Engineering Discoveries: Bridges

Bridge Basics

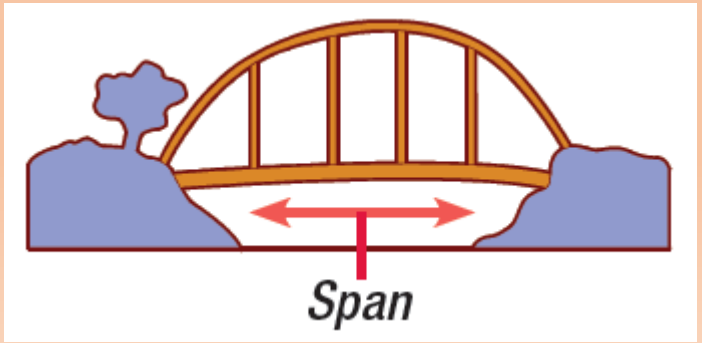
A bridge is a simple way to pass over an obstacle, like a river, valley, or railroad track.

There are many types of bridges and they are usually designed to connect two points together.

The distance between the two points is called the span of the bridge. The distance of the span will determine which type of bridges will be built.

In order for a bridge to carry a load, it must be designed to support a lot of weight across an open space.

Bridges are designed to spread the weight of the load out over the span of the bridge so that it is not just pushing down at one point. This is called dissipation.



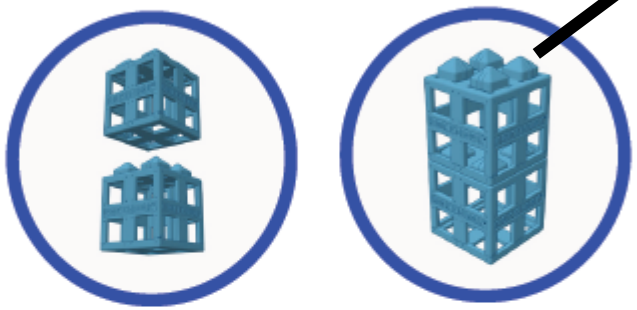
Building Basics

Building Basics with Rokenbok

The following tips will be helpful when using the Rokenbok Student Design and Engineering System.

Connecting/Separating ROK Blocks:

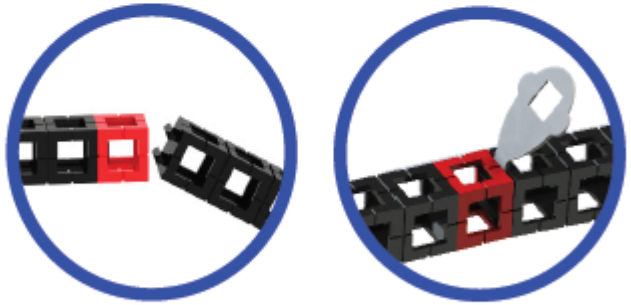
ROK Blocks use a friction-fit, pyramid and opening system to connect. Simply press pyramids into openings to connect.
To separate blocks, pull apart.



Pyramids or connectors

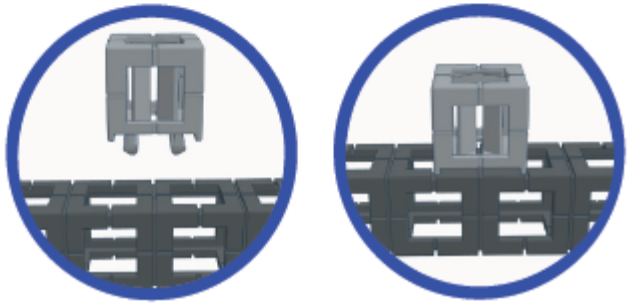
Connecting/Separating Rokenbok Components

Smaller Rokenbok components use a tab and opening system to connect. Angle one tab into the opening, and then snap into place.
To separate, insert key into the engineered slot and twist.



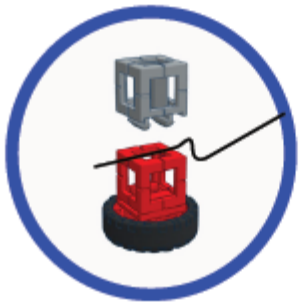
Snapping Across Openings

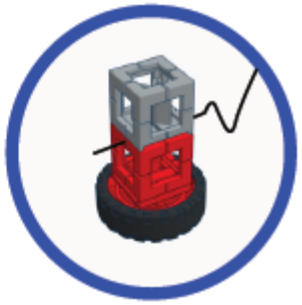
The tabs on Rokenbok components can also be snapped across openings to provide structural support to a design. This will also allow certain designs to function correctly.



Attaching String:

In some instances, string may be needed in a design. Lay string across opening. Snap any Rokenbok component with tabs or pyramids into opening. Make sure tabs run perpendicular to string for a tight hold.

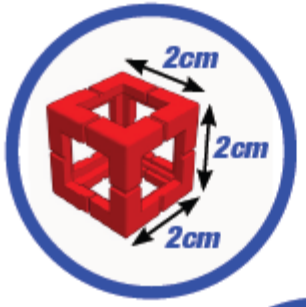


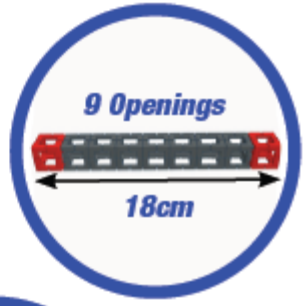


Measuring:

The outside dimensions of each Rokenbok connector block is 2cm³. This means the length, depth, and height are all the same.

To determine the size of a Rokenbok build in cm, simply count the number of openings and multiply by two. Repeat this process for length, depth and height.



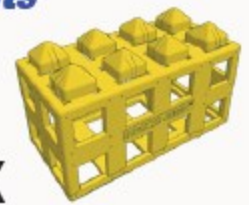


Bridge Experiment

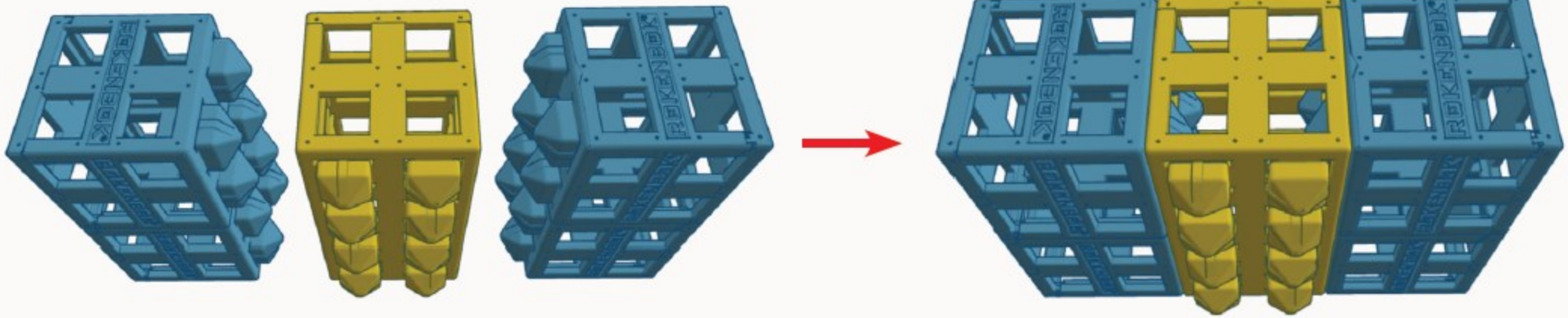
- Students will work in teams of 4
- Each team will receive one lab set
- Teams are only to remove the pieces indicated on the slide
- Each team member MUST participate equally

