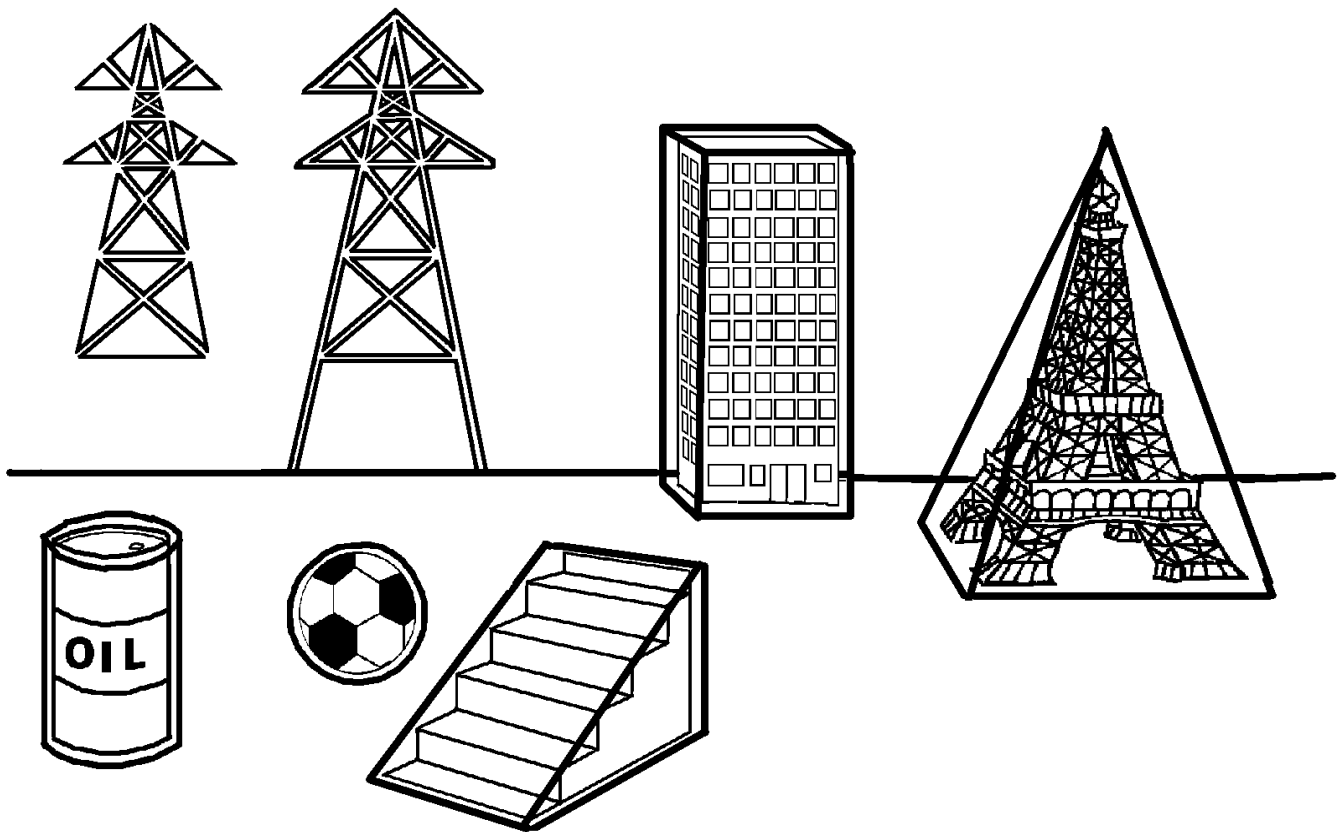


Professor Beaker's  
Everyday Structures and Systems

Chapter C - Shapes and Patterns in Structures

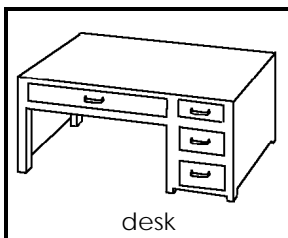


# Educator's Background to Shapes and Patterns in Structures

## Shapes of Structures (overall shape of the entire structure)

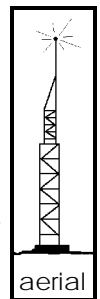
Many structures are built so they have overall shapes that are geometric (e.g., a sky scraper is a tall narrow rectangular block in overall shape). Each geometric shape has certain strengths and weaknesses that are considered when designing a structure. The strength of a structure is its ability to maintain its original shape and integrity when forces (or loads) are applied to it. The stability of a structure is its tendency to maintain its original position and orientation despite forces that act to 'push it over'.

