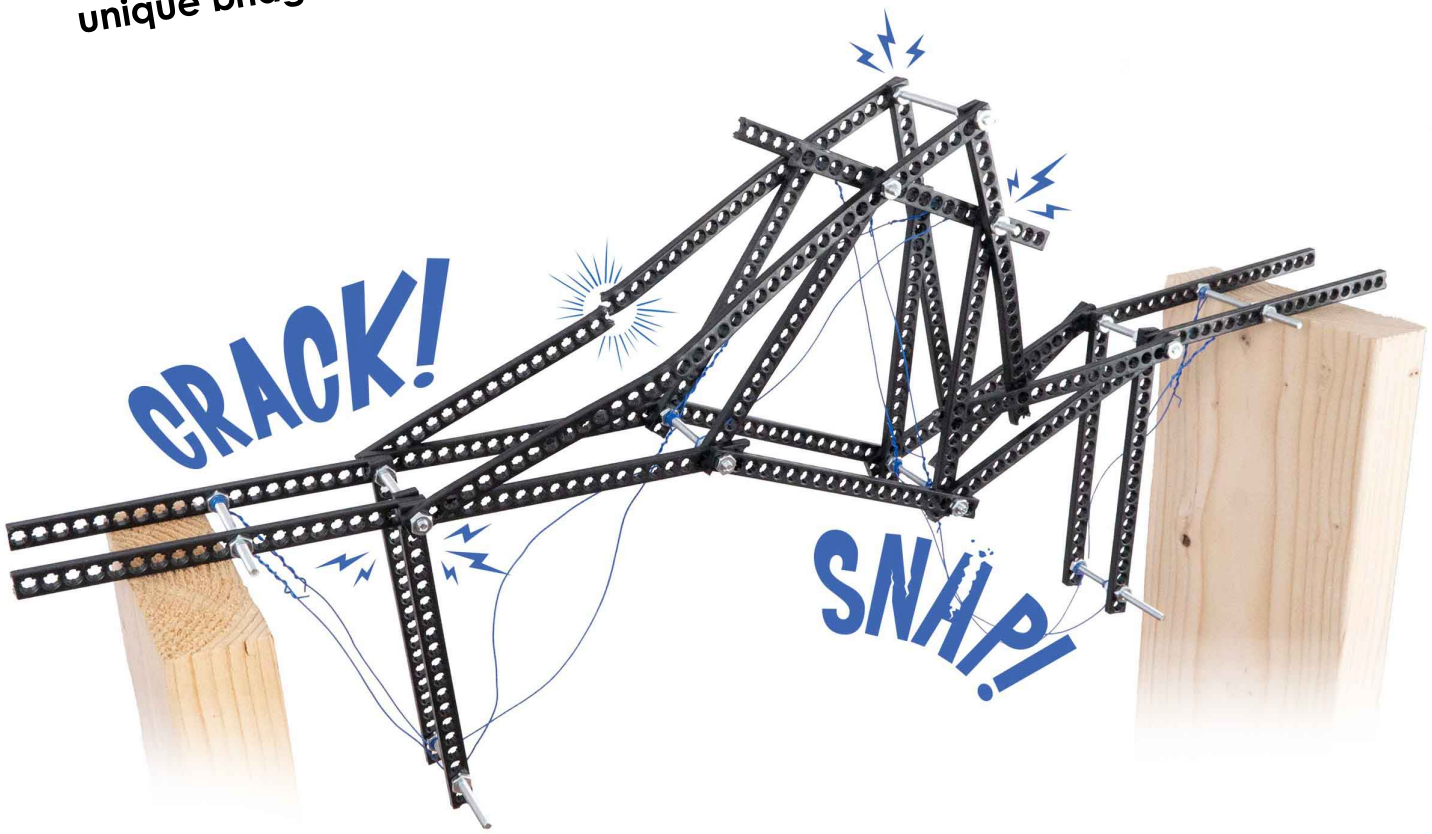
BREAKING BRIDGES GO GUIDE

Grades 3-5

6-12+ version available at teachergeek.com/bridges

Learn how structures react to forces by designing, testing, and improving your own unique bridge!



You Are Here

Choose how you would like to complete this activity.
Download documents & videos at **teachergeek.com/bridges**

Go Guide

Start here! Build your example bridge, evolve your design, and begin the Distance Challenge!

