_letters(4)
        random_middle = generate_random_letters(4)
        random_end = generate_random_letters(4)
        encoded_attempt = f"{random_start}{problem_ID}-{random_middle}{attempt_counter()}{co

        # Store the most recent encoded attempt in a reactive value so it persists across sub
        session.encoded_attempt = reactive.Value(encoded_attempt)

        # Append the attempt data to the attempts list without the encoded attempt
        attempts.append(f"{datetime.now()}, {attempt_counter()}, {input.answer()}, {check}\n"

        # Show feedback to the user.
        feedback = ui.markdown(f"Your answer of {input.answer()} is {check}. For reference in
        m = ui.modal(
            feedback,
```

```
            title="Feedback",
            easy_close=True
        )
        ui.modal_show(m)

    @session.download(filename=lambda: f"Problem_Log-{problem_ID}-{input.ID()}.csv")
    async def download():
        # Start the CSV with the encoded attempt (without label)
        final_encoded = session.encoded_attempt() if session.encoded_attempt is not None else
        yield f"{final_encoded}\n\n"

        # Write the header for the remaining CSV data once
        yield "Timestamp,Attempt,Answer,Feedback\n"

        # Write the attempts data, ensure that the header from the attempts list is not writ
        for attempt in attempts[1:]:  # Skip the first element which is the header
            await asyncio.sleep(0.25)  # This delay may not be necessary; adjust as needed
            yield attempt


# App installation
app = App(app_ui, server)
```

Problem 2.38

This is a static rendering of the problem.

Problem Image

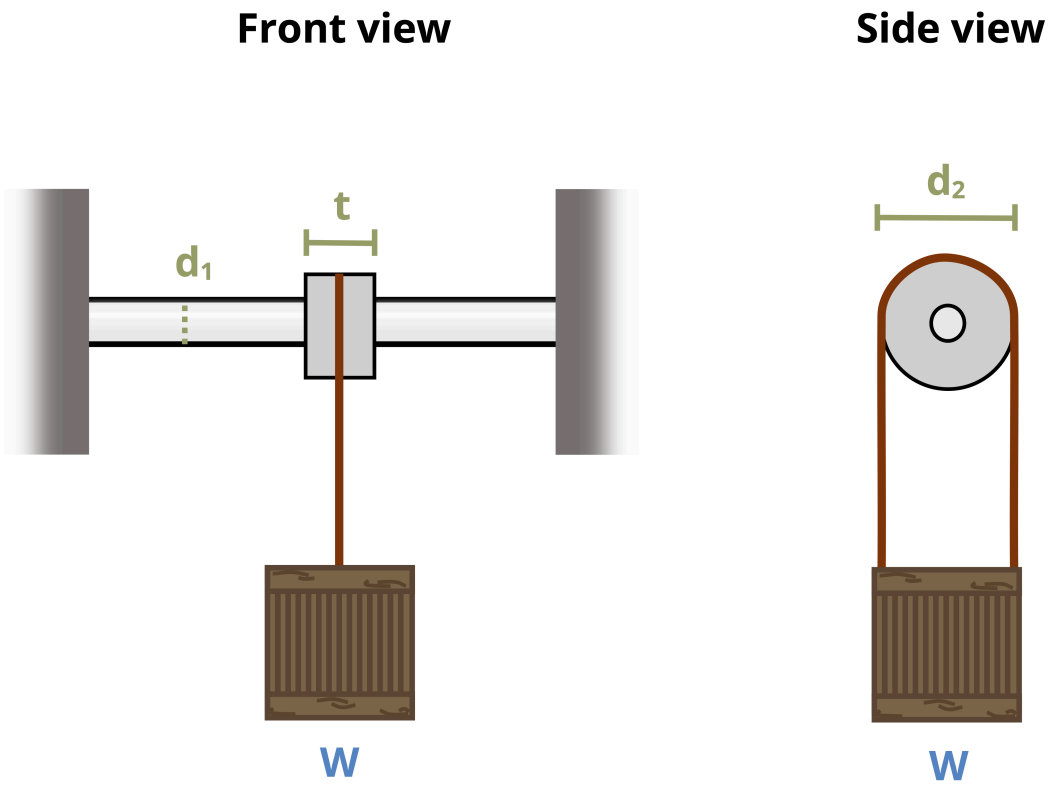


Figure 0.10: Figure 1: A crate is hanged on a circular solid metal rod.

