Constructables

Real life construction toys

Lesson Plan: Truss Bridge Construction

NZC Level:	**4**	**Class**	
Year:	**7-8**		
Ages:	11-12 years old	**Teacher**	
Duration:	1-2 Hours		
Class Size:	Up to 30 Students	**Date**	

Subject:	**Key Competencies:**
Technology • Technological Practice • Technological Knowledge • Nature of Technology	• Relating to Others • Participating and Contributing • Managing Self

Learning Intentions

Students will:

- Understand the principles of tension and compression in bridge design.
- Apply teamwork, planning, and iterative design to solve a real-world problem.
- Evaluate the strengths and weaknesses of their structures and justify design decisions.
- Reflect on how civil engineering affects communities and environments.

Materials Needed:

- **Constructables Truss Bridge Set**: 1 box per 2-4 children
- **Additional materials**: cars, signs, animals, rocks

Lesson Structure:

Set Up:

1. Place all Constructables building parts in a central location.

Form Groups of 4-6:

2. Form groups for children to work together. You can do this yourself or allow children to form their own groups.
3. Each team to collect:
    - Set of Blueprints
    - Set of Learning Cards

Introduction:

4. Talk about different bridge types (see learning card included in sets) and engineering. Choose a few questions

Question	**Answer (for teacher)**

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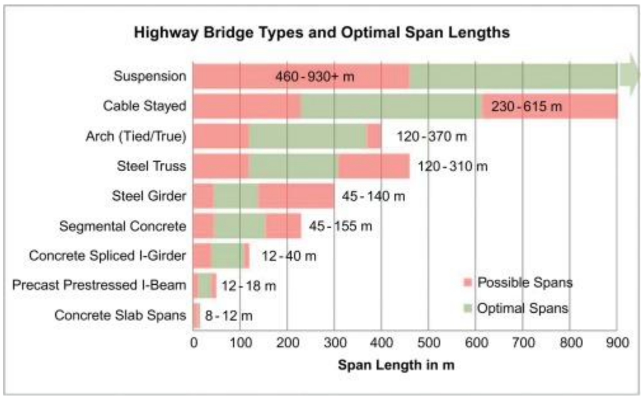
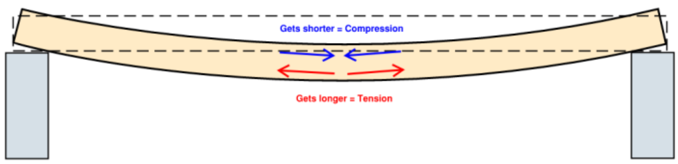
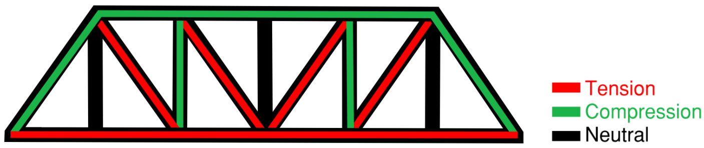
What are bridges for?	Students to answer
Who are engineers? What are their jobs?	Engineers are professionals that invent, design, analyse, and build things. Civil Engineers work on infrastructure and construction. Mechanical engineers work on things that move.
Which bridge type can span the longest distance?	Suspension Bridge. The longest one spans nearly 2km! 
What are blueprints?	These are drawings that engineers created. They show builders how the bridge should be built.
How do bridges work?	When you put a weight on a bridge, the bridge needs to transfer that weight (or load) through the bridge parts to its supports at the end. This happens through tension & compression (push & pull)
How do bridges bend? Imagine standing on a wooden plank.	Bridges bend just like the wooden plank. When the plank bends, you can imagine that the bottom of the plank gets longer. This is why we know that the bottom of the plank is under tension (getting pulled). This is how it transfers the weight in the middle all the way to the outside of the bridge - by pulling forces through the bottom of the plank.  (the top of the plank gets shorter and is in compression) This concept is used in Truss Bridges. The top of the bridge is being pushed. The bottom of the bridge is being pulled.

How does the weight on the bridge get supported by the edges? How does this weight “transfer” through the bridge?	The weight on the bridge will travel through “load paths”. The weight is ultimately supported by the ends of the bridge. So, the weight travels through the bridge beams in either tension (pulling) or compression (pushing). In every structure, the loads down (from gravity) will also equal the loads up (the support). The same is true for loads side to side! 

5. Talk to the children about the different parts and how they relate to real bridges. Use the photos included in this lesson plan.