Optional Challenges

-Distance Challenge*
-Strength Challenge*

*See Page 8

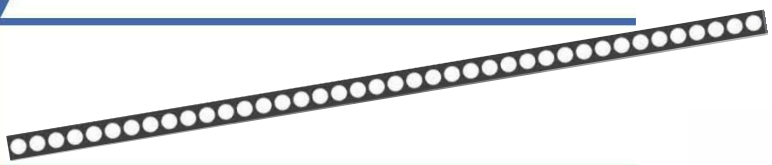
Other Resources

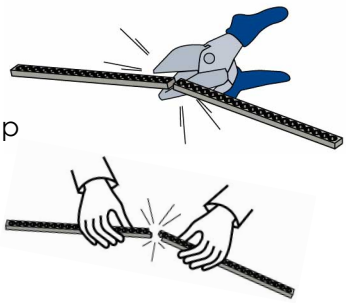
-Strength Testing Guide
-Engineering Notebook
-Design Grid

BREAKING BRIDGES GO GUIDE

BRIDGE COMPONENTS

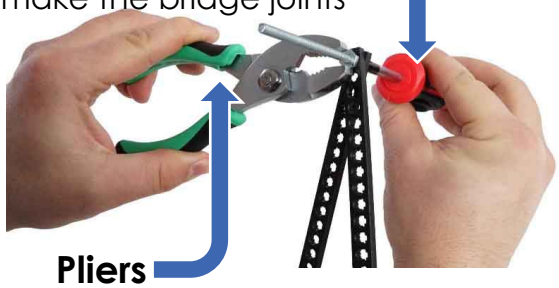
What parts will you need to create your bridge? The list below includes extra parts so you can experiment and develop your own unique designs.

NAME	QTY	PICTURE
Strips 30cm (12in.) SKU 1821-31	**6**	
Half Strips 15cm (6in.) SKU 1821-31	**20**	 If you do not have half strips, cut or snap them from full strips.
Colored Wire SKU 1821-43	**1**	 Wire can be used, just like strips, as parts of your bridge.
Bridge Nuts size #8 SKU 1824-80	**33**	 Note: These are not the usual #10 nuts and screws used on TeacherGeek projects. They are thinner (#8), so they can slide through strip holes.
Bridge Screws #8 76mm (3in.) SKU 1824-78	**11**	



TEACHERGEEK TOOLS

Phillips Screwdriver
to tighten the screws that make the bridge joints

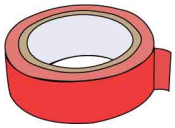


Pliers
to hold the nuts while tightening screws.

OTHER MATERIALS

2 Markers

Tape
duct tape preferred



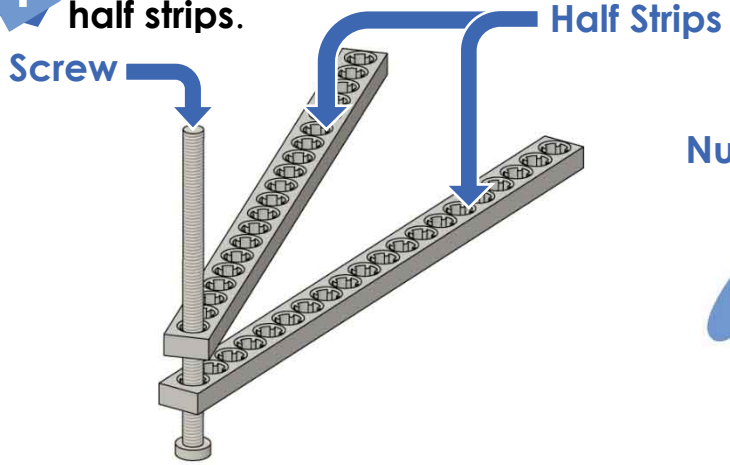
Scissors

BREAKING BRIDGES GO GUIDE

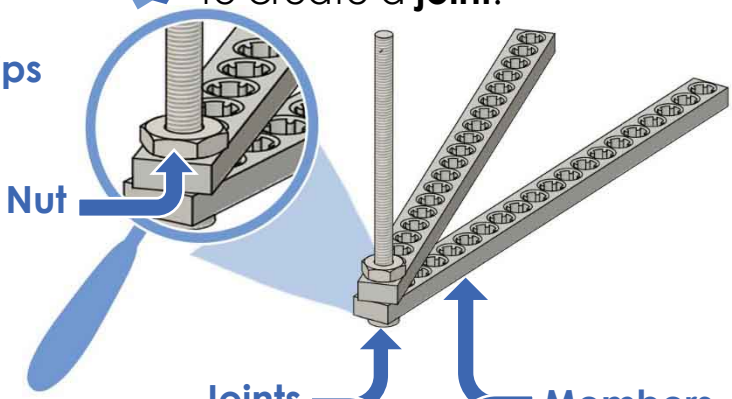
MAKING JOINTS

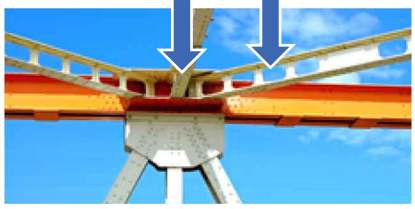
How do you connect bridge parts?