Part II

List of Complete Problems - Static Version

Problem 2.1

This is a static rendering of the problem.

Problem Statement

A series of solid circular bars are loaded with three loads as shown, F1 = 60 N, F2 = 20 N, and F3 = 40 N. What is the largest absolute normal stress in any bar?

Problem Image

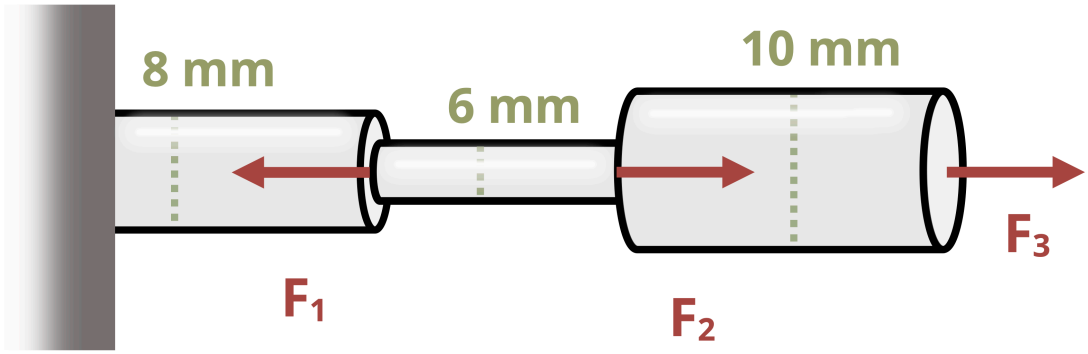


Figure 0.11: Figure 1: A series of solid circular bars are loaded with three loads

Problem 2.2

This is a static rendering of the problem.

Problem Statement

Two cylinders are stacked on top of one another and two forces are applied at the top surface and at the joint between the cylinders as shown. If L1 = 3 in., L2 = 4 in., FA = 500 lb, and FB = 200 lb, find the total deflection in the stack of cylinders. Assume E = 30 x 106 psi for both cylinders.