Question	**Answer**
Which direction of the H-Beam is the strongest?	 With the flat side down. The beams are strongest when the most amount of material is the farther from the centre of the beam.
What do connections look like?	Show photo on connection. These are the most complicated parts of the bridge.
What makes Truss Bridges strong?	Triangles

Main Activity:

1. Define the purpose of the activity (e.g. for the bridge to support 10kg).
2. Teams to define roles.
3. Study the blueprints and discuss the truss design. Decide if they’ll follow the blueprint or modify it.
4. Teams need to collect the necessary parts from the pile in the centre.
5. Teams to build the bridge.
6. Option to test the bridges with a weight (e.g. 10kg)
7. Suggest different scenarios such as wind loading or earthquakes. How would the bridge survive and what could you do to make it strong in real life?

Teams will need to problem solve as they build. Key things to watch out for are:

- Make sure the H-beams are flat to the ground.
- Make sure that the beams are pushed in far enough. You may want to help with this if they are struggling.

Finishers (optional):

- Make the bridges span across tables to play with.
- Connect bridges together with spare beams and see how long you can make the bridge!

Reflection:

Teamwork:

- What challenges did they face while building the bridge?
- How did they overcome these challenges?
- What was hard about working in a group?
- What made your group work well?
- How did you solve problems together?

Technology:

- What real-world problems does your bridge design solve?
- If this bridge were full-size, what materials would you use and why?
- What were the strengths and weaknesses of your team's process?
- How did your design decisions change as you went along?

Assessment options

- Student design briefs and reflection journals.
- Verbal presentations explaining design decisions.
- Group self-assessment and peer feedback on collaboration and contribution.

(Optional) Cross-Curricular Integration

- **Math**: Measure angles, calculate span-to-height ratios.
- **Science**: Explore material properties under stress.
- **Social Studies**: Research famous bridge failures and what we've learned from them.

Lesson Goals and Learning Outcomes:
Technology - Technological Practice
Planning for Practice Students will plan a structured approach to building their bridge, identifying stages of development, resources, constraints, and team responsibilities. In Practice: • Develop a design brief with functional goals and success criteria. • Break the project into phases (design, testing, construction, improvement). • Assign specific roles and responsibilities within the team. • Consider time management and materials usage during planning.

Brief Development

Students will describe the essential features and performance requirements of their truss bridge and justify design choices.

In Practice:

- Identify and justify key design features (e.g., stable truss type, strong joints, appropriate span-to-height ratio).
- Modify or improve the blueprint to better meet the functional needs.
- Ensure their design solves a specific problem (e.g., holding weight, covering a gap, resisting movement).

Outcome Development and Evaluation

Students will investigate and evaluate design ideas and produce an outcome that meets the specifications and justified design decisions.

In Practice:

- Build models and adjust as needed based on test results.
- Evaluate the success of their bridge against defined goals (e.g., load capacity, span, durability).
- Use specific reasoning (e.g., "We used a Warren truss because...") to explain design decisions.

Technology - Technological Knowledge

Technological Modelling

Students will understand that functional models are tools used to test ideas and predict performance before creating final products.

In Practice:

- Create test sections of the bridge to analyse strength and stability.
- Compare different truss arrangements to find the most effective.
- Use results to revise their final construction method or structure.

Technological Products

Students will understand that different materials and shapes perform differently under load, and these properties influence engineering decisions.

In Practice:

- Reflect on how design choices (e.g., placement of beams, use of connectors) impact the bridge's strength.
- Understand how tension and compression affect materials and shapes.

Technology - Nature of Technology

Characteristics of Technology

Students will explore how bridge technologies impact society and reflect the context in which they are developed.

In Practice:

- Discuss why certain bridge types are used in specific locations.
- Investigate the social and environmental role of bridges in real life (e.g., connecting rural communities, enabling trade, protecting habitats).

- Consider sustainability and efficiency in bridge design.

Characteristics of Technological Outcomes

Students will understand that technological outcomes are created with specific purposes and are shaped by constraints, users, and environments.

In Practice:

- Identify that their bridge is a purposeful design solution.
- Reflect on how design was shaped by available materials, the build task, and team collaboration.
- Consider how different environments (e.g., weather, terrain) might impact a real-world version of their bridge.

Core Competencies

Relating to Others

Work effectively in diverse groups, valuing different perspectives and contributing respectfully to group success.