1 Build Bridge Roadway

Components

1x 

4x 

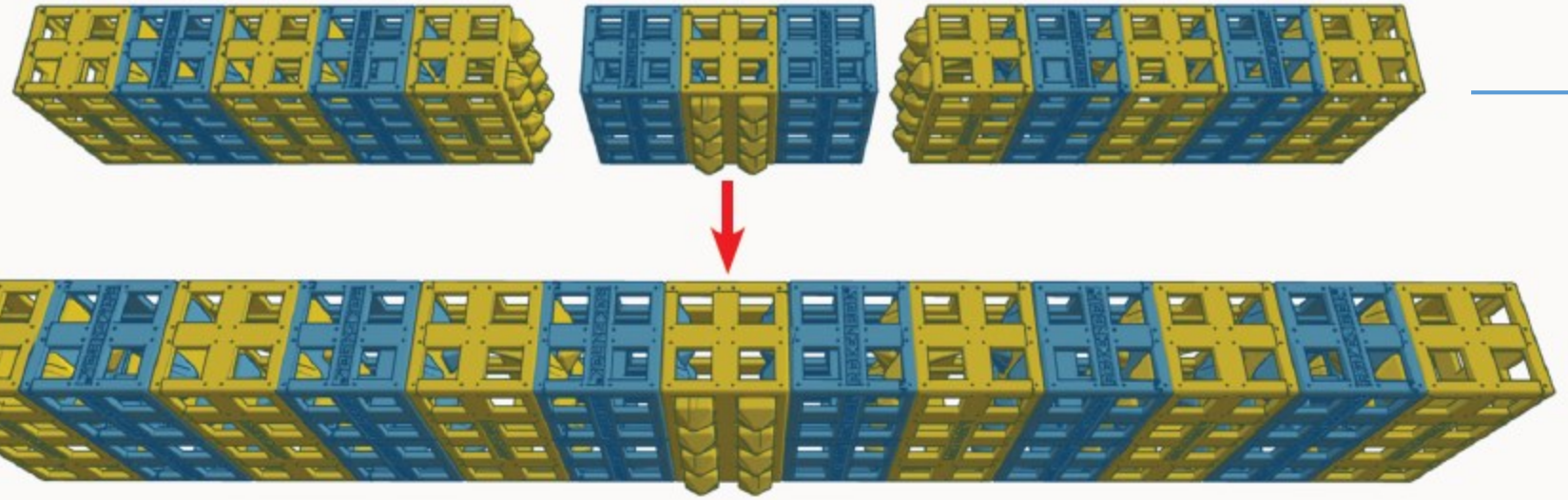


2 Build Bridge Roadway (Continued)

Components

6x 

8x 



Attach to blocks from step 1

Finished product

Abutments

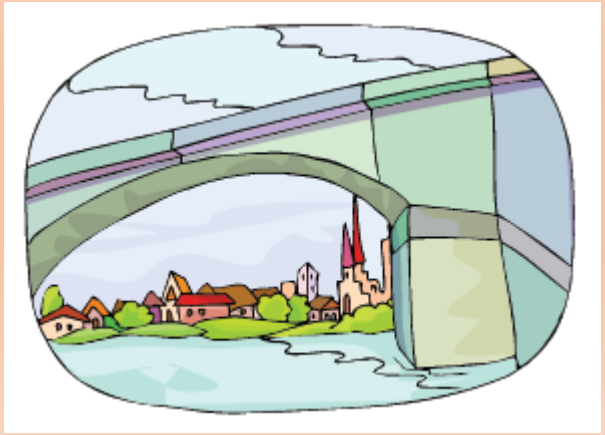
At each end of a bridge, you will find a solid support that allows the bridge to be anchored or attached to each end of the span.

The supports are known as abutments.

On real bridges, these are usually made of concrete and are very large and very heavy.

Abutments hold up each end of the bridge and on most bridges, are needed to make the bridge strong.

In order to build your bridge design, you need to first build the anchor abutments for each end of the bridge.