Problem Image

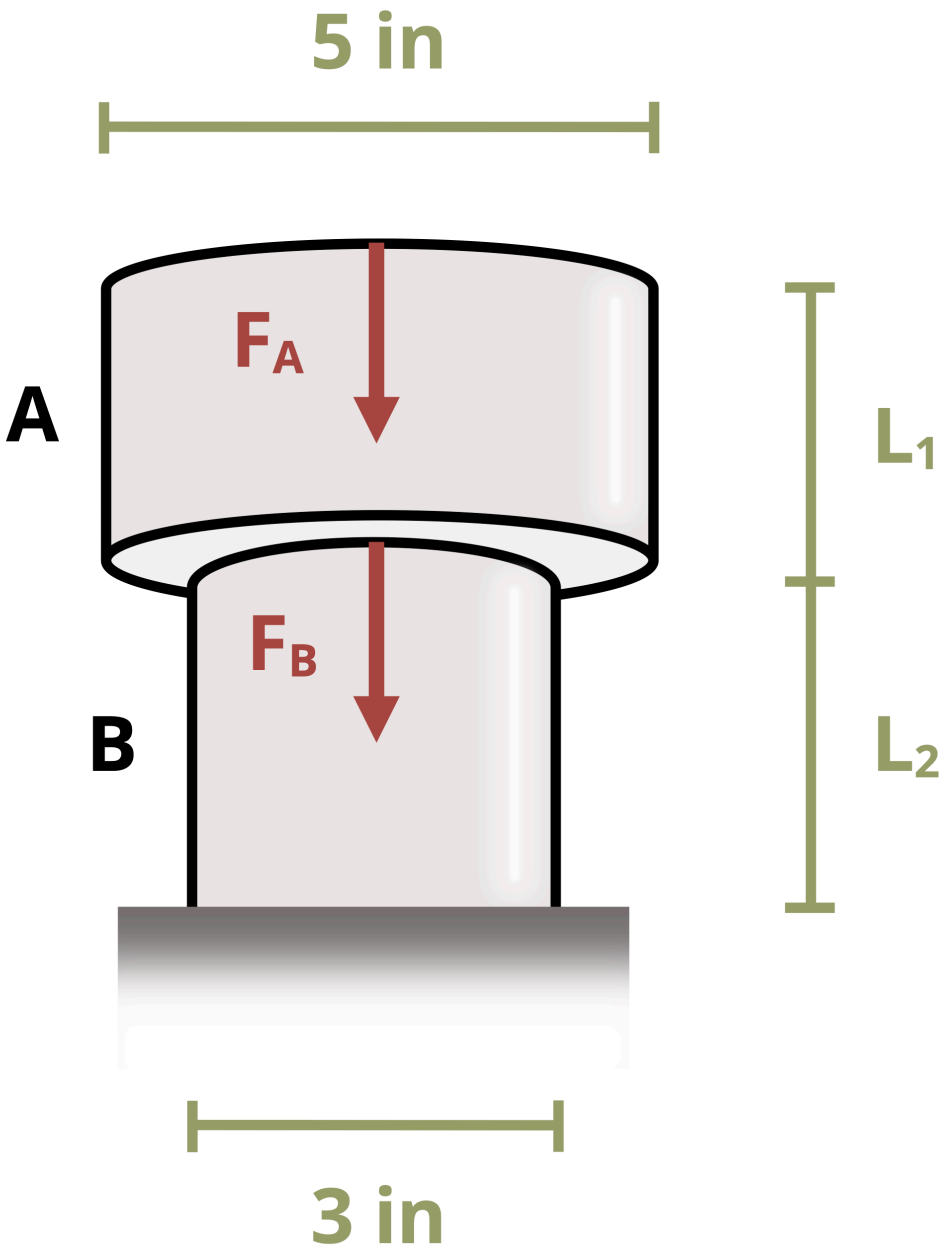


Figure 0.12: Figure 1: Two sylinders are stacked on top of each other.

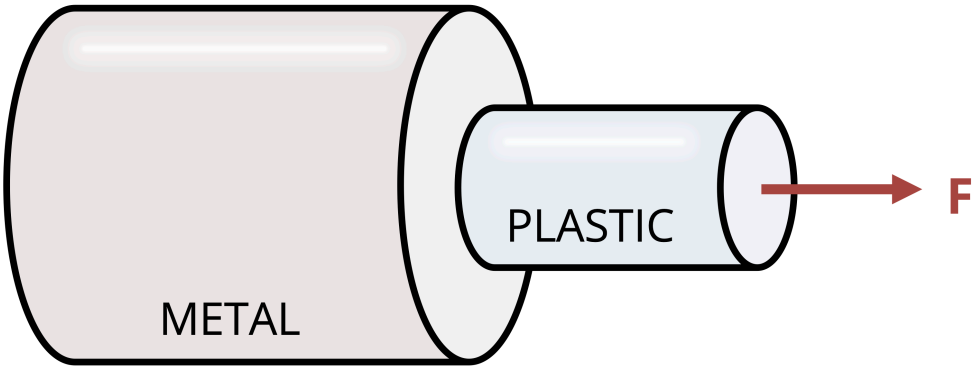
Problem 2.3

This is a static rendering of the problem.

Problem Statement

A plastic cylindrical peg is constrained by a metal cap as shown. An axial load of F = 40 lb is applied to the peg. If d1 = 0.5 in and d2 = 0.9 in, determine the normal stress in the peg. Assume the axial load is evenly distributed across the peg and that the metal cap is fixed and does not move.

Problem Image



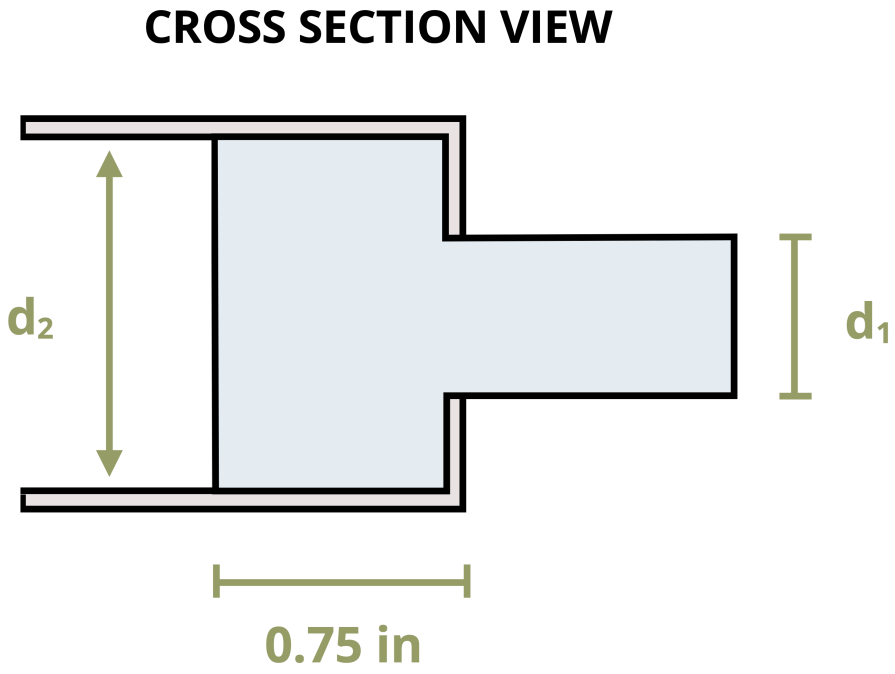


Figure 0.13: Figure 1: A plastic cylindrical peg is constrained by a metal cap

Problem 2.4

This is a static rendering of the problem.