1. Slide a **screw** through two **half strips**.



2. **Spin** a **nut** onto the **screw** to create a **joint**.



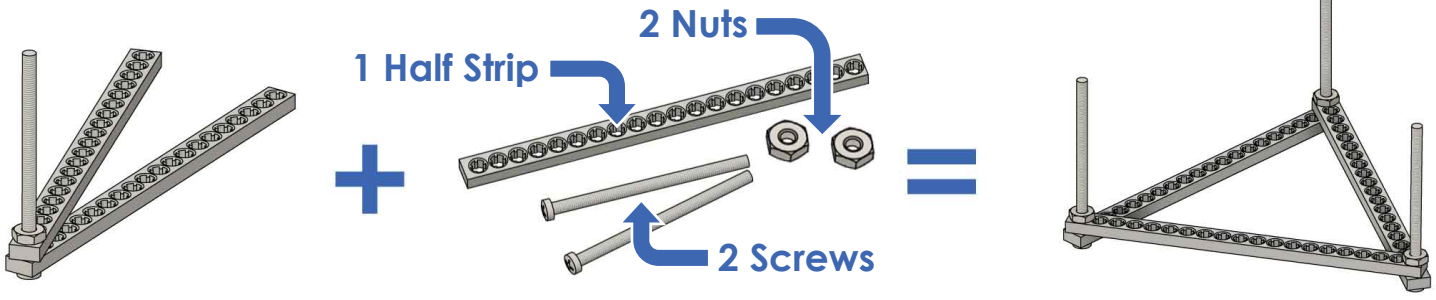


Joints are the points on the structure where members connect.

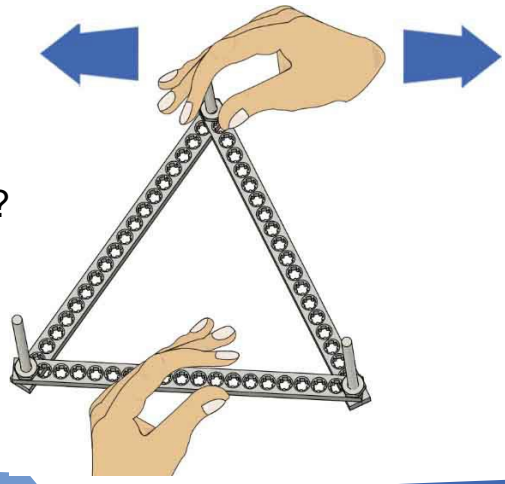
STABLE SHAPES

What shapes should your bridge use?

3. **Make a triangle** by adding more parts. Attach it with screws and nuts.



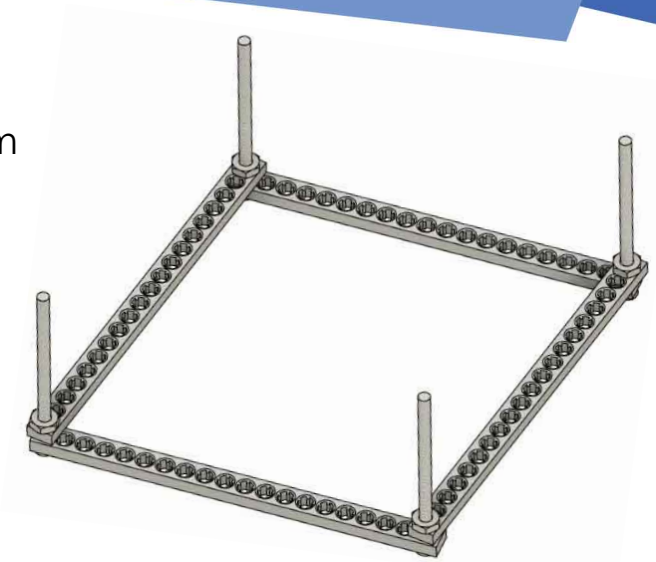
4. **Push** and **pull** on the **triangle**. Is it **stable?** Can it hold its shape?



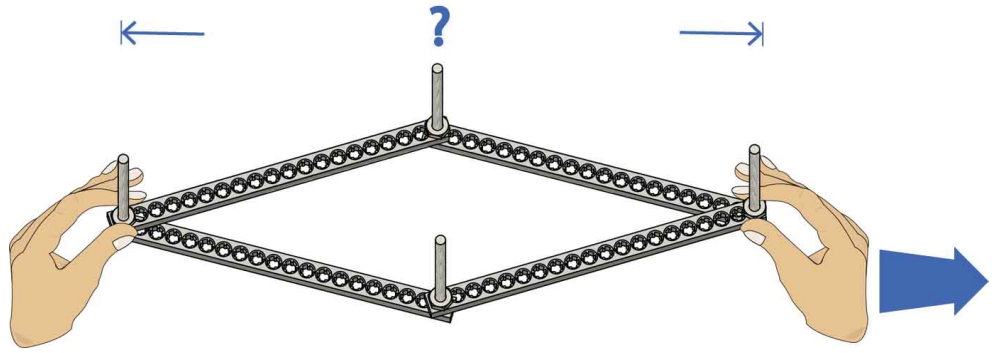
Is it stable?