In Practice:

- Share and explain ideas clearly within the group.
- Listen actively to team members and build on their suggestions.
- Use constructive feedback to improve team performance (e.g., "Let's combine your idea with this design I saw…").
- Resolve disagreements respectfully through discussion or voting.

Participating and Contributing

Engage confidently in group tasks, support others, and take responsibility for shared outcomes.

In Practice:

- Take on defined roles (e.g. team leader, quality checker, parts manager).
- Encourage all voices in the group to be heard.
- Reflect as a group on successes and areas to improve.
- Contribute ideas and effort to meet the team's goal.

Managing Self

Demonstrate self-discipline, perseverance, and independent thinking in a practical, open-ended task.

In Practice:

- Persist with difficult parts of the design or build without giving up.
- Organise personal tasks and manage time effectively within the team.
- Take initiative to solve problems or support others.
- Reflect on personal contributions and areas for growth.

Questions to extend learning:

- What makes a triangle stronger than a square in a bridge? Can you show this using your parts?
- How would your bridge design change if it had to withstand high winds or earthquakes?
- Why are some bridges made with arches, while others use cables or trusses? What are the trade-offs?
- If you were building this bridge for real, what materials would you use and why? Could you use plastic?
- How do civil engineers make sure bridges are safe for many years?
- What are the environmental impacts of bridge construction, and how could they be reduced?
- Can you create a new type of bridge using principles from more than one bridge style?
- How does the weight you add to your bridge affect the forces (tension/compression) in different parts of the structure?
- How do real engineers test bridges before building the full-scale version? Can you think of ways to do similar testing here?

Extensions to the basic Constructables box include:

- Adding pins to further explore tension/compression.
- Building upwards to create buildings.
- Creating different types of bridges (some examples can be seen on our website).
- Additional connector sets will enable you to build even more bridge types and have more variety for children to choose from.
- Build a railroad track or other structure across the bridge.
- Build a bascule bridge (i.e. a draw bridge)

Should you have any questions, comments, or suggestions, please get in touch with us at info@constructables.co.nz.