Problem Statement

A crate weighing 45 kN is suspended by a set of cables. The diameter of each cable is 5 mm. What is the maximum stress in any cable, exluding the cable attached to the crate.

Problem Image

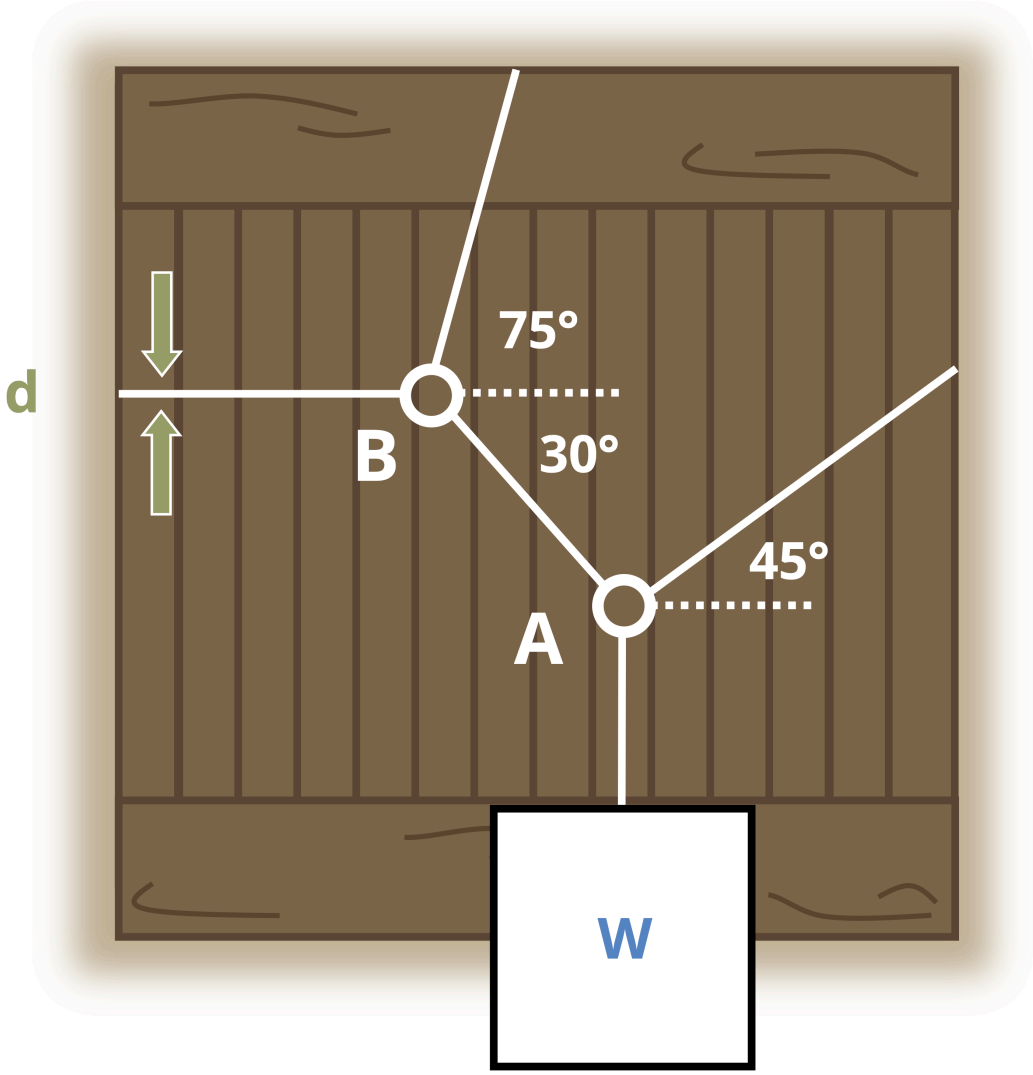


Figure 0.14: Figure 1: A crate is suspended by a set of cables

Problem 2.47

This is a static rendering of the problem.