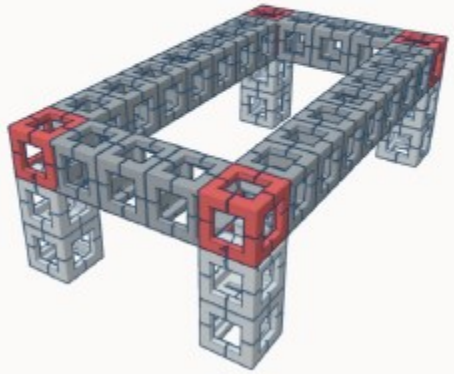


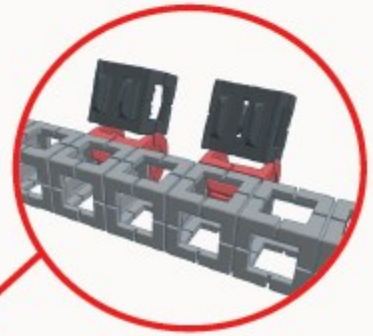
1 Build Bridge Abutments

Components

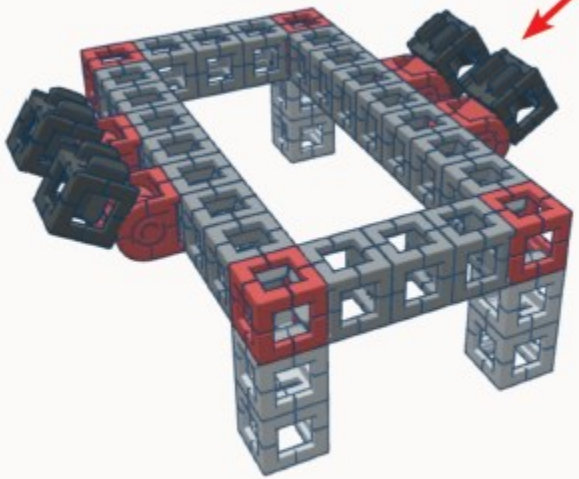
8x 4x 8x

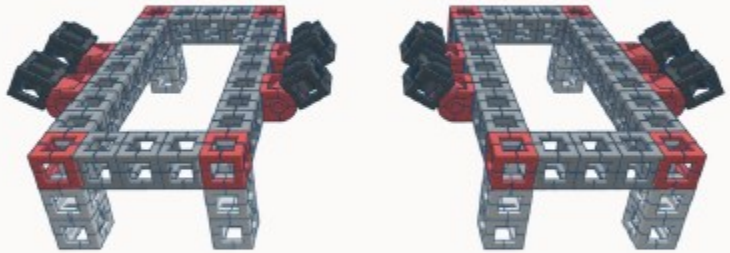
4x 8x 8x





The direction is VERY important

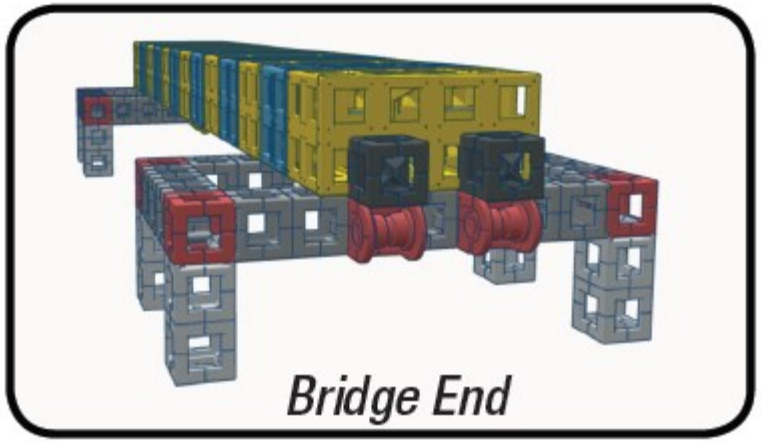




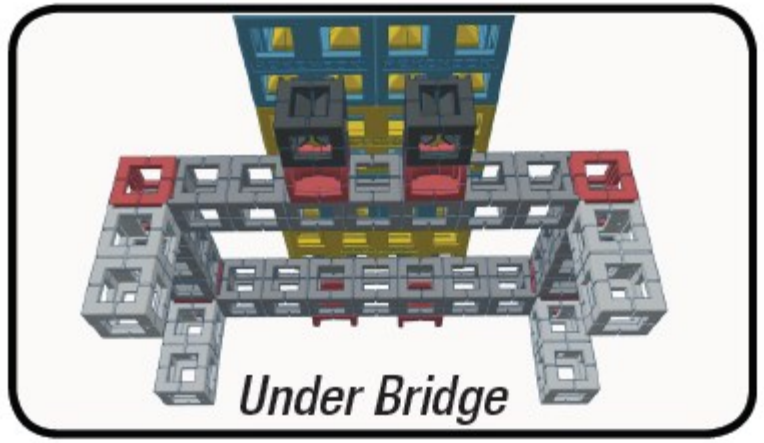
You need to make 2 abutments

How Does a Bridge Work?

Once the bridge abutments have been built, it is time to connect the bridge roadway to the abutments. Connect the single snaps to the blocks as shown below:

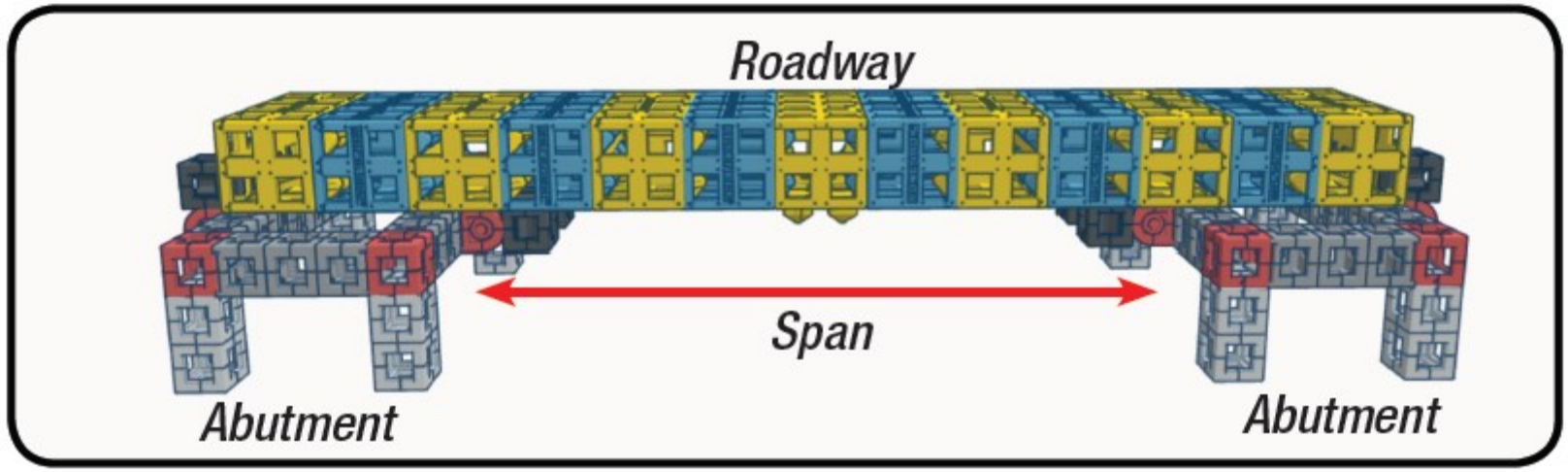


Bridge End



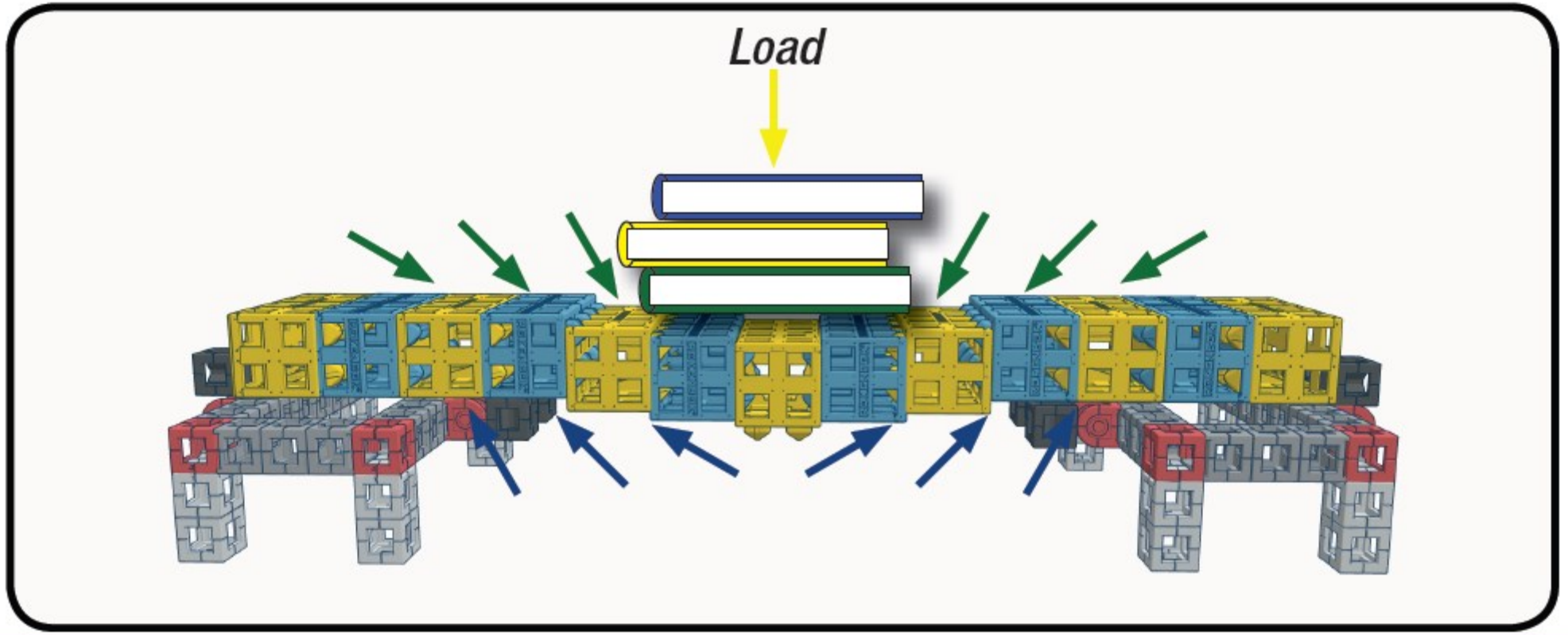
Under Bridge

After both abutments have been attached, the bridge roadway should be suspended as shown below. The space between abutments is referred to as the span.