Yes! **Triangles** are **stable**. They can hold their shape.

5 **Make** a **square out of** your **triangle** from Step 3. You will need another half strip, screw and nut to do this.



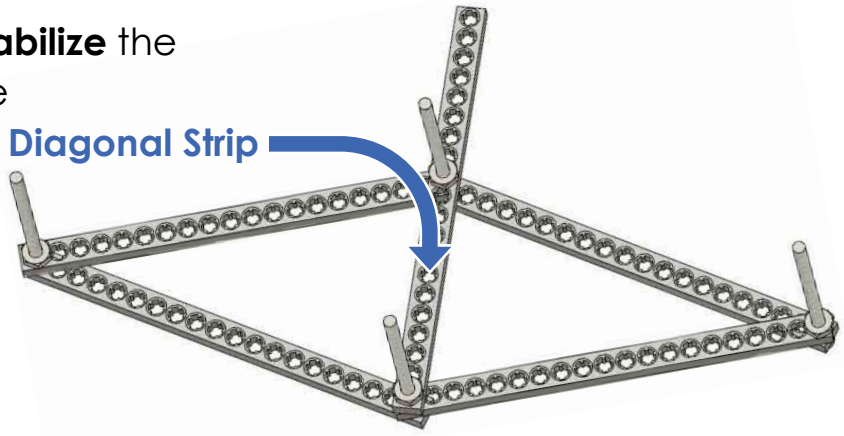
6 **Push** and **pull** on the **square**. Is it **stable?** Can it hold its shape?



Is it stable?

Nah… **Squares** are **not stable**. The square changed shape to a rhombus.

7 Can a **diagonal** strip **stabilize** the **square**? Try adding one (you don't need to match the picture).

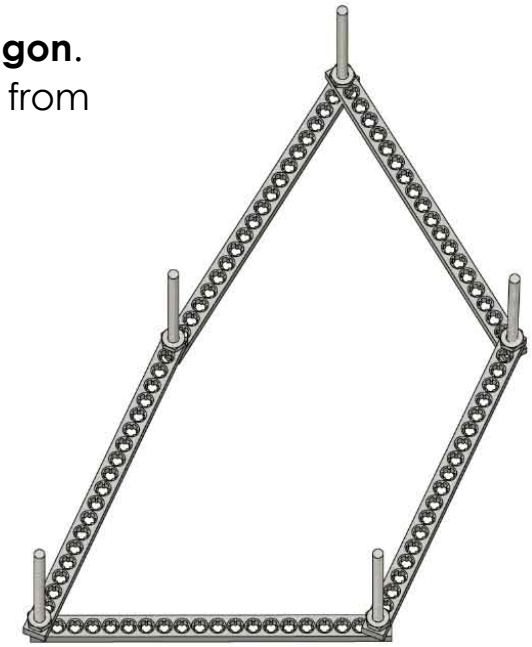


Is it stable?

Yes! Diagonals divide the square into triangles and **make it stable**.

This bridge is stabilized with diagonals.

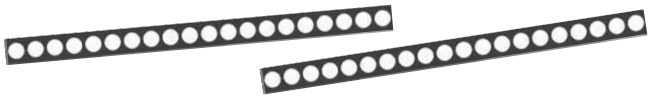
8 **Turn** the **parts** from Step 7 **into** a **pentagon**. You will need to remove the diagonal from Step 7 and add more parts.



Is it stable?

Nope… **Pentagons** are **unstable** shapes.

9 **Make** the pentagon **stable** by adding two **diagonal strips**. How does it react?