Problem Statement

Two slanted brackets are glued together as shown. If F = 500 lb, L = 4 in., and Θ = 20 °, determine the shear stress parallel to the inclined plane. Assume loads are inline and there is no rotation.

Problem Image

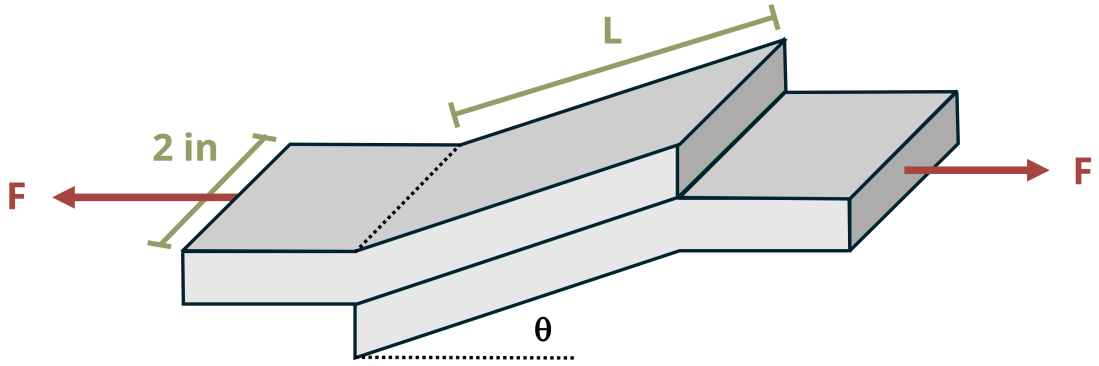


Figure 0.15: Figure 1: Two slanted brackets are glued together

Problem 2.48

This is a static rendering of the problem.

Problem Statement

A 2 inch thick board is cut and then glued back together along a line that is $\Theta = 15°$ off the vertical as shown. If height h = 10 in. and F = 3500 lb, determine the normal stress along the cut line.

Problem Image

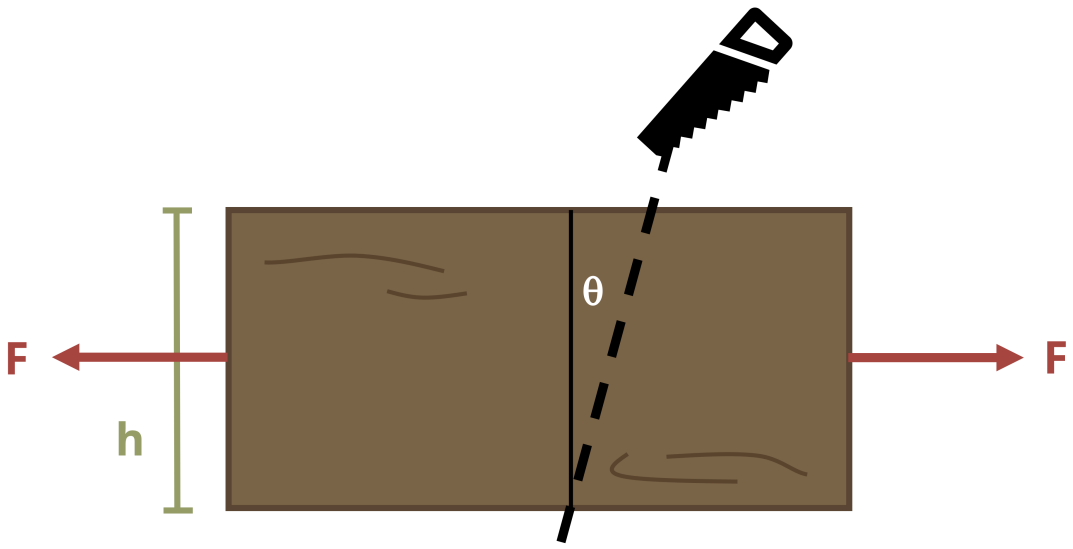


Figure 0.16: Figure 1: A 2 inch thick board is cut and then glued back together along a line

Problem 4.37

This is a static rendering.

