

Lesson Plan

Grades: 11th–12th

Subject: Engineering Design and Presentation 2

Topic: Stress Analysis and Load Testing Analysis on Wooden Bridges, built on Fusion 360, using Python Coding

Lesson Goals:

Students will identify and apply basic principles of force distribution, including tension, compression, and stress, in truss and beam bridge designs on a bridge they will build using Fusion 360. Students will use Python code to calculate stress, strain, and safety factor from bridge component data.

Learning Objectives:

1. Design a truss-style wooden bridge model using Fusion 360, applying real-world constraints on size, support, and material.
2. Apply knowledge of tension, compression, and stress to identify critical load paths in a bridge structure.
3. Assign appropriate material properties (e.g., pine or oak) to their digital bridge model to simulate realistic structural behavior.
4. Write a Python script to calculate axial stress, cross-sectional area, and safety factor for wooden bridge components.
5. Import and process bridge component data (e.g., beam dimensions and loads) using Python and a CSV or JSON file.
6. Evaluate whether stress in individual beams exceeds material limits by comparing calculations to known yield strength values.

Materials Needed:

Access to Autodesk Fusion 360
Wood, Screws, Saws, Drills
Access to Visual Studio Community
or Code HS to run Python

Activity:

Tasks:

Build a digital bridge model in Fusion 360.

Export key beam dimensions and forces.
Then build and test a bridge using wood.

Use Python to:

Calculate stress in each beam
Compare to material strength
Output weak points and safety factor
Reflect: Does the simulation match physical tests?

Assessment:

Does the simulation match physical tests?

Students will interpret simulation or calculated results to evaluate the effectiveness and safety of their bridge design.

Students will be expected to turn in the following:

- Design summary
- Load assumptions
- Simulation + Python analysis
- Safety evaluation
- Suggested improvements

Note: If you're looking for automated load testing via Python, consider switching your bridge model into:

Tools That Work with Python:

ToolCapability

Abaqus + Python

Full FEA control and scripting

ANSYS PyMAPDL

Python interface for simulations

CalculiX + Python

Free FEA with text-based solver control

OpenSeesPy

Structural engineering FEA in Python

SimScale + API

Cloud-based, limited free use, data exportable

You can export your Fusion 360 bridge as STEP or STL, then load it into one of these tools for scripting and simulation.