VOL. 2, NO. 2

aaas SCIENCE RESOURCES FOR SCHOOLS

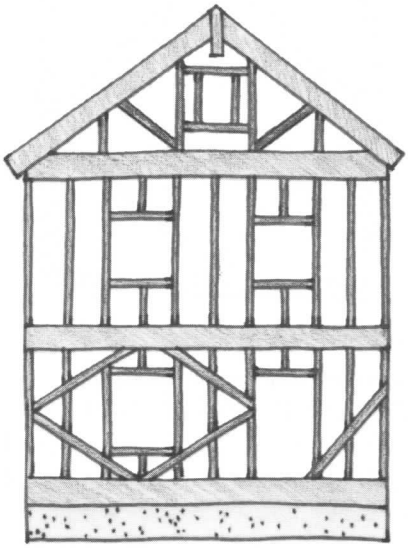
DOING SCIENCE

BUILDING A MODEL HOUSE

DS-1

Introduction

The house or apartment building in which you live has been built to withstand many stresses: pounding rain, the heavy weight of snow, or the battering winds of a storm. The floors hold heavy furniture and sometimes large numbers of people. The design of these structures is a result of continual experimentation and development over a period of many centuries. Although it may take years to learn how to construct your own house, it doesn't take much time to understand some of the basic principles of why buildings stand up. Using simple materials, one can learn a great deal by building and testing models. It is a direct way of seeing and feeling how forces act on a structure.

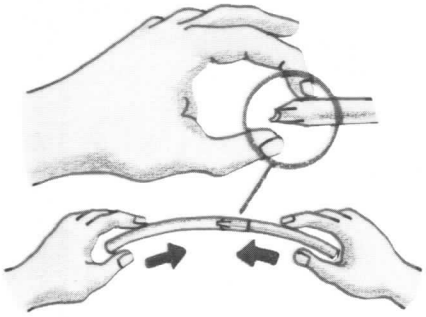


Getting Started

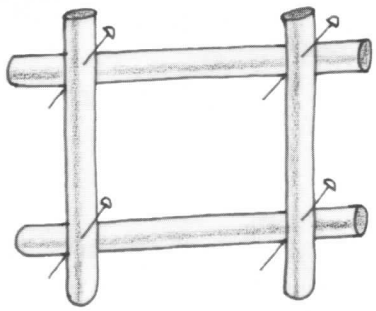
Model houses can be built with all kinds of materials. Newspaper rolled up into tubes, wooden dowels, and strips of balsa wood are among some of the common materials that can be used. One material that is uniform in strength, is relatively cheap, and is easy to join together is the drinking straw. Following some simple procedures and using your imagination, you can build all kinds of structures.

To Assemble

1. To make longer sections squeeze one end of a straw and place this into another.



2. Pins can be used to join the sections at the corners. You must be cautious in working with pins.



Science Themes

structures
technology

Science Skills

planning experiments
analysis

Time Frame

one class period

Materials

- ☐ *plastic drinking straws*
- ☐ *pins*
- ☐ *finishing nails 12 d. (3 ¼ inches)*

Do not poke yourself or your partners with the pins. Do not scratch yourself with the pins that stick out on the models you build.

Before building a real building the architect makes drawings and plans how to construct it. You should do the same. Get together with your group and discuss what kind of structure you want to make. The drawings do not have to look like a real house. They can show only how the frame of the house will look.

The size of a model is an important consideration. If you make it too big, it may take too long to complete. If it is too small you may miss observing how the forces act on it when testing. You will also need to consider how to test it. The following directions and challenge will help you.

