

Engineering with Legos : Sturdy Structures & Tall Towers

Name: _____



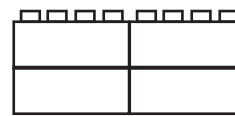
BUILDING STURDY STRUCTURES

Building sturdy structures using Lego blocks is not as hard as you may think. However, there are some basic principles that you must follow in order to have a successful build.

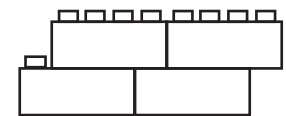
JOINTS: Joints are where two or more blocks meet. In a house, a joint would be where two pieces of wood meet.



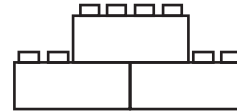
You can build strong joints a couple of ways. One way is by overlapping the blocks on top of each other. If you have ever seen a brick wall, this is how the bricks are structured. Here are some examples of weak joints and strong joints.



Weak Joint



Strong Joint



Strongest Joint: this is how brick walls are made!

"SANDWICHING" JOINTS

This is another way to make a very strong joint. In this type of joint, you use two plates, placing one on top and one on the bottom. Just how a "sandwich" has two pieces of bread, the plates are the bread that holds everything in the middle together!



Use these tips to build strong structures and put your project to the test!

Challenge 1 - Individual build

-Build a free standing wall that is at least 10 bricks tall that can survive the wrecking ball or rotating hammer.

Challenge 2 - Individual build

-Build a free standing wall at least 14 bricks tall that won't fall over.
-Encourage the use of technic pieces from their individual boxes.

Challenge 3 Ultimate Challenge - Individual build

-Who can build the tallest structure that won't fall over!

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STRONG SHAPES

Pass out this weeks worksheets

- Pass out worksheet and read through it with the students.

LESSON: Today you will be building just with the technic bricks. You will be finding out what are the strongest shapes are when building.

3 shapes you will be building are:

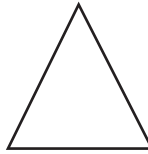
- 1. Square
- 2. Pentagon (5 sided polygon)
- 3. Triangle

Who can identify different shapes in the room?
Does anyone see triangles?

BRACING: When bracing is done correctly, it will form the shape of triangles inside your main structure.

Today, use ONLY the technic pieces.

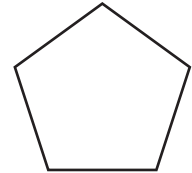
Using only the Lego Technic beams, build each shape and see which ones are the sturdiest.



Triangle



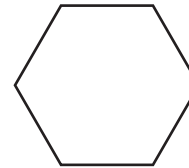
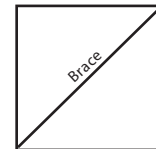
Square



Pentagon

Which shape did you find to be the sturdiest? _____

Now try to make the weak shapes more sturdy by bracing them. You can use another Technic beam to brace the structure. Usually when bracing is done correctly, a triangle will form inside the main structure. Here is one example to help you. Can you do the same for the pentagon?



Try to brace a hexagon. This is what a hexagon looks like; it is a 6 sided polygon. Brace it so it is sturdy when squeezed from all sides. Remember, try to make multiple triangles within the main shape.

Challenge 1 - Individual build

-Build all 3 shapes and find out which one is the strongest.

Challenge 2 - Individual build

- Brace all the weak structures (square and pentagon). Must pass the squeeze challenge and look like the shape they are trying to build.

Challenge 3 Ultimate Challenge - Individual build

-Build a hexagon and brace it!

Challenge 4 Ultimate, Ultimate Challenge - Individual build

-Build a Octagon(8 sides) and brace it!

REVIEW:

- What is Bracing?
- How do you make a strong joint?
- What is a strong shape?

NO WORKSHEET

LESSON:

-Students will build individually or in teams to try and survive against the air cannon! They will combine what they learned about strong shapes and joints.

AIR CANNON RULES:

- For Teacher use only! Any student messing with the cannon will get an automatic strike 2 which is a time out.

- Set up a firing zone, mark off with masking tape. Students need to be behind the air cannon to watch.

FOR FUN! - Have students build the weakest structure and see who can make the biggest explosion!

Challenge 1 - Individual or Team Build

-Build a structure at least 8 bricks tall that can survive 3 pumps of the air cannon

Challenge 2 - Individual or Team build

- Build a structure at least 12 bricks tall that can survive 3 pumps of the air cannon

Challenge 3 - Individual or Team build

-12 bricks tall, 5 pumps!

Challenge 4 Ultimate, Ultimate Challenge - Individual build

-who can survive the most pumps!

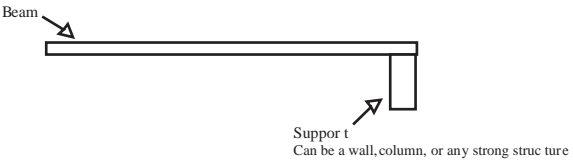


Engineering with Legos : Sturdy Structures

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Cantilever

A cantilever is a long beam attached only on one end. Cantilevers are used all throughout construction. Some examples are bridges, balconies, some shelves, and brackets that stick out from a wall. If you point your arm straight out it is now a cantilever. Your arm is attached to your body on one end!