Problem Statement

A small truss is constructed with solid square wood members and subjected to a load of F = 30 kN. Determine the minimum dimension, a, of the member so that the truss will have a factor of safety of 2. All members have the same cross-section. The wood has a failure stress of fail = 50 MPa.

Problem Image

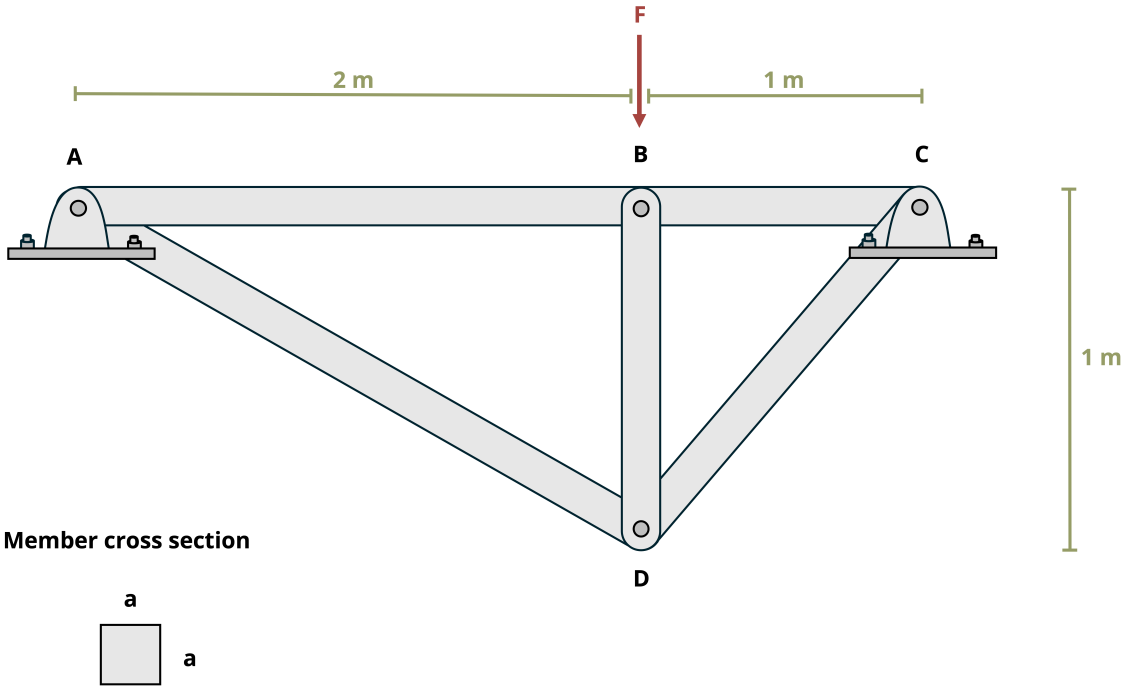


Figure 0.17: Figure 1: A small truss is constructed with solid square wood members

Problem 2.21

This is a static rendering of the problem.

Problem Statement

A double lap joint is glued together using glue with a shear stress failure strength of 8000 psi. If dimensions L = 6 in. and t = 8 in., what is the maximum load P that the joint can withstand? Assume the load is evenly distributed across the joint on both sides.