### Rectangle (rectangular block)



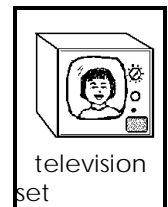
A rectangular structure with the long side on the bottom is very stable when resting on the ground. An object that has a rectangular shape, with the long side down, is not easy to push over. Tables, desks, and many buildings are examples of such a stable structure. Rectangular shapes are especially good for buildings because they are easily divided into rectangular rooms. Rectangular rooms are ideal for furniture placement and saving space.

A narrow rectangular structure with a short side at its base is not very stable. Structures having this structure are easy to push over. A television aerial support pole is an example of a narrow rectangular structure. Often these narrow structures must have their bottoms sunk into the ground to give added support, or be supported by outside wires or buttresses.



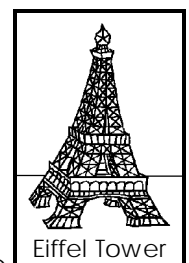
### Square (cube)

A square structure is a stable structure that is not easy to push over. It has flat surfaces, which may make it useful for some functions. Some tables, TV sets, stools, tables, and smaller houses are square structures.



### Triangle (pyramid)

A triangular structure is very stable because it has a wide base. The Eiffel Tower is a good example of a triangular structure. Occasionally, triangular structures, with a point at the bottom, are used for hydroelectric power towers. Such an inverted triangular shape is strong, but not stable and must be supported by extra guy wires to keep the tower from falling over. This shape enables many power lines to be strung across the wide top, while keeping a safe distance between the lines. Very little space is needed on the ground for such an inverted triangular structure.



### Circle (sphere)

Circular structures, or more accurately, spherical, are ideal structures for submersibles, which must support the tremendous external water pressure and



for balls, which must contain pressurized air (i.e., basketballs and soccer balls).

Educator's Notes:

Make the diagonal from a cardboard strip 18 cm (7") long and punch a hole near each end. Add the strip onto the two opposite corner fasteners already in place. Gently press downward and slightly to one side on the top of the square shape. What do you observe?

C-3. If the opportunity presents itself, visit or view a building site where the internal structures of a building are exposed. Look for the geometric shapes built into the overall structure. If a field trip is not possible, look for pictures of structures where the geometric shapes are easily seen. Where possible, use pictures of local structures that the students may recognize. Mark or draw the geometric shapes seen in the pictures.

### 3. Investigating the Strength of Flat and Arched Bridges - Experiment

(See work pages, pages 46 and 47)

Purpose of activity: To investigate, through experimentation, the relative strength of two structural shapes that are used to build a bridge.

Students complete an activity to construct two simple bridges. They load the two bridges with equal weights to determine which structural shape is stronger.

Educator's Notes:

If desired, a survey similar to the one provided for the Investigation of Strength of Squares and Triangles (Investigation number 2a above) may be completed for the two bridge shapes.

#### Equipment

- |   |  |
|---|--|
| 1 piece of bristol board, 8cm X 13cm (3"x 5")             | plasticine                               |
| 2 blocks of wood (each about 8cm X 10cm X 2cm [3"x4"x1"]) | several small weights (about 50 gm each) |
| ruler (15 cm; 6")   | 4 straight pins or push pins             |

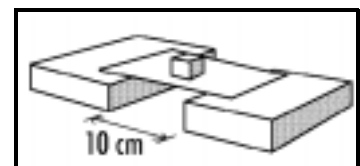
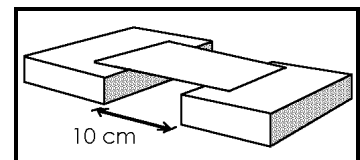
Educator's Notes:

A cube of plasticine about 3 cm (1¼") on a side makes an ideal weight. Prepare several cubes.