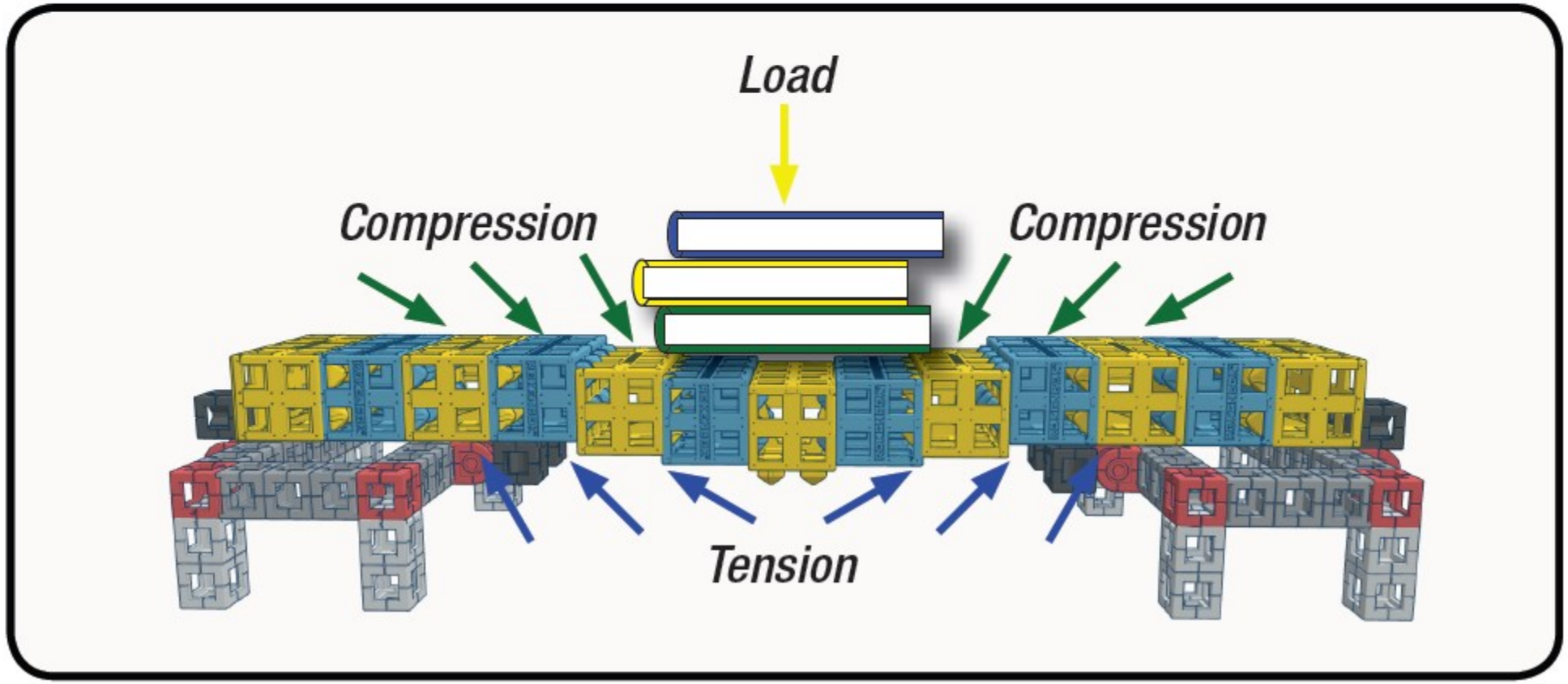
Testing Bridge Roadway

Next, let's test our bridge to see how strong it is. Place a few textbooks on the center of the bridge and see what happens. Keep adding weight until the bridge begins to fail.



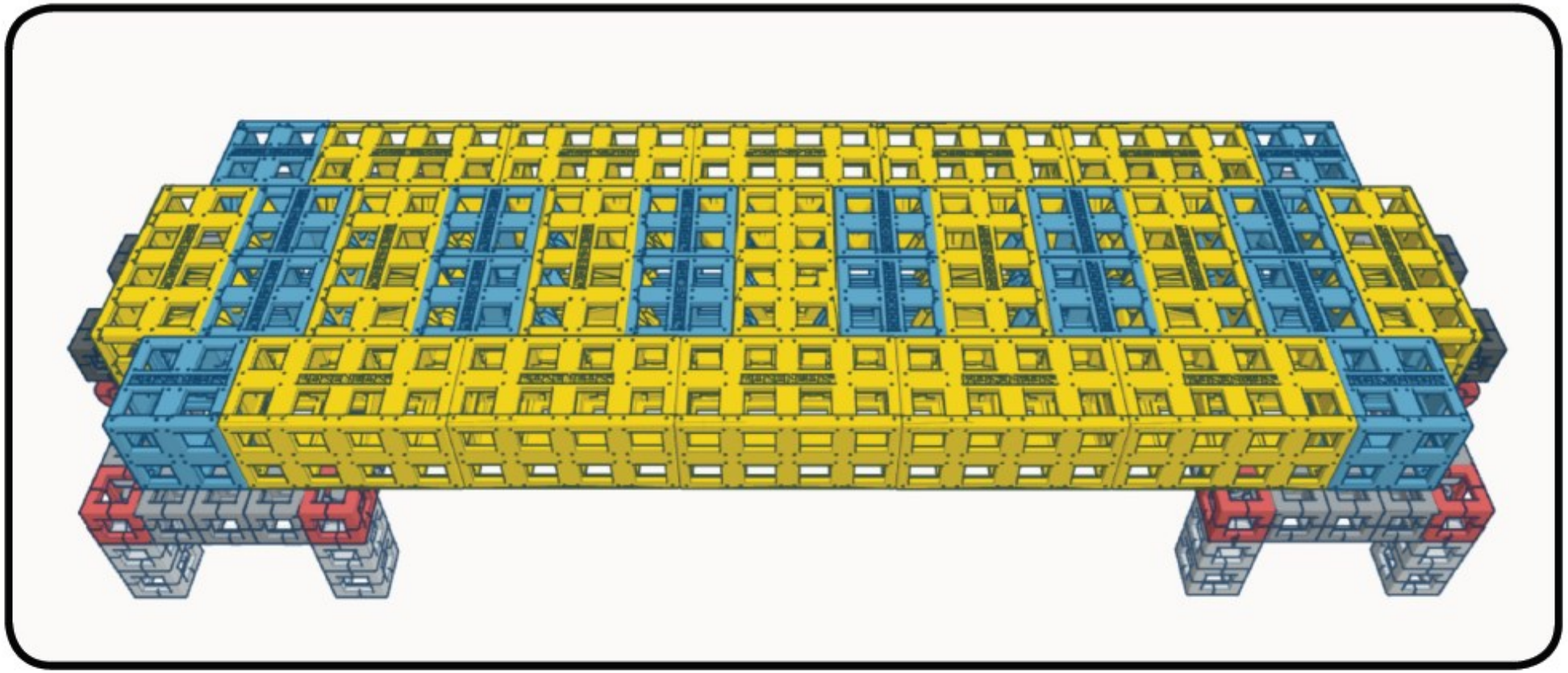
What Makes a Bridge Strong?

When a load is placed on a bridge, the weight of the load causes forces to react to the stress created by the load. The force on the top of the bridge is pushing downward and causes the top of the bridge to compress or squeeze together, while the force on the bottom of the bridge creates tension and has a tendency to pull apart. The effect of these two forces must be overcome in order for the bridge to hold the load.



Adding Strength to the Roadway

Locate ten yellow blocks and four blue blocks and attach them to each side of the roadway as shown below. Next, test the bridge again with the books to see what happens.



Bridge Building: Bridge Types

Why Are There Different Kinds of Bridges?