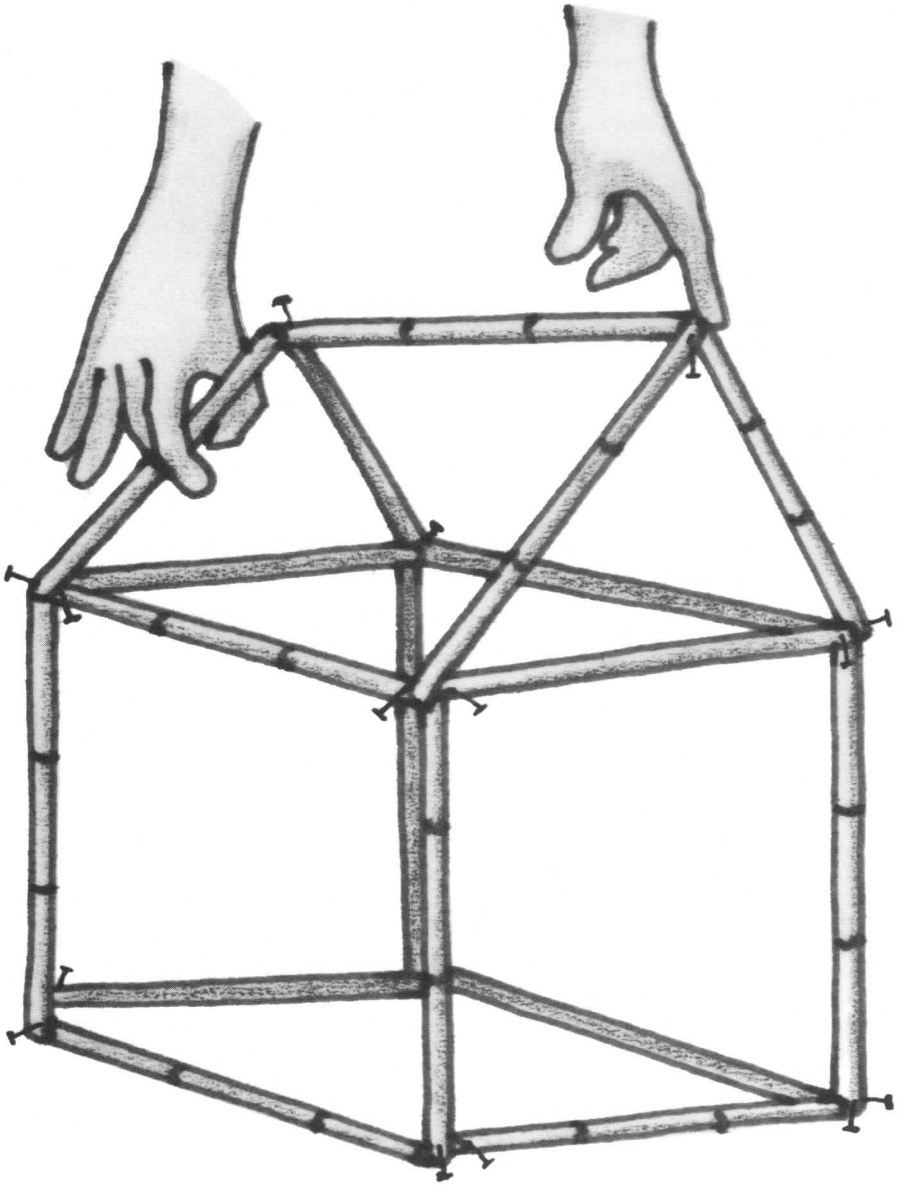
The Activity

There are many ways of making and testing a drinking-straw house. To help you get started here is a challenge:

Can you build a frame of a house that is three straws high and three straws wide that will hold a paper container (milk carton or paper cup) with 25 nails in it? The container can be hung at the top of the roof.

The challenge is to do this with a minimum number of straws, using only pins as connectors.

As you build your house you will quickly discover that the sides of the house have a tendency to buckle and fall down or dance back and forth. To solve this problem experiment with one side of the frame at a time to see how you can stop this motion.



A square can be made rigid by placing a diagonal or several diagonals across it.

By introducing the triangular arrangement into the frame, you make it rigid and stronger. Keep this in mind as you put the whole frame together and make the frame for the roof.

Discussion and Analysis

If others in your class have also built models, compare your results to theirs. How do they differ, and what parts of the construction are the same?