Problem Image

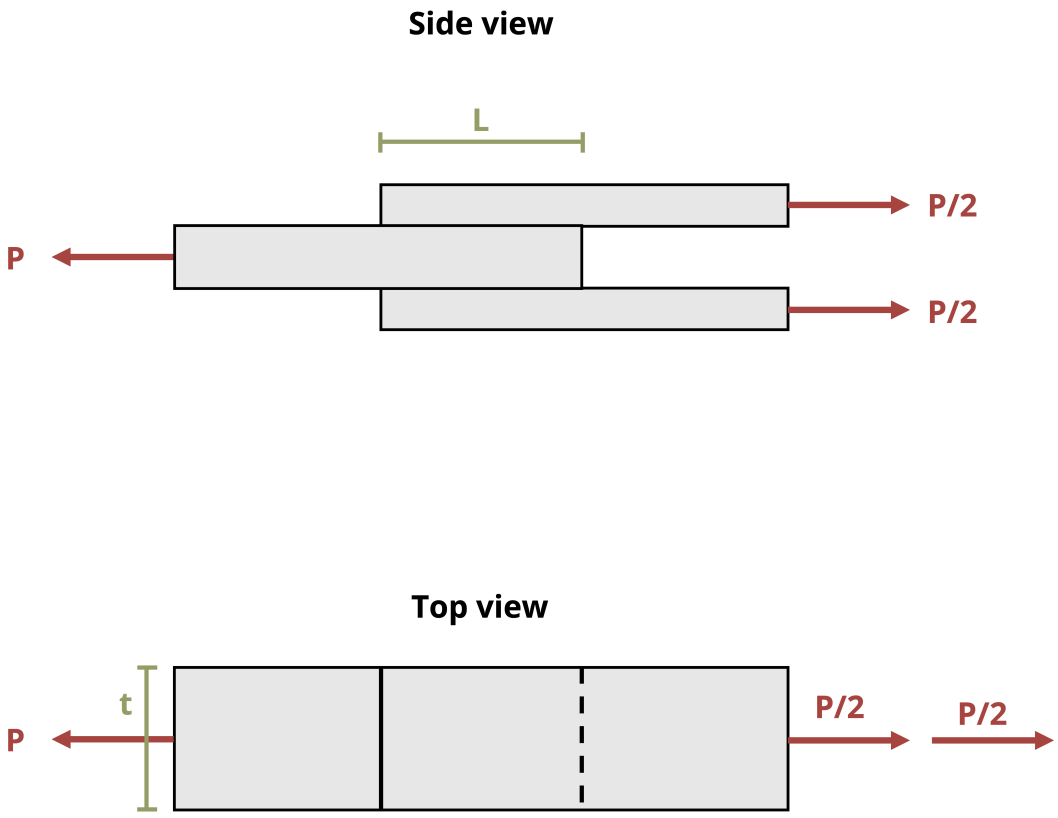


Figure 0.18: Figure 1: A double lap joint is glued together

Problem 2.22

This is a static rendering of the problem.

Problem Statement

A bracket is attached to a wall with two circular rivets of diameter d = 20 mm. A load F = 50 kN is applied in the center of the bracket. Assuming the load is split evenly between the two rivits, determine the shear stress in each rivet.

Problem Image

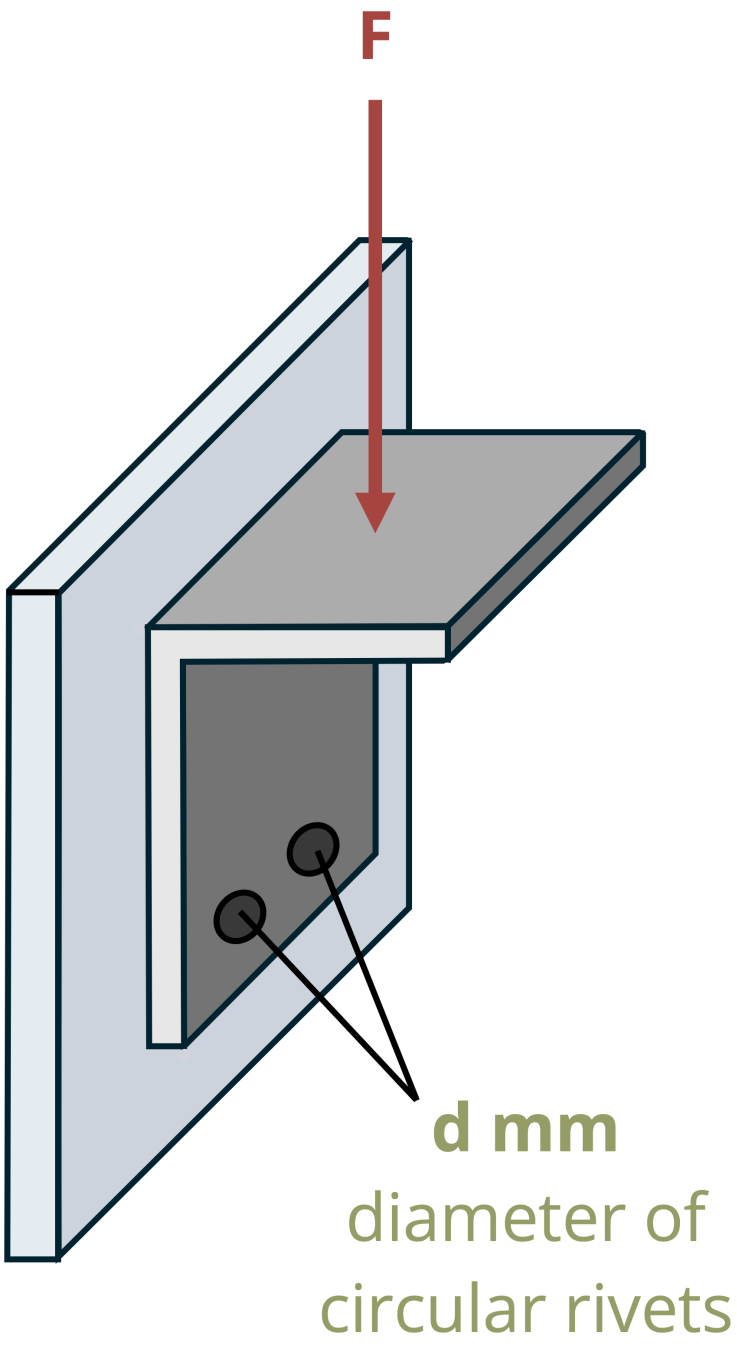


Figure 0.19: Figure 1: A bracket is attached to a wall with two circular rivets

Problem 2.37

This is a static rendering of the problem.