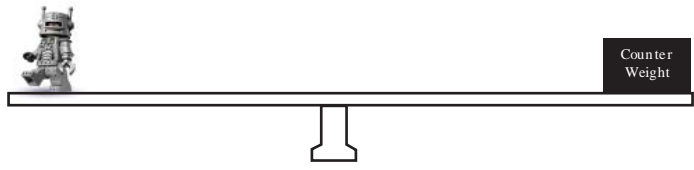
When a cantilever is built correctly, it can carry weight at the ends without breaking or falling over.



When designing a cantilever it is important that :
 . The beam is strong
 . The support is strong

You can construct a strong support by making its base big and heavy. Also make sure the beam is attached securely to the support.

In this example, there is counter weight on one side of the cantilever to help it balance so that it won't tip over.



CHALLENGE Build a cantilever that can support a heavy weight at the end. The beam should be at least 4 inches long. Can you build one where the beam is 10 inches long?

REVIEW:

- What is Bracing?
- How do you make a strong joint?
- What is a strong shape?

LESSON:

Building a Cantilever

What is a Cantilever?

- A beam supported by only one side.
- EXAMPLE- your arm can be used as a cantilever if you stick it straight out.
- EXAMPLE- some balconies and bridges and shelves in your house.

Has anyone ever hung off of a tree branch? That is also a cantilever as the branch is connected only by the main part of the tree.

- Hints: a cantilever can be balanced a few ways.**
1. Make sure the base is heavy and wide.
 2. Add weight to the opposite side to counterbalance the project.
 3. Build legs on the base that extend out further than the arm.

Challenge 1 - Individual or Team Build
 -Build a Cantilever at least 6" tall that can hold a weight at the end without breaking or falling over.

Challenge 2 - Individual or Team build
 - Build a Cantilever at least 8" tall that can hold a weight at the end.

Challenge 3 - Individual or Team build
 -Build a cantilever at least 8" tall that can hold 2 weights!

Challenge 4 Ultimate- Individual or Team build
 -who can balance the most weight.

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BRIDGES

There are many different bridges, but here are a few types. Try building some of these bridges and see which ones are the sturdiest! You can also combine different designs to make the bridge even sturdier.

REVIEW:

- What is Bracing?
- What is a cantilever?
- What is a strong shape?

LESSON: Bridges

Q: What is the purpose of a bridge?

A: Usually to connect to land masses which are separated by a river, body of water, or a big ditch.

Q: What does a bridge do?

A: It helps support weight so you can get from one side to another.

Who has ever seen a bridge?

Has anyone gone to the Golden Gate Bridge in San Francisco?

WORKSHEET: Pass out worksheet and go over bridges.

Bridges that work well are always symmetrical and do a good job at distributing weight down to the ground through their columns.



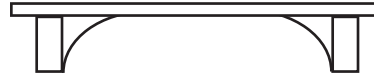
BEAM BRIDGE: Consist of a strong beam. These bridges are usually shorter in length and are the simplest bridge to build.



TRUSS BRIDGE: These bridges are more complex to build. But when built properly, they are very strong. They consist of multiple triangles which help distribute weight and make it very sturdy.



ARCH BRIDGE : This design uses arches to help distribute the force to the sides of the bridge. These can be complex. You can also try using a beam to triangulate the bridge instead of the arches.



SIMPLE CANTIL EVER BRIDGE : This bridge has beams that are supported by another beam or a tower that goes straight to the ground. This helps distribute weight in important areas.

Challenge 1 - Individual or Team Build

- Build a free standing bridge at least 10" long. (a little shorter than the length of a piece of paper). Must be off the ground.

Challenge 2 - Individual or Team build

- Build a bridge at least 12" that can support weight at different locations.

Challenge 3 - Individual or Team build

- Build a bridge that has arches or triangles to support it.

Challenge 4 Ultimate- Individual or Team build

- Build a bridge that can support the instructors foot!

REVIEW:

- What makes a strong bridge?
- Strong joints and shapes.

LESSON: Who can build the strongest bridge

THE BRIDGE CRUSHER!

- Teacher use only!
- Bridge has to be long enough to reach from side to side.
- no part of the bridge can touch the base of the crusher.
- Needs to look like a bridge and not a wall.

Medals for:

- **The most extreme**
- The most creative**

Make sure students have good sportsmanship and behavior or they will not have a chance at a medal, even if they have the strongest bridge.

BUILDER BUCKS- Students can trade their bucks in for more pieces towards their projects.

Don't forget to pass out medals, pins of completion, minifigures, and next class details at the end of class.

Challenge - Individual or Team of 2 Build

Who can build the strongest bridge!

SUPER STRUCTURES!

Class Outline:

1. Strong Joints : What are strong joints in engineering?
2. Strong Shapes & Bracing
3. Air Cannon Challenge : Putting their knowledge to the test!
4. Tall Structures : Load bearing columns
5. Building a Cantilever
6. Bridges
7. Final day challenge, Bridge Crusher

Students will be exploring the world of structures and basic structural engineering principles that make a strong structure. They will be testing out their projects against our AIR CANNON and BRIDGE CRUSHER!

Everyday students will be building and completing challenges in our class. They will use what they learn in the next 7 weeks to be able to build the strongest bridge on the final day.