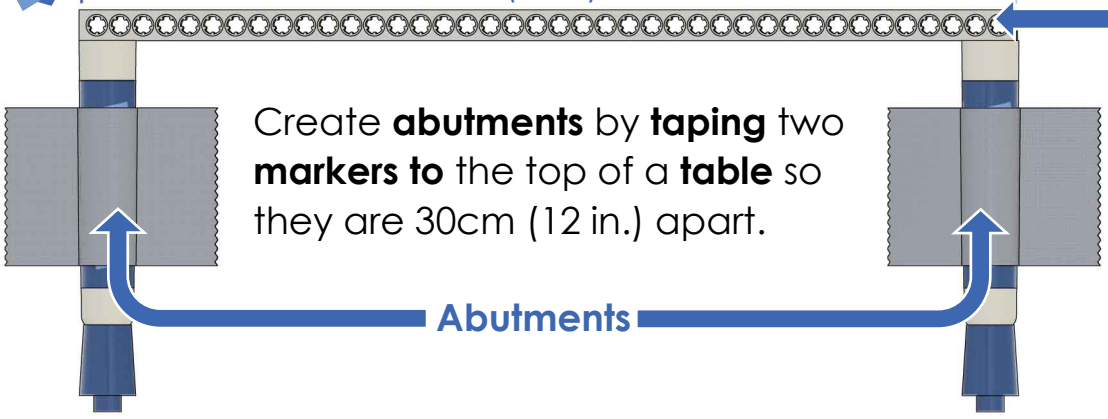
10 **Take apart** your stabilized **pentagon**.

CREATING ABUTMENTS

Get ready to test bridge designs!

Abutments: The structures that hold up the ends of a bridge.

11 **30cm** (12in.)



Create **abutments** by **taping** two **markers to** the top of a **table** so they are 30cm (12 in.) apart.

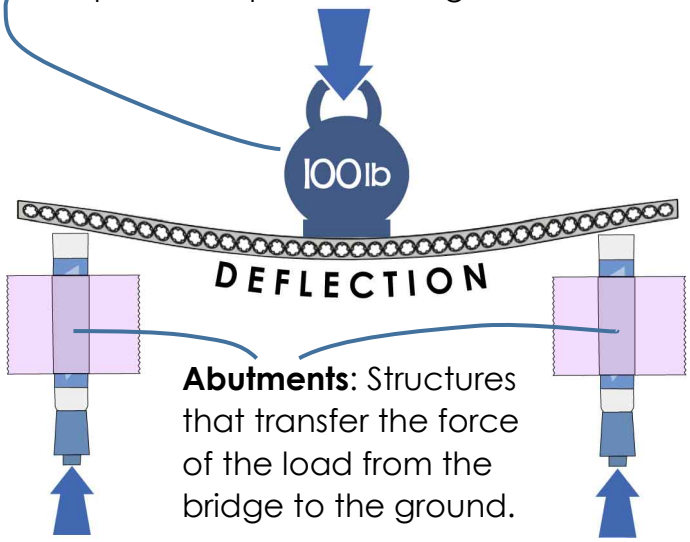
You can measure the gap with a full strip.

DEFLECTION

Time to test some designs!

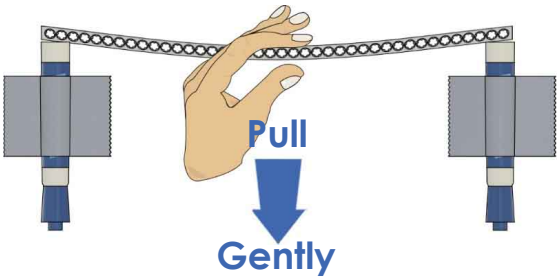
Deflection: When a bridge bends as it carries a load. Even the strongest bridges will deflect.

Load: The weight carried by a bridge, which pushes or pulls the bridge downward.



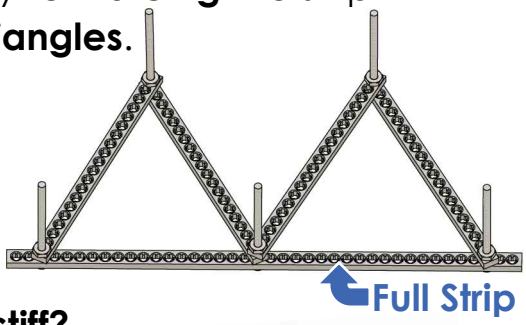
Abutments: Structures that transfer the force of the load from the bridge to the ground.

12 Place a **full strip** on your abutments. **Gently pull** the middle down. Does it **flex**, or is it **stiff?**

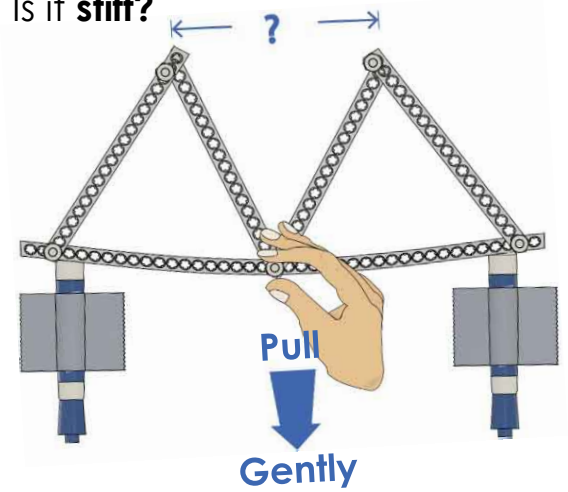


The strip is **flexible**. It **deflects** (bends) **easily**. Let's try and make it deflect less.

