

DESIGN PROJECTS



BRIDGES

GRADE LEVEL

Grades 9-12

MODELING TIME

2-4 hours

MATERIALS

- Filament – Approximately 203g

DESIGN OBJECTIVES

- 3D Printed
- Minimize waste using Flat-Pack Design principles.
- No Fasteners or Adhesives

DESCRIPTION

Bridges are everywhere and are a vital part of a society's infrastructure helping assist in the ability to transport people and products to destinations they need to go.

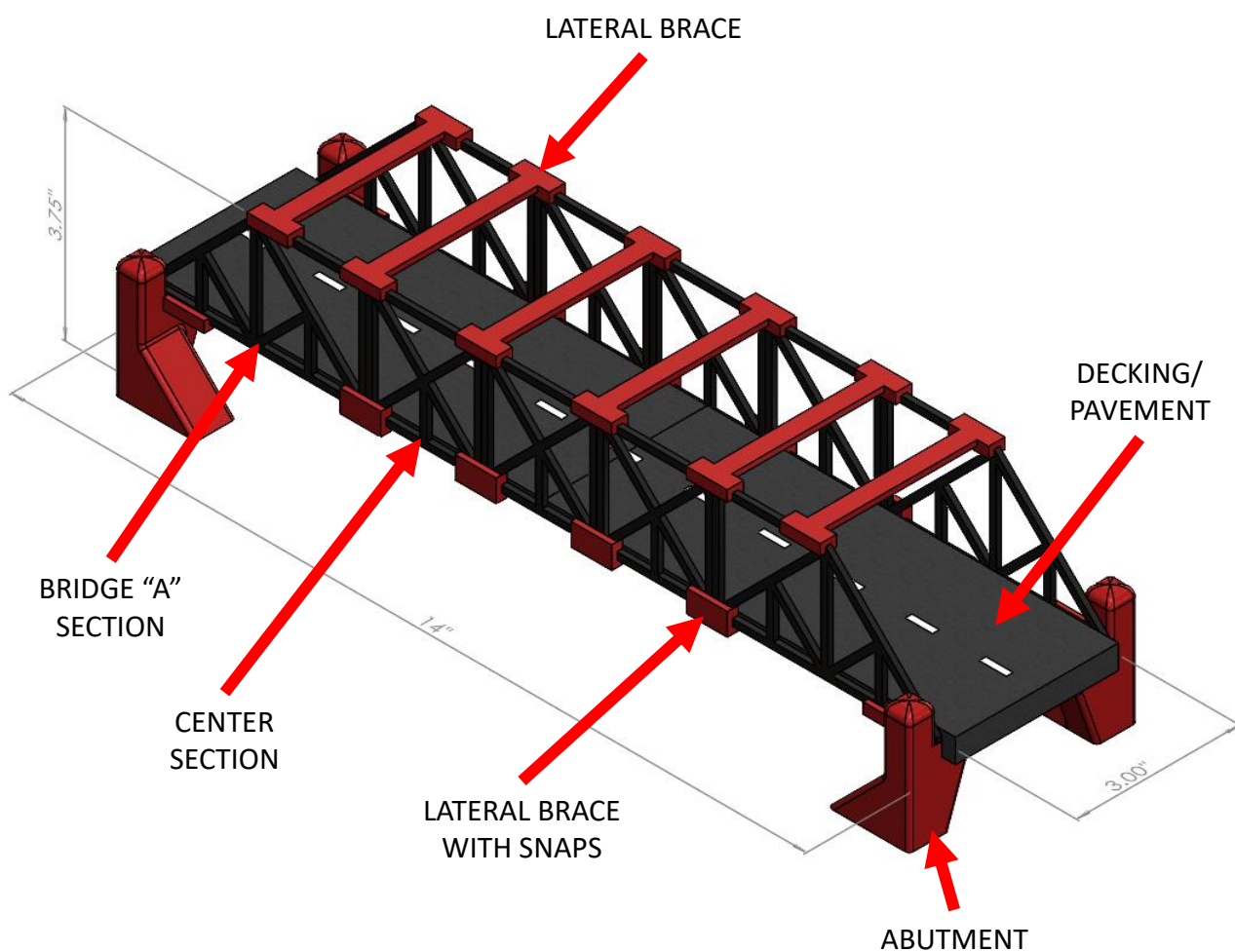
This activity presents a wide range of possibilities for the instructor. The individual components are simple enough for beginners to learn the basics of designing with CAD and the result is a model that can be used to explore the aspects of bridge design. This project is suitable for individuals and teams to eventually design and build their own bridge.

HISTORY

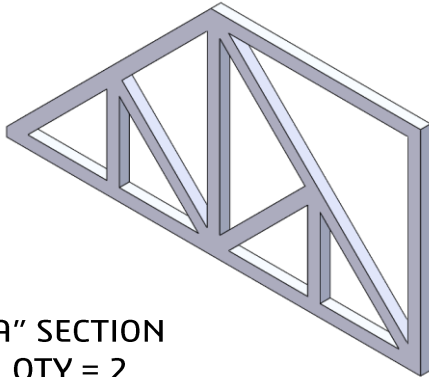
Pratt Truss – In Boston, Thomas Pratt and his father Caleb Pratt designed a bridge truss structure that was to become a standard in bridge construction up to World War 2. It was able to span anchor points up to 250ft (76 meters) apart.