Website

Constructables.co.nz

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Multimedia

Figure 1 Matapihi Rail Bridge in Tauranga

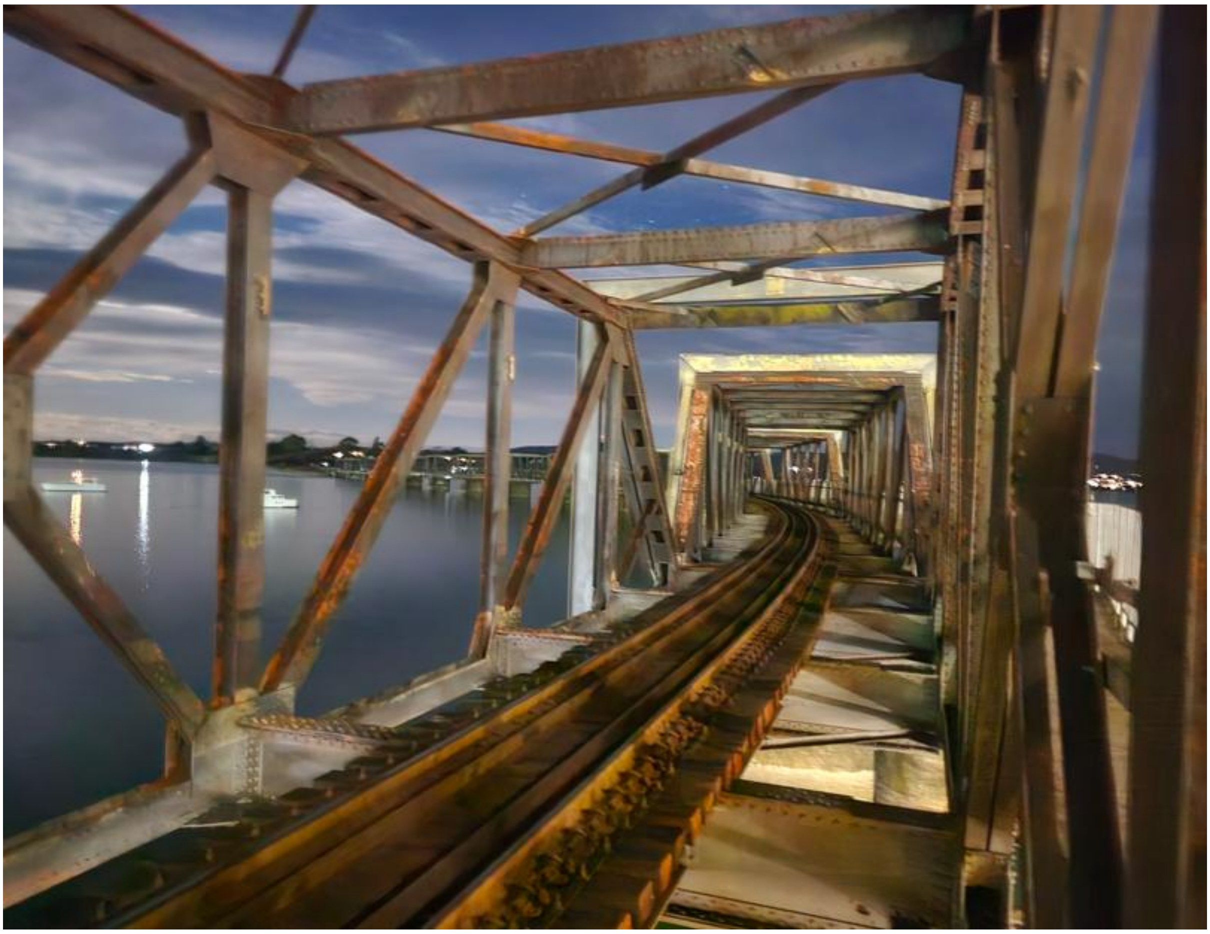

Figure 2 Matapihi Rail Bridge in Tauranga

Figure 3 Route 60 Gauley Bridge, WV, USA

Figure 4 Lifting a truss bridge in its place

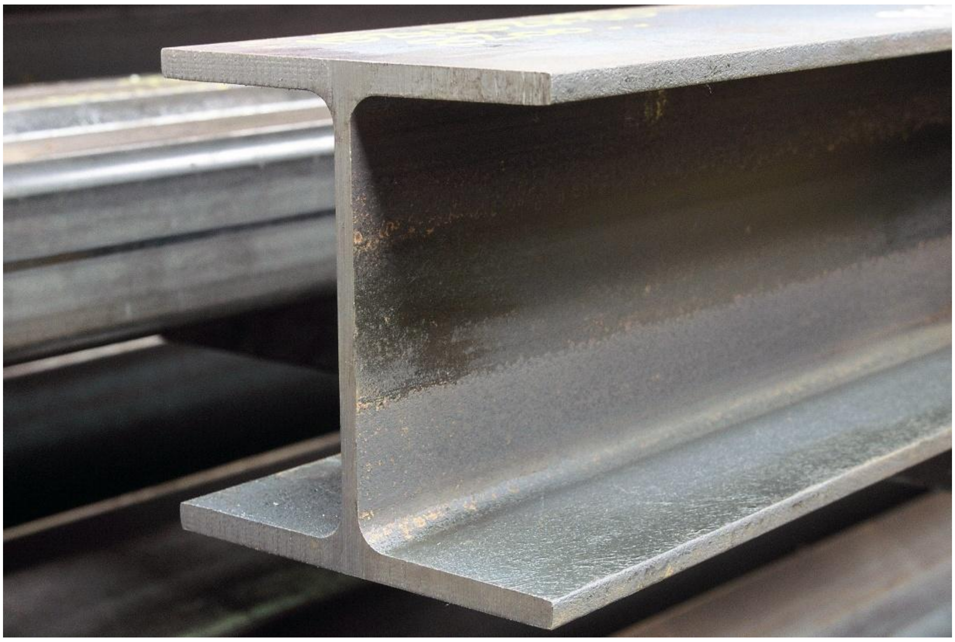

Figure 5 An H-Beam

Figure 6 Matapihi Rail Bridge Beam Connection

Figure 7 H-Beam Connection

Bridge Type	Max Span	Example
Suspension	~2,000 m	Akashi Kaikyō, Japan – 1,991 m
Cable-stayed	~1,000–1,200 m	Russky Bridge, Russia – 1,104 m
Arch	500–600 m	Chaotianmen Bridge, China – 552 m
Cantilever	500–600 m	Quebec Bridge (Canada) – 549 m
Truss	300–400 m	Ikitsuki Bridge (Japan) – 400 m