13 Try **reinforcing** the strip **with triangles**.

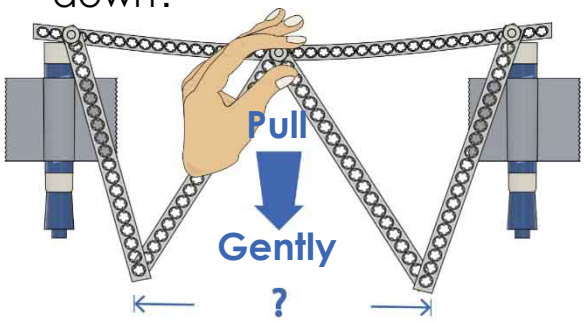


Is it **stiff?**



It's **stiffer**, but the **middle deflects**. What happens to the tops of the triangles?

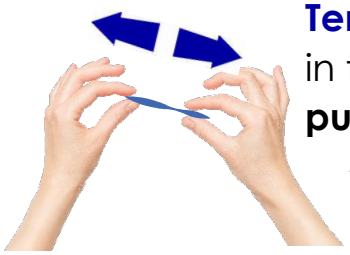
14 How does the **deflection change** if we turn it upside down?



What's happening to the bottom points of the triangles?

TENSION AND COMPRESSION

How can you use wire in your design?



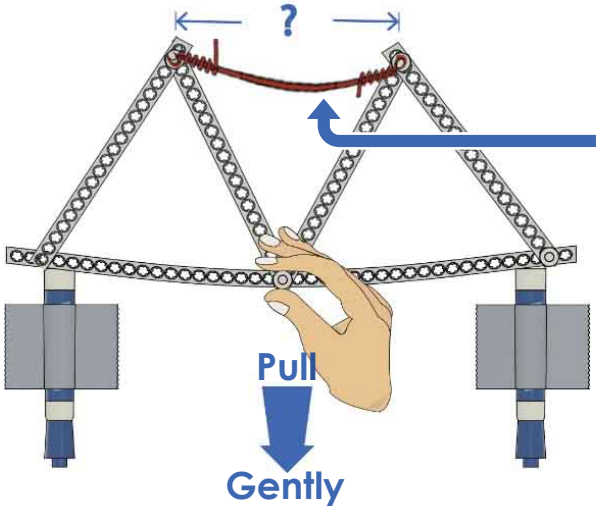
Tension: a member is in tension when it is **pulled** outward.

Molecules pull on each other, struggling to stay together.

Compression: a member is in compression when it is **squeezed** or pushed inward.

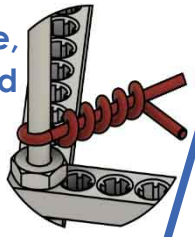
Molecules push back, trying to stay apart.

15 **Add wire** to reinforce your structure. Does the **wire stiffen it?**



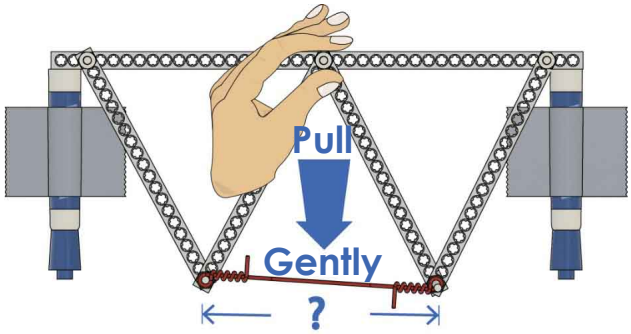
Tip

To attach wire, wrap it around a screw, then twist the wire around itself.



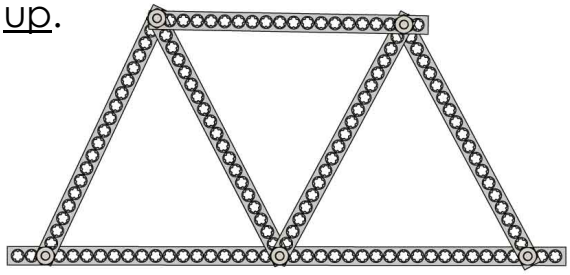
Nope… The **wire** is under **compression**, and wire bends instead of pushing back.

16 Turn your structure **upside down**. Does the **wire stiffen it?**



Yes. The **wire** is under **tension** this time, and it pulls back to stiffen the structure.