The investigation method listed below is a detailed version of the method given on the student work pages(pages 46 and 47).

#### Method

1. Place the wooden blocks flat on a desk. Measure and move them so there is a 10 cm (4") gap between them.
2. Lay one bristol board card on the blocks to bridge the gap.
3. Gently place one weight on the centre of the 'bridge'.
4. Observe what happens to the card bridge. Record your observations.
5. Stack another weight on top of the first weight.

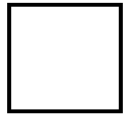


6. Observe what happens to the card bridge. Record what you see.  
name: \_\_\_\_\_

## Finding the Shapes Hidden in the Structures



triangle  
(blue)

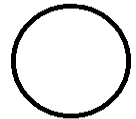


square  
(green)

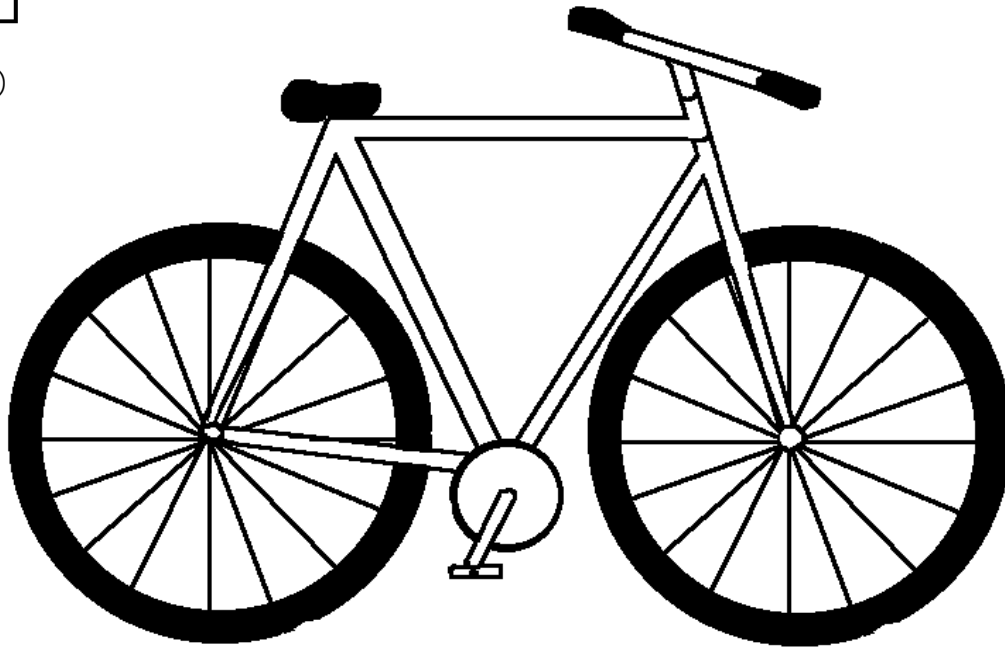
1. Look at the structures.
2. Find the hidden shapes in the structures.
3. Use different coloured crayons to mark each shape you find.



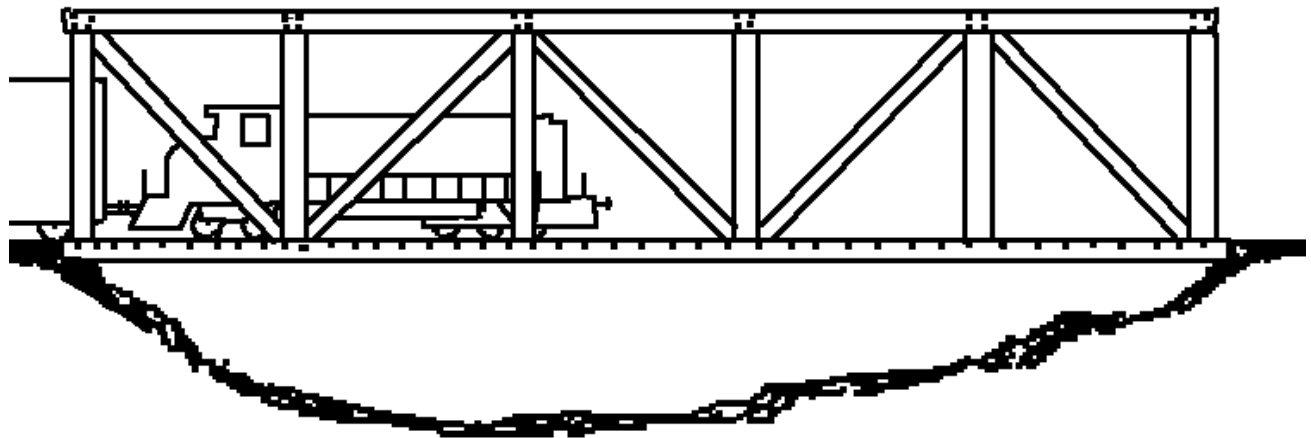
rectangle (red)