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DOING SCIENCE

TESTING A MODEL HOUSE

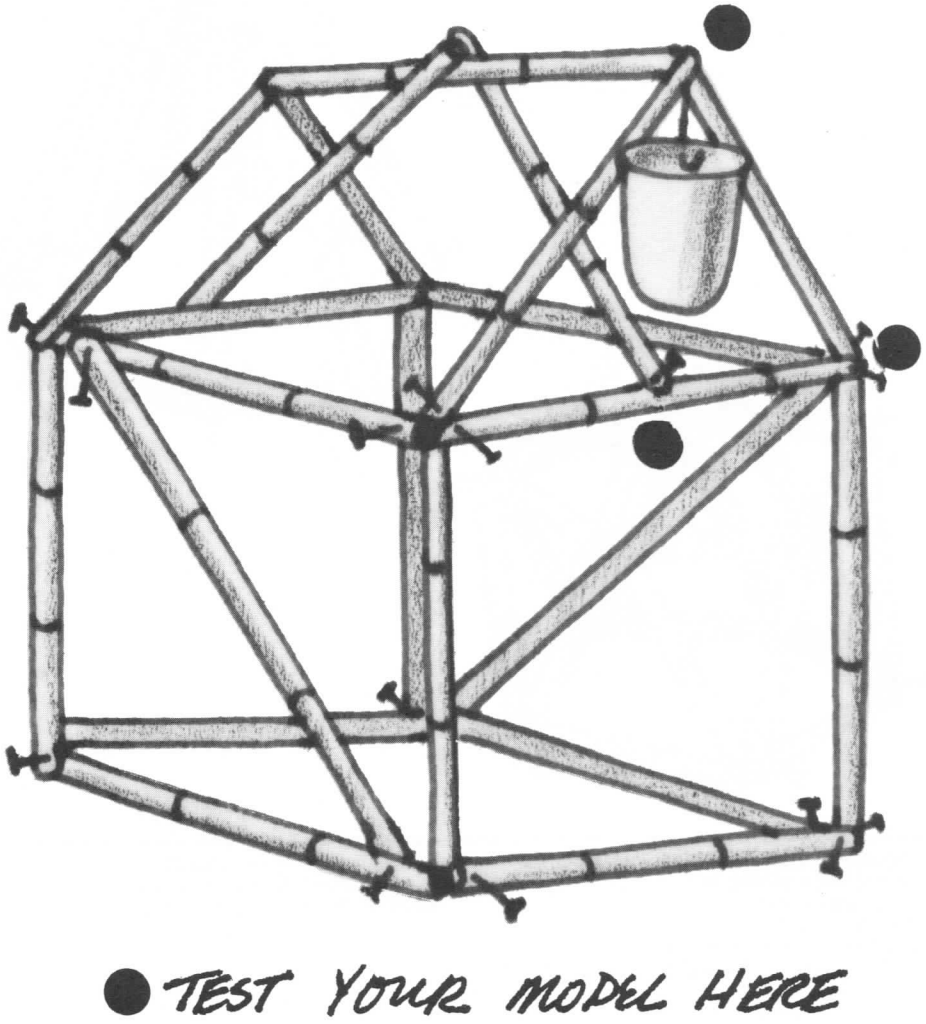
DS-2

Introduction

When you complete and strengthen all the sides and roof of your model house, you are ready for testing the frame. The milk carton or cup can be hung anywhere you think is the strongest part of the frame. The drawing suggests a few places.

The Activity

When testing, add one nail at a time and watch closely where straws are starting to bend. If the bending becomes great, you may have to add a few more straws at that point. First see if your house will support 25 nails. Add extra straws where they are needed. Once you have reached 25 nails keep adding more and see how many more can be added before some part starts to bend a great deal. Then add some more reinforcement. Will any part of the house support 100 nails?



Science Themes

structures
technology

Science Skills

planning experiments
analysis

Time Frame

one class period

Materials

- ☐ *plastic drinking straws*
- ☐ *pins*
- ☐ *finishing nails 12 d. (3 ¼ inches)*
- ☐ *paper containers, such as pint milk cartons or paper cups*