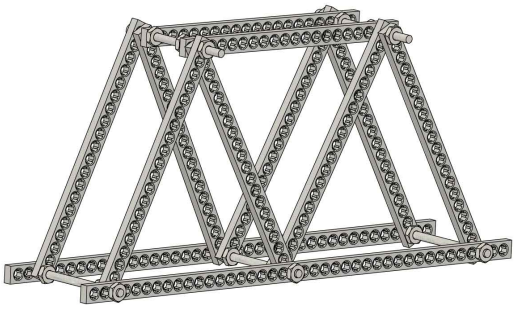
17 **Replace** the **wire** with a **half strip**. **Test it** upside down and right side up.



Strips are **strong under both** compression and tension.

You created a truss (half a bridge)!

BUILDING A BRIDGE

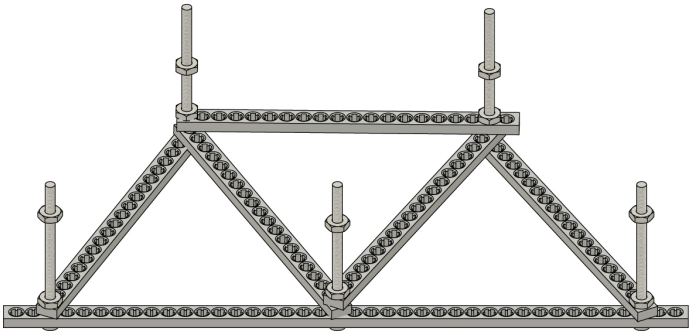


You're *almost* ready to design your own bridge! Follow these last few steps to turn your truss, from Step 17, into a bridge.

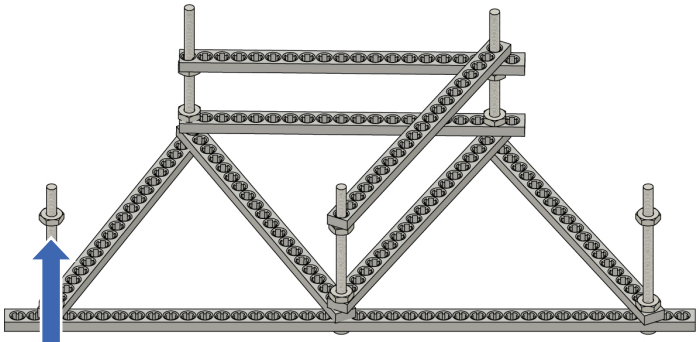
Trusses: structures that make bridges stiff and stable.

Deck: the surface cars, trains, people, and pipelines use to cross a bridge.

18 Your second truss will need nuts to rest on; **add** a **nut to each screw**.

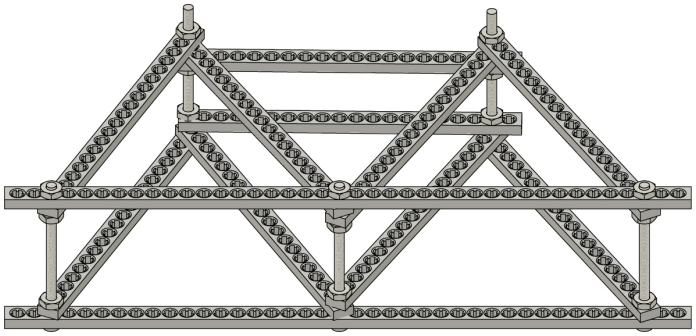


19 **Create** the second **truss** by placing **half strips** on the nuts.



You may need to adjust your nuts so that your trusses stay parallel.

20 Finish the bridge by **tightening nuts onto** the **screws.**



Tip

You can use a screwdriver and pliers to make your joints tighter.