circle  
(orange)



bicycle

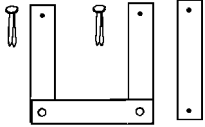


bridge

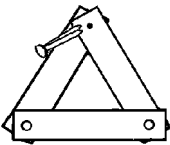
name: \_\_\_\_\_

## Investigating the Strength of Squares and Triangles - Experiment

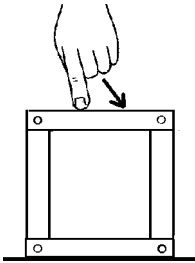
### Method



1. Use 4 fasteners and 4 strips to make a square.



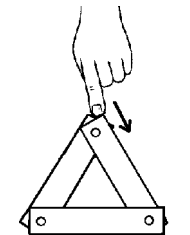
2. Use 3 fasteners and 3 strips to make a triangle.



3. Stand the square up. Press downward and at an angle on the square.



4. Observe and record what you see.



5. Stand the triangle up. Press downward and at an angle on the triangle.

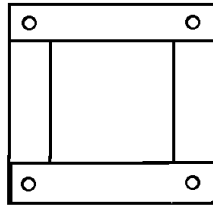


6. Observe and record what you see.

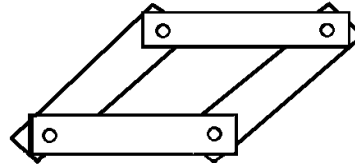
name: \_\_\_\_\_

### Observations

Circle what happened to the square

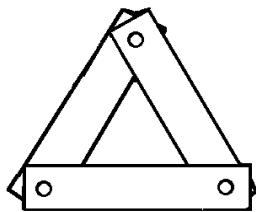


did not change

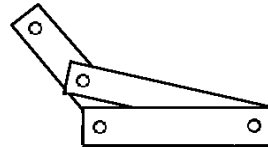


collapsed

Circle what happened to the triangle



did not change



collapsed

### Conclusions

Which shape is the stronger shape? Circle the stronger shape.



triangle

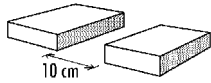


square

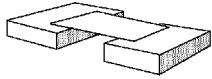
name: \_\_\_\_\_

## Investigating the Strength of Flat and Arched Bridges - Experiment

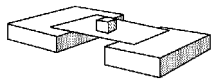
### Method



1. Put the blocks 10 cm apart.



2. Lay the card like a bridge between the blocks.



3. Put 1 weight on to the bridge.



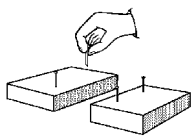
4. Observe and record what you see.



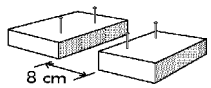
5. Put another weight on top of the first weight.



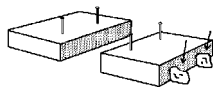
6. Observe and record what you see.



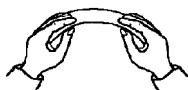
7. Push two pins into each block.



8. Put the blocks 8 cm apart.

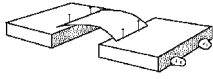


9. Use plasticine to stick the blocks in place.

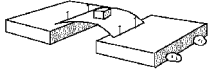


10. Gently curl the card.

name: \_\_\_\_\_



11. Place the card on the blocks like a bridge.



12. Put one weight on to the bridge.



13. Observe and record what you see.



14. Put another weight on top of the first weight.

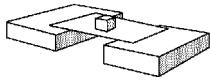


15. Observe and record what you see.

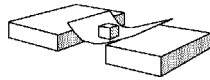
### Observations

#### Flat Bridge

With 1 weight on the flat bridge, it looked like this. Circle what you saw.