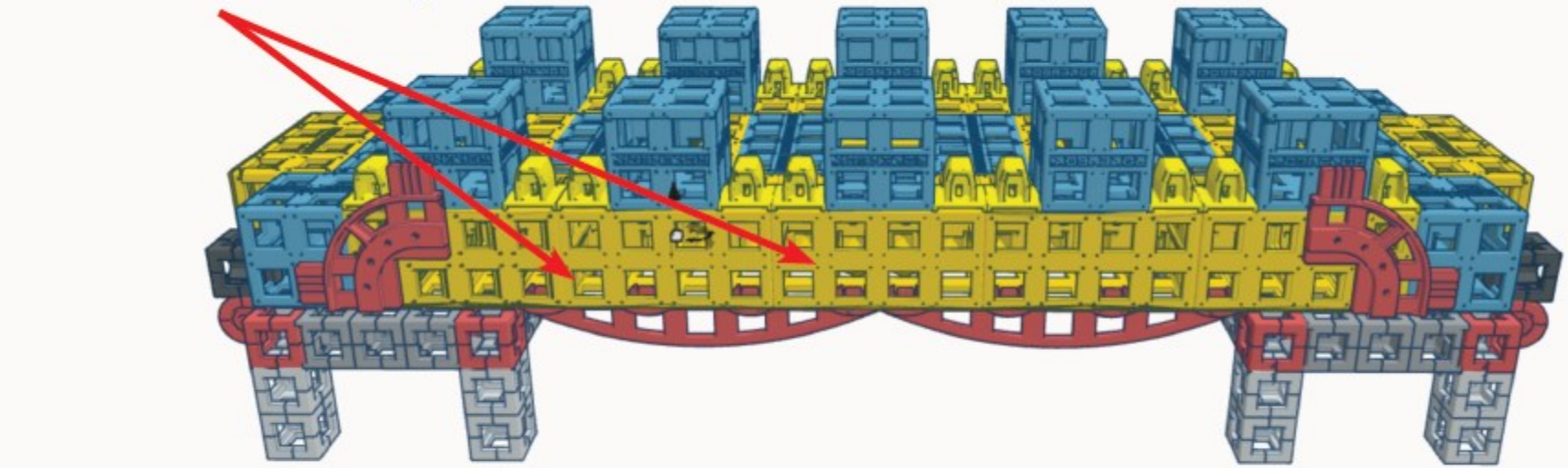
There are many different types of bridges that are designed for different purposes, but bridges are mainly designed and engineered to carry loads over different spans.

Let's take a look at several common bridge designs and learn a little about the design and engineering needed for each type of bridge to carry a load. Your structural engineering team will then choose one of the bridge designs to build and present to the rest of the class.

Girder/Beam Bridges

The first bridges were beam bridges. Large logs placed across a creek or valley were strong enough to hold a lot of weight, but could only span a short distance based on the length and diameter of the logs.

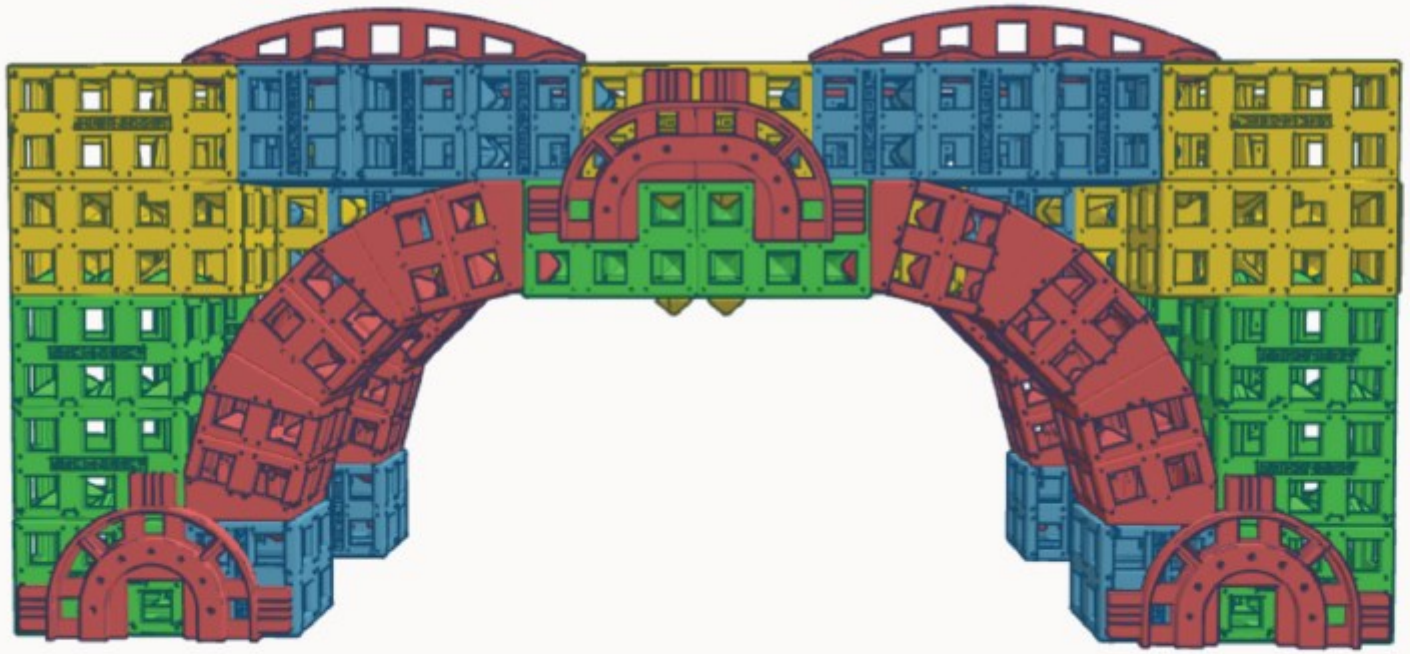
The bridge roadway that you tested was an example of a girder/beam bridge. All of the load is dissipated over the entire surface of the roadway and is only as strong as the beams that you attached to the side of the roadway.