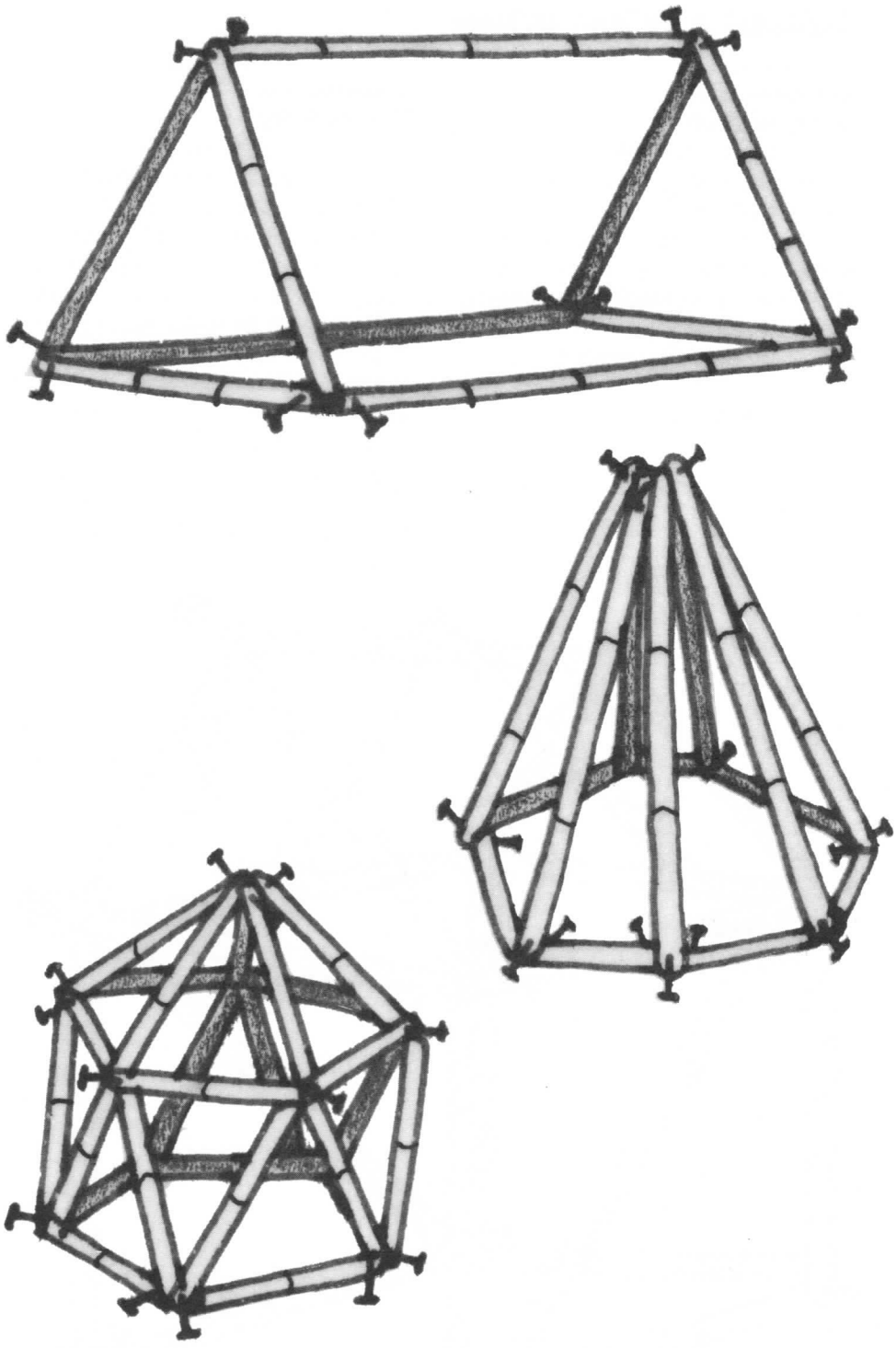
Discussion and Analysis

In the building and testing of your model, you may have added many straws to make sure it would support lots of nails. Some of these straws may not be needed for support. To test this, hang the box with only 25 nails on the top part or center of your house. Start taking away the straws you think are not essential. Do this one at a time until the house just about supports the 25 nails. Can you now describe what elements of the frame you need to keep it standing up?

As you have seen, placing a diagonal at the corners was necessary. This triangular arrangement of the straws is one of the essential elements of the structure. The triangle is a rigid shape compared to a square or any other geometric shape. It helps make structures rigid. The triangle is also useful in distributing the stress on a structure. You can see how this happens in the next activity.

Going Further

Try building other shapes of houses and testing them. A-frame, dome-shape, and tepee arrangements are sometimes built.