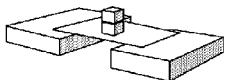


no change

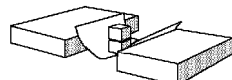


bridge bends

With 2 weights on the flat bridge it looked like this. Circle what you saw.



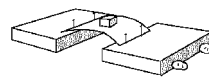
no change



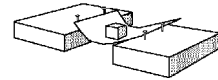
bridge bends a lot

#### Arched Bridge

With 1 weight on the arched bridge, it looked like this. Circle what you saw.

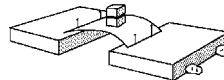


no change

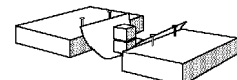


bridge bends

With 2 weights on the arched bridge it looked like this. Circle what you saw.



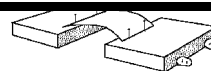
no change



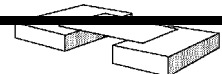
bridge bends a lot

### Conclusions

Which shape makes the stronger bridge?  
Circle the stronger shape.



arched bridge

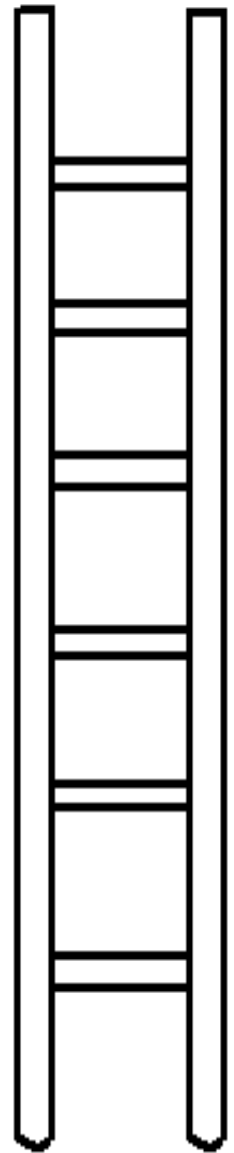
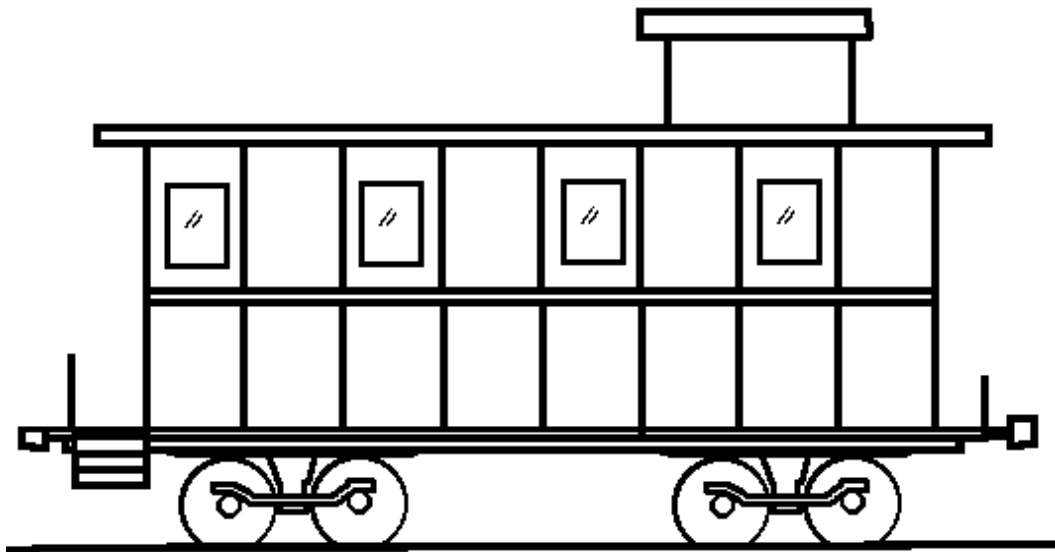
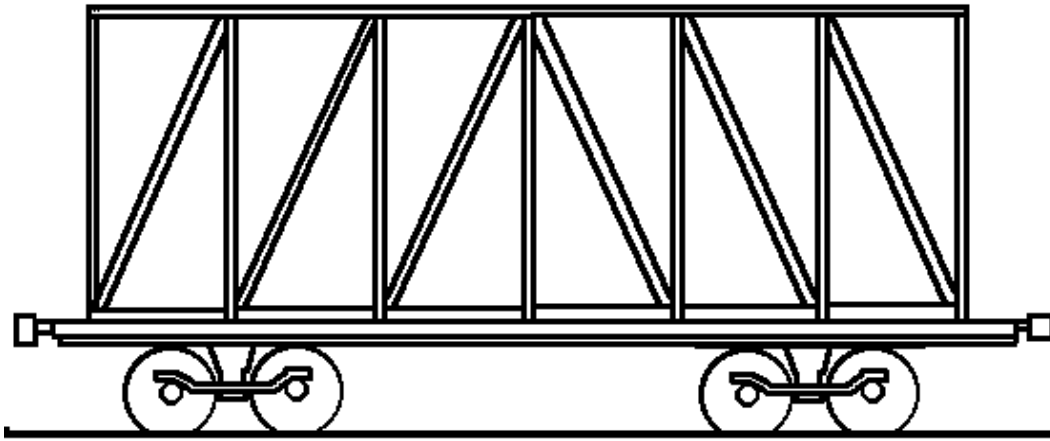