Rokenbok Beam Bridge

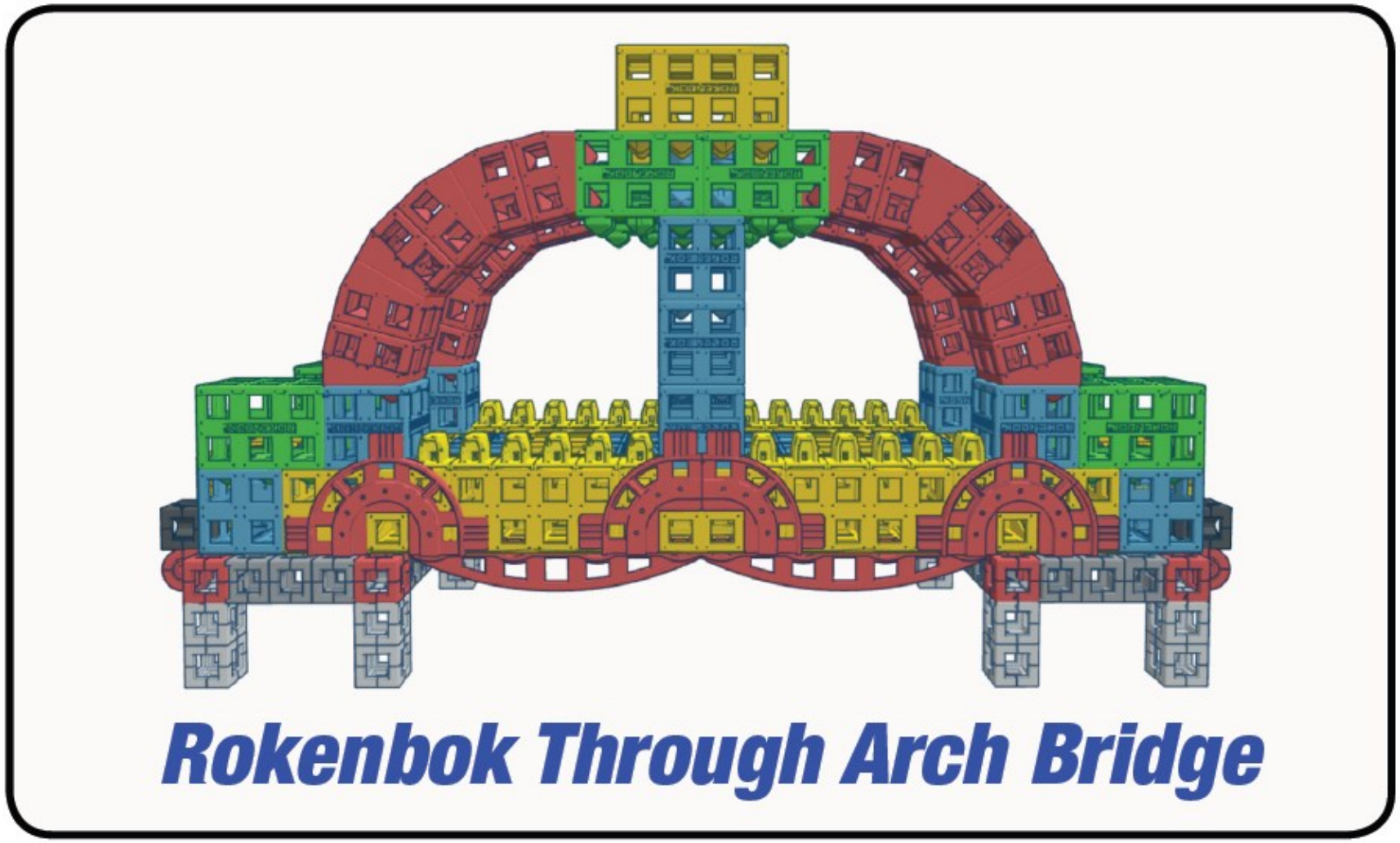
Arch Bridges

Many ancient bridges were built based on an arch design. The shape of the arch allowed the load to be dissipated from the bridge roadway down through the arch shape to the ground. Using multiple arches in a row allowed for the bridge to be longer and carry heavier loads.



Rokenbok Deck Arch Bridge

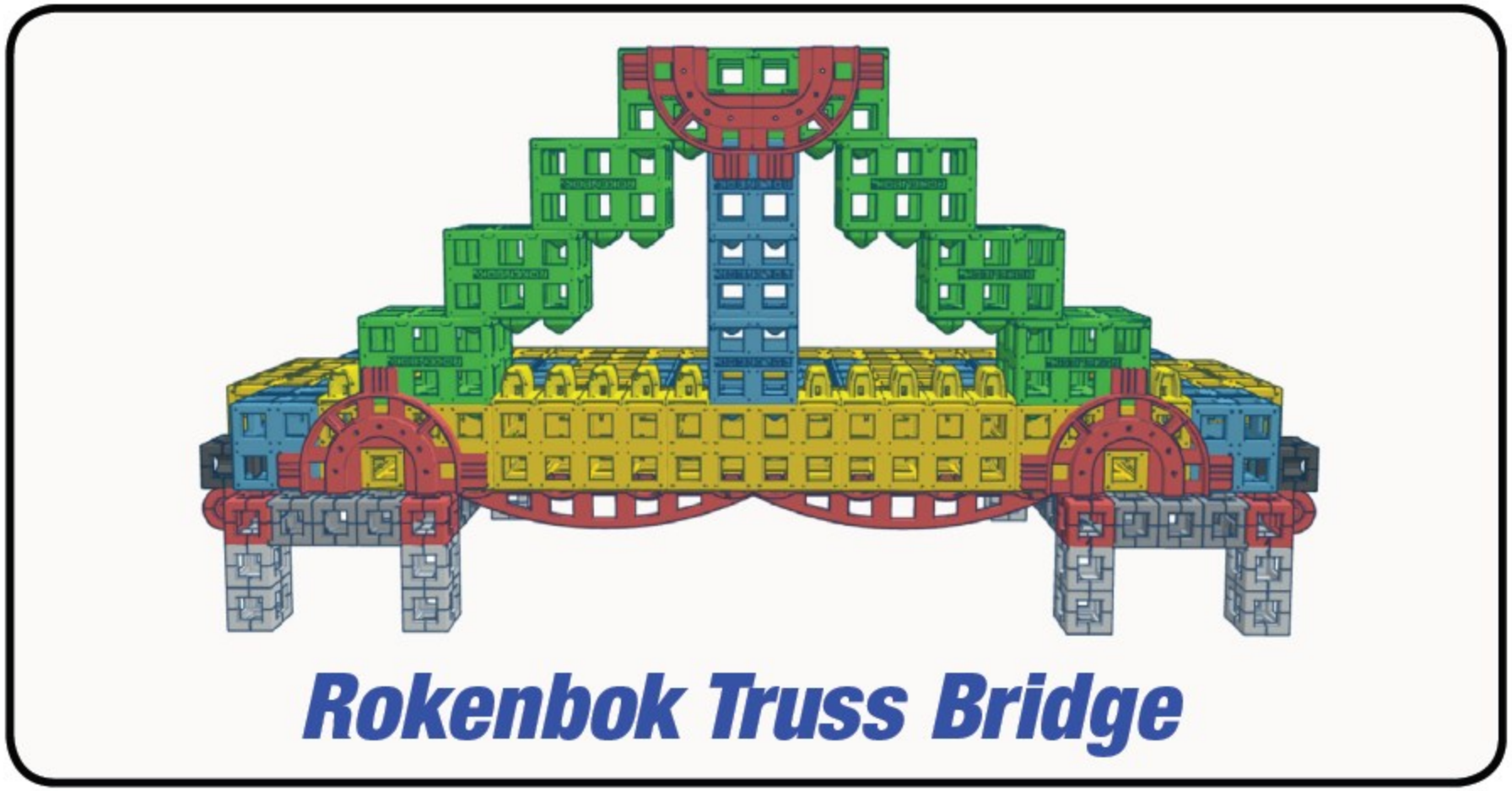
Arch bridges can also be engineered with the arch on top of the bridge roadway. While it looks different than the first example, the load is dissipated from the lower arch support to the abutments rather than directly to the ground.