Problem Statement

A crate of weight W = 8000 lb hangs from a solid circular metal rod of diameter d1 = 1 in.. The cable is wrapped around a support collar of diameter d2 = 3 in. and thickness t = 2 in. to evenly distribute the cable load. What is the bearing stress on the support collar due to the rod?

Problem Image

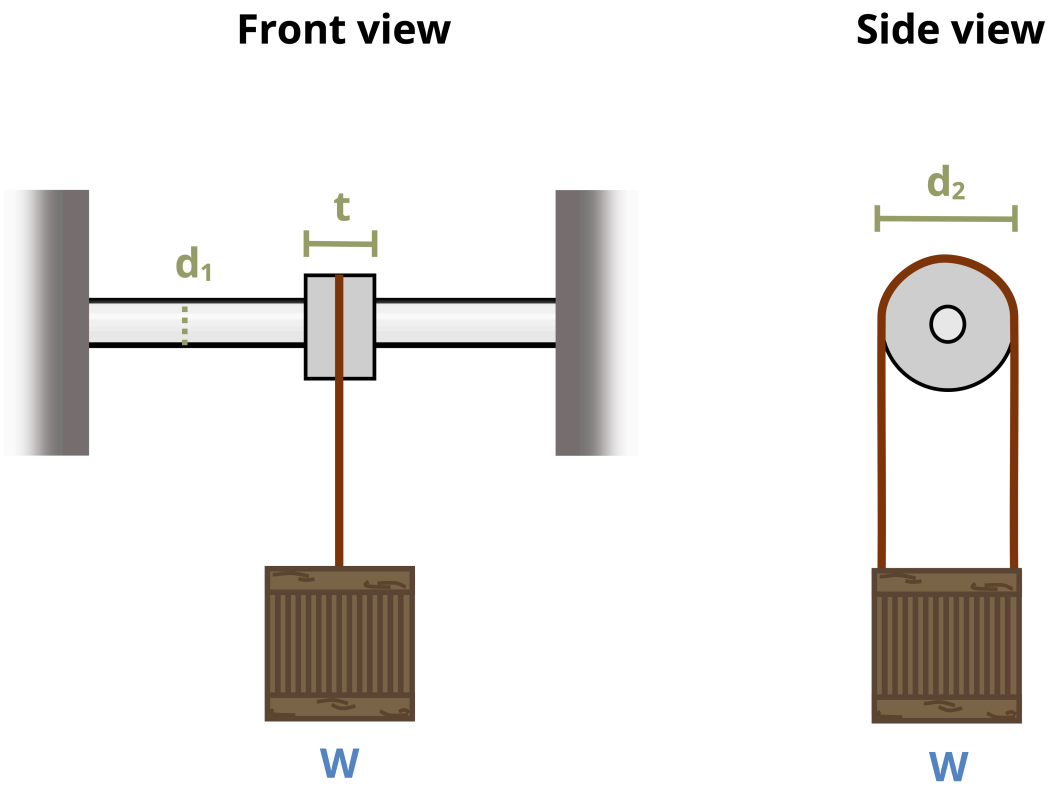


Figure 0.20: Figure 1: A crate is hanged on a circular solid metal rod.

Part III

Interactive Interface Demo