flat bridge

name: \_\_\_\_\_

## Finding the Patterns in the Large Structures

1. Look at the picture of the large structures.
2. Find the pattern in the structures.
3. Use a crayon to mark the pattern in the structures.



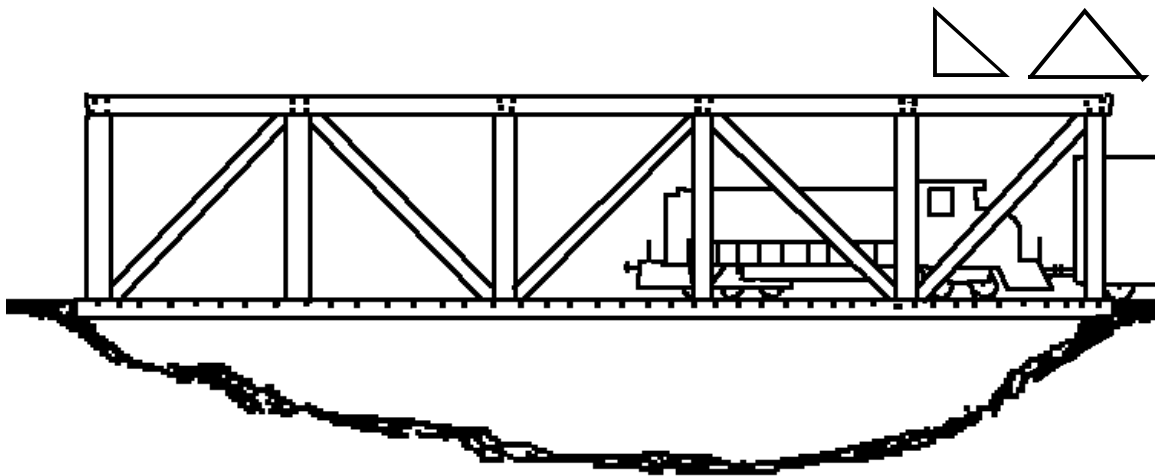


## Shapes and Patterns in Structures

A structure is the part of an object that allows that object to support a load. Sometimes the structure is visible and sometimes the structure is hidden beneath other materials.

The overall shape of a structure has a regular geometric shape (e.g., a ladder is a rectangle in overall shape). The overall shape of the structure determines how difficult it is to topple over. Structures with wide bases tend to be more stable than structures with narrow bases. A spherical (ball) shape is not at all stable on land because it rolls easily.

When a large structure is closely examined, smaller structures can be seen within it. Most often those smaller structures are triangular in shape because triangular shapes are very strong and stable (e.g., see the triangles in the picture of the structure below).



bridge