Rokenbok Through Arch Bridge

Truss Bridges

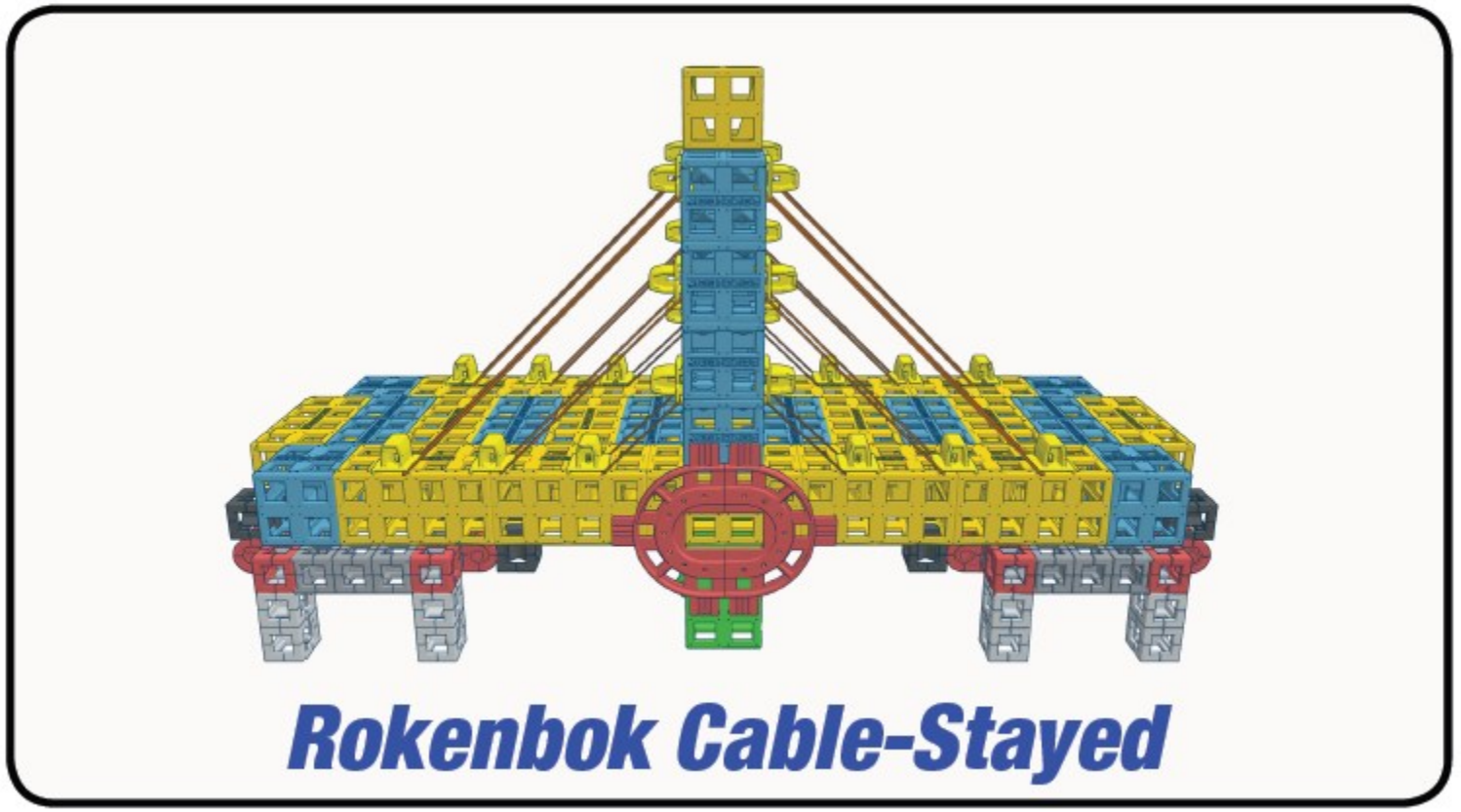
The truss bridge uses the strength of the triangle to help spread the load throughout the bridge structure. The truss is made of smaller components and then assembled on site. It is used on many railroad bridges because of its ability to carry heavy loads like a locomotive.



Rokenbok Truss Bridge

Cable-Stayed Bridges

A cable-stayed bridge has at least one tower, from which cables support the bridge roadway. It looks similar to a suspension bridge, but only requires one tower and the cables are attached directly to the tower and anchored at intervals along the bridge roadway and to the abutments. Some cable-stayed bridges have a single row of cables on each side of the tower, and some have two sets of cables to allow traffic to pass through the center of the bridge.