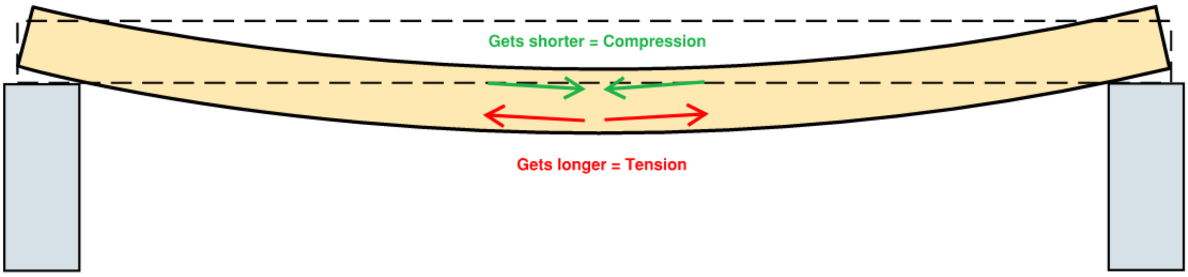

Figure 8 Schematic showing a plank bending. The bottom of the plank is being "pulled" and the top is being "pushed".

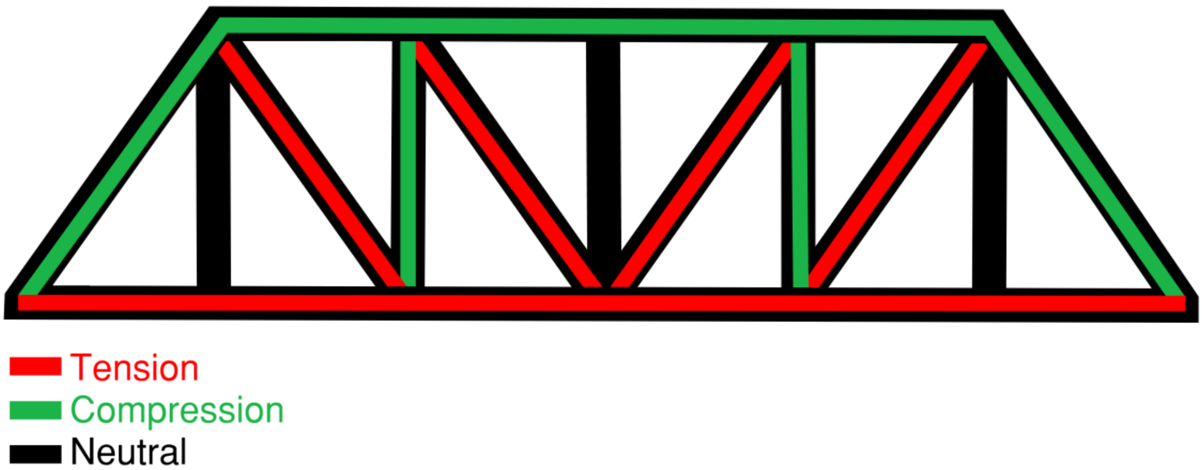

Figure 9 Truss Bridge Push-Pull Model

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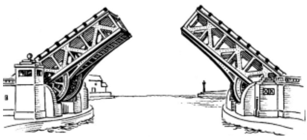
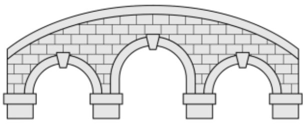
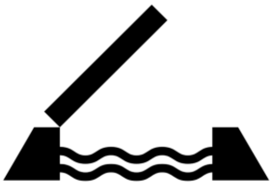
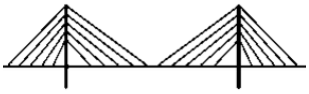
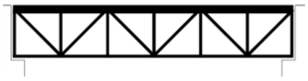
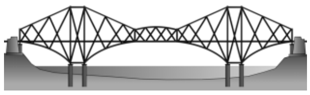
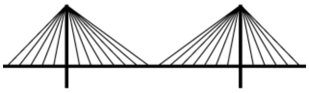
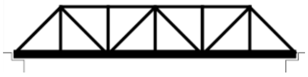
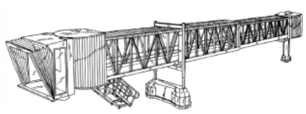
 **Deck Arch Bridge**	 **Bascule Bridge**	 **Truss Bridge**	 **Box Girder Bridge**
 **Suspension Bridge**	 **Three Arch Bridge**	 **Suspension Bridge**	 **Draw Bridge**
 **Harp Cable-Stayed Bridge**	 **Deck Truss Bridge**	 **Tied Arch Bridge**	 **Cantilever Bridge**
 **Arch Bridge**	 **Fan Cable-Stayed Bridge**	 **Truss Bridge**	 **Jet Bridge**