BREAKING BRIDGES GO GUIDE

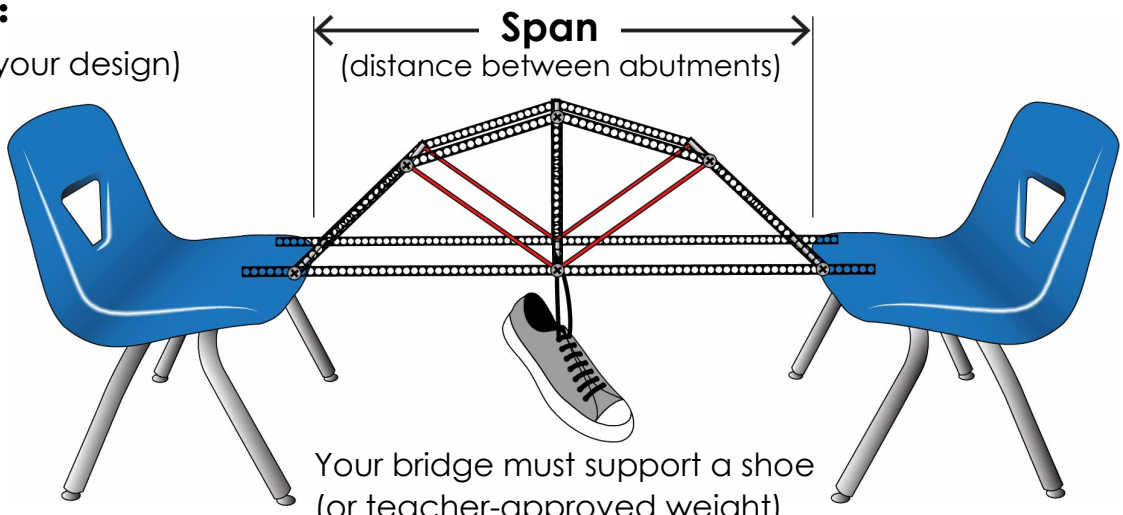
DISTANCE CHALLENGE

Test it, change it, and repeat!

CRITERIA:
(what your design must do)

Redesign your bridge to make it as long as possible. The bridge with **the longest span wins!**

CONSTRAINTS:
(rules and limits for your design)



Use chairs or desks as abutments on each end of the bridge. Piers (middle supports) are not allowed.

Your bridge must support a shoe (or teacher-approved weight) above the ground.

Nothing may be used to hold the bridge on the abutments (e.g., no tape, weights, etc.).

Components: You may only use the components listed on Page 1 – you can't add extra parts. Connector strips can be cut or left whole.

Use the optional **Design Grid** and **Engineering Notebook** to plan and document your designs! Documents available at **teachergeek.com/bridges**

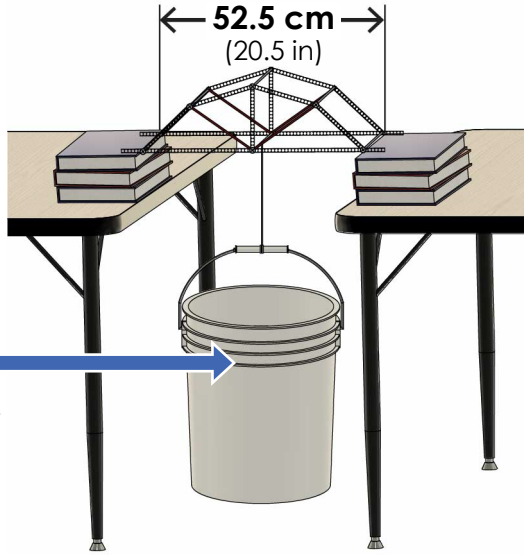
(optional)

STRENGTH CHALLENGE

CRITERIA:

Redesign your bridge to hold the most weight possible.

The bridge that holds the **most weight wins!**



Hang a bucket near the middle of your bridge, then fill with water bottles or other weights.

CONSTRAINTS:

Your bridge must hold the weight over a **span** of **52.5 cm** (20.5 in).

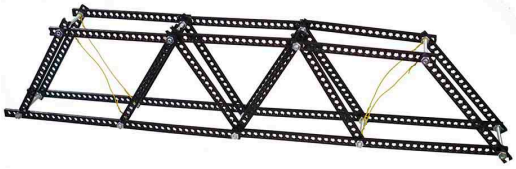
All other constraints are the same as the Distance Challenge (above).

Want more guidance for Strength Testing? Get the **Testing Guide** at **teachergeek.com/bridges**

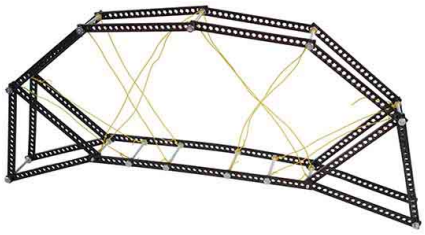
What type of bridge will you build?

RECOMMENDED BRIDGE TYPES

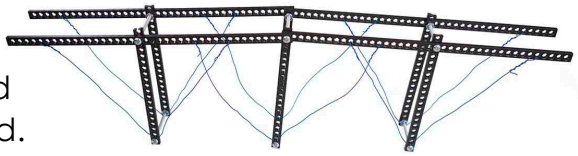
Truss Bridges – Use trusses to carry a load. Trusses are typically made of triangles. Other bridge types may incorporate trusses, too.



Arch Bridges – Use arches, or circular shapes, to carry a load. Arches are very strong in compression, and can go over, under, or through the bridge deck.



Cable Stayed Bridges – Use cables (called "stay cables") attached to towers to carry a load.



OTHER BRIDGE TYPES

These types of bridges can be built with TeacherGeek components, but they cannot be tested on a normal testing station.

Cantilever Bridges – Use cantilevers – structures that are supported on one side, like a diving board. A cantilevered bridge would be built like two diving boards, which are connected in the middle after each side is built.

Suspension Bridges – Use cables to support the deck. Main cables are connected to towers and anchored to the ground. Suspension cables support the deck from the main cables.