Baltimore Truss – A Baltimore truss is similar to a Pratt truss design with additional bracing in the lower section to prevent buckling and add strength. The Baltimore truss style bridge is a simple and very strong design often used for supporting trains.

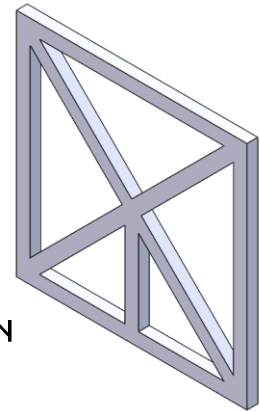
BRIDGE COMPONENTS



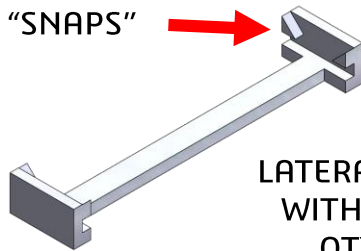
BRIDGE COMPONENTS



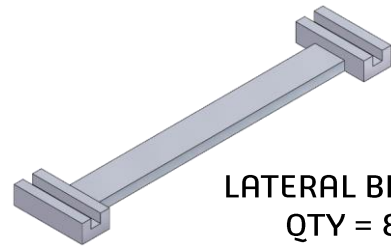
"A" SECTION
QTY = 2



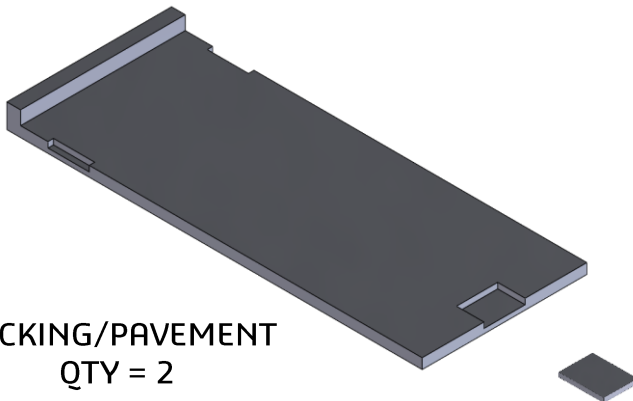
CENTER SECTION
QTY = 3



LATERAL BRACE
WITH SNAPS
QTY = 4

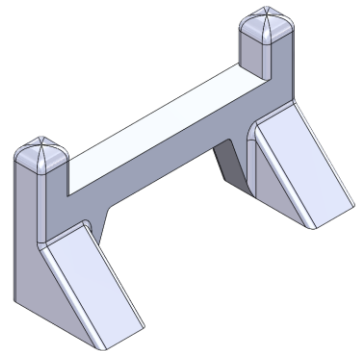


LATERAL BRACE
QTY = 8



DECKING/PAVEMENT
QTY = 2

DECKING
CONNECTOR
QTY = 1



ABUTMENT
QTY = 2

EDUCATIONAL CONCEPTS

A bridge design and construction project is an excellent way to integrate multiple STEM concepts. Here are some potential teaching approaches:

SCIENCE

- Discuss properties of materials like tensile strength, compression, elasticity, and their suitability for bridges.
- Test the strength of different 3D printing materials, such as PLA vs. ABS.
- Explain forces acting on a bridge (e.g., tension, compression, shear, and torsion).

TECHNOLOGY

- Teach students to use 3D modeling for creating their bridge designs.
- Demonstrate how 3D printers work, from slicing software to the actual printing process.
- Discuss additive manufacturing principles and how they differ from traditional methods.
- Emphasize the importance of DFAM, Designing for Additive Manufacturing, by minimizing waste through smart design.

ENGINEERING

- Compare designs like suspension, arch, truss, and cable-stayed bridges.
- Challenge students to select a design type based on specific constraints (e.g., span length, weight capacity).
- Introduce failure analysis to identify and fix weak points in the design.
- Focus on problem-solving and overcoming design failures.

MATHEMATICS

- Discuss geometric principles used in bridge design, such as triangles in trusses for stability.
- Calculate angles, lengths, and dimensions for accurate CAD modeling.
- Measure and analyze load capacities of printed models, comparing results to predictions.
- Have students estimate material costs, factoring in 3D printer filament usage.
- Compare budget-friendly designs to more elaborate ones.

OPTIONAL CHALLENGES

- Assign roles (e.g., design engineer, materials specialist) to mimic real-world engineering teams.
- Divide students into teams. Have each team design a unique bridge and have a competition using the models.

DISCUSSION STARTERS

- How does adding the decking improve the strength of the bridge?
- Why should the bottom angles of the abutments face inward?
- How long of a span can be achieved in order to support a 10lb weight? (add center sections, with decking or without)
- How does the Baltimore design compare to other bridge designs?

ASSESSMENT CRITERIA

- **SUSTAINABILITY** – How much waste is generated in the manufacturing process?
- **ASSEMBLY** – With no adhesives or fasteners, does the model hold together on its own?
- **MANUFACTURABILITY** – Do the components fit within the parameters of the 3D printer? Laser cutter?
- **PERFORMANCE** – How long of a span with the bridge?

ADDITIONAL RESOURCES

[LINK TO DOCUMENTS](#)

[LINK TO YOUTUBE VIDEO](#)

[LINK TO STEP-BY-STEP](#)