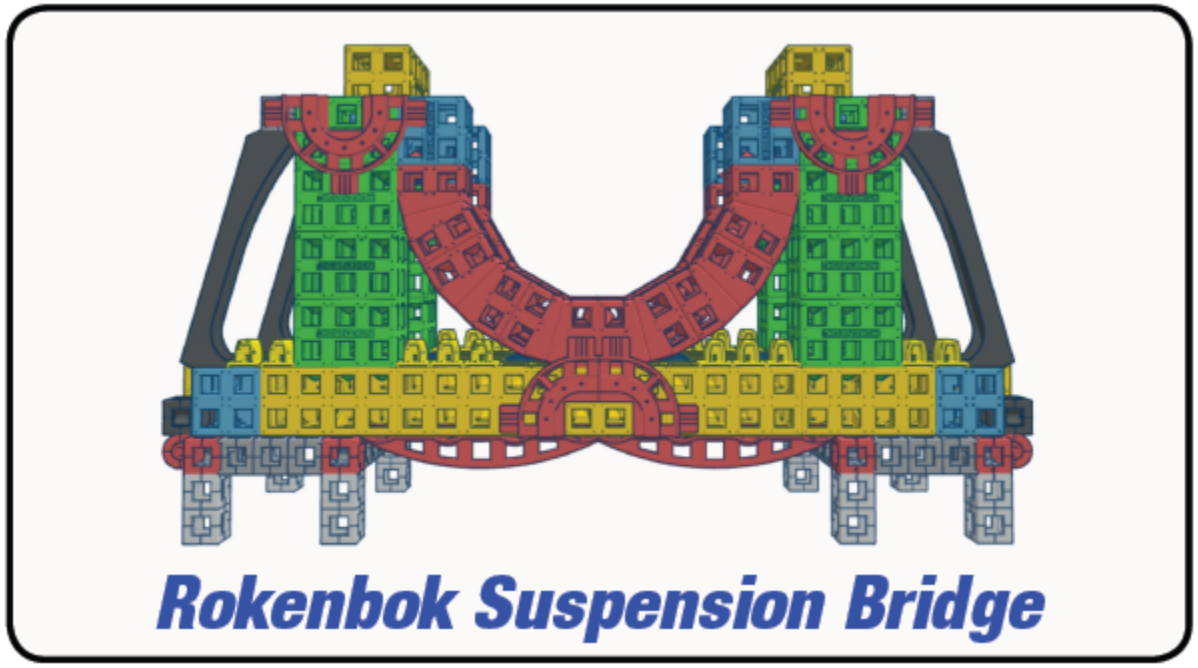


Rokenbok Cable-Stayed

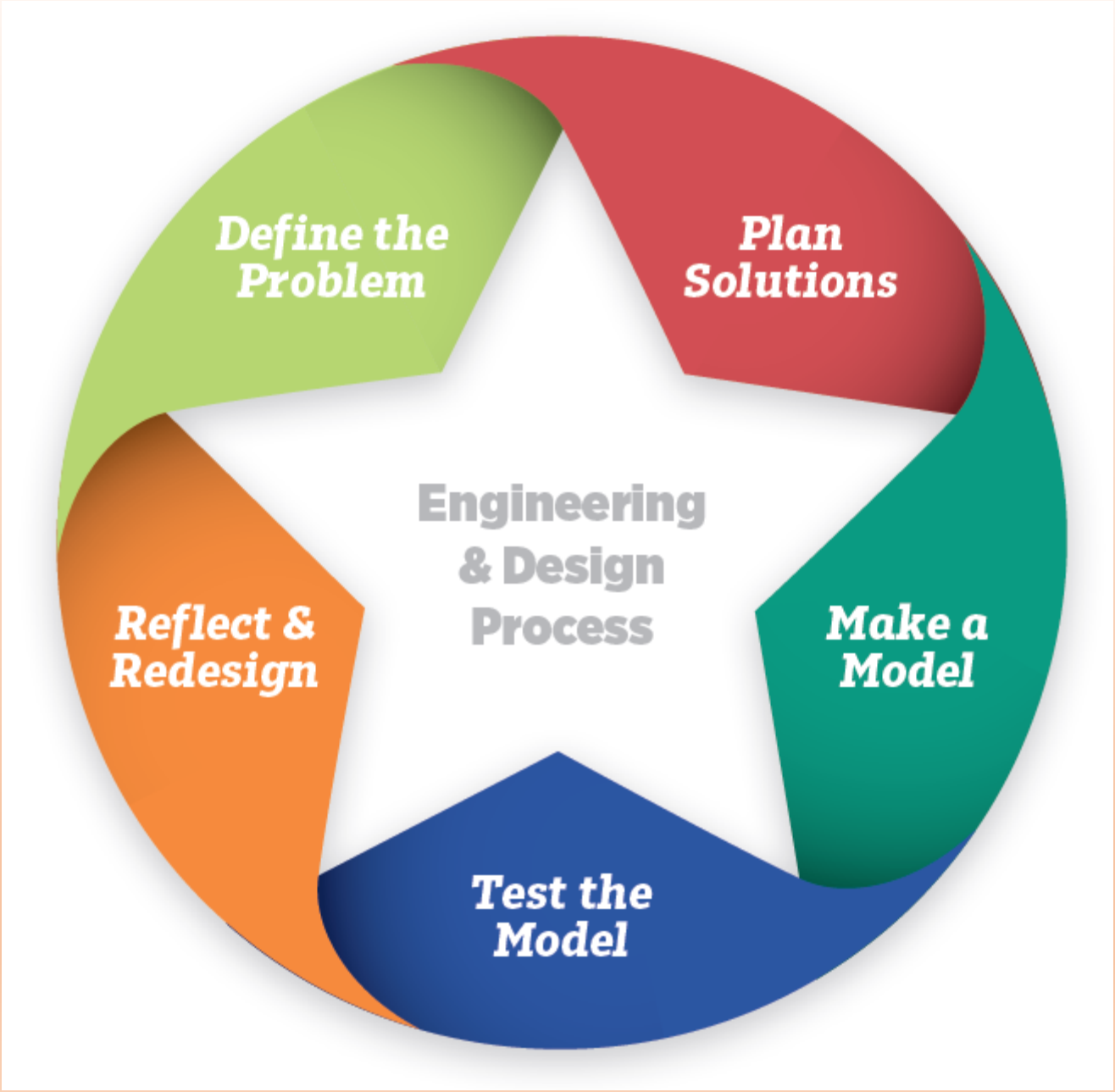
Suspension Bridges

The suspension bridge allows for the longest spans of any bridge because of its unique design. The concept of the suspension bridge is really not new. Ancient bridge builders used to pull ropes across a span and tied the roadway with vertical ropes to the main ropes above.

Suspension bridges begin with the construction of two tall towers near each end of the bridge. Once the towers are in place, cables are attached to each abutment and then connected to the top of the towers to form the primary cable system that will hold up the roadway. Next, vertical cables are connected from the primary cable to the roadway and this is how the roadway is supported.



Rokenbok Suspension Bridge


Define the Problem
Plan Solutions
Engineering & Design Process
Reflect & Redesign
Make a Model
Test the Model

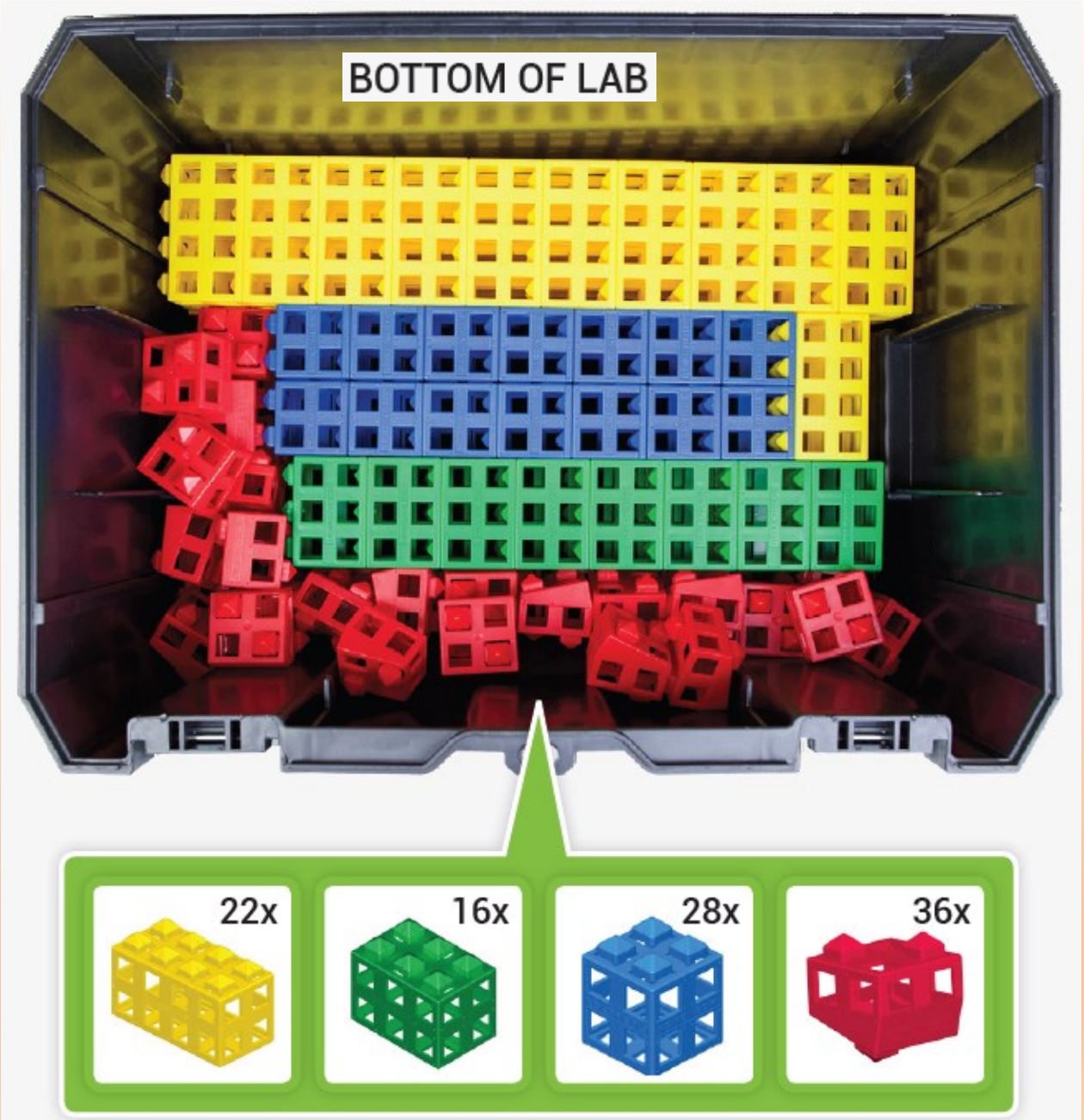
Bridge Building

Presentations

Prepare a short presentation to answer the following questions:

1. What type of bridge did your team build?
2. How does the bridge distribute weight to support a load?
3. What challenges did your team face?
5. How did you solve those challenges?

Clean Up



ROK Block rows are 2 blocks deep.

TOP
TRAY

MESH SACKS

Place mesh sacks underneath top tray.