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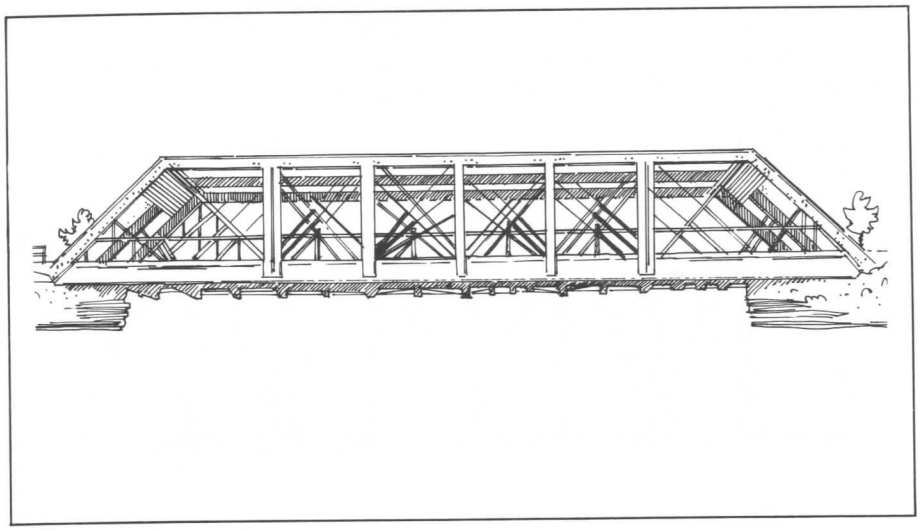
DOING SCIENCE

BUILDING AND TESTING A MODEL BRIDGE

DS-3



Science Themes

structures
technology

Science Skills

planning experiments
analysis

Time Frame

one or two class periods

Materials

- ☐ *plastic drinking straws*
- ☐ *pins*
- ☐ *finishing nails 12 d. (3¼ inches)*
- ☐ *paper containers, such as pint milk cartons or paper cups*

Introduction

Another kind of structure that we frequently see and use is the bridge. Some cross over small streams while others span large rivers or harbors. Some of the long bridges are suspended from cables while the smaller ones are often systems of connected, triangulated, steel beams.

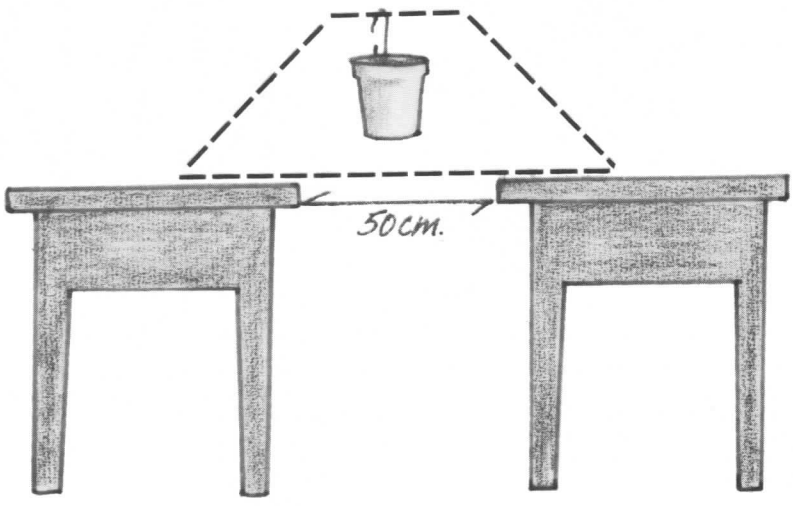
The roof of a building performs a function similar to that of a bridge. Both structures need to span a distance without lots of vertical supports, and to carry a heavy load. Recall your experience with the model house. What type of roof was strong enough for supporting the weight of the nails? Could this shape be adapted to function as a bridge? Think about your experience with the model house, as you now take up the more challenging structure of making a bridge.

Preparation

There probably are bridges near your home or school. Before building a model bridge study these bridges by making simple drawings of them. You can also find pictures of bridges in books about engineering or structures. Then, plan with the rest of your group how to assemble a simple but strong bridge.

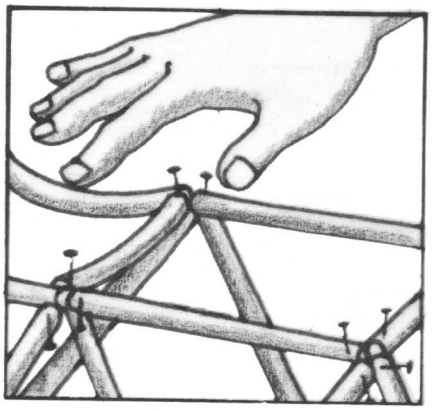
The Activity

Using drinking straws and pins, build a free-standing bridge that will span a gap of 50 cm (22 in.) and hold 50 nails in a paper container hanging in the middle. The ends of the bridge cannot be anchored by the chairs or tables, and there should be no vertical supports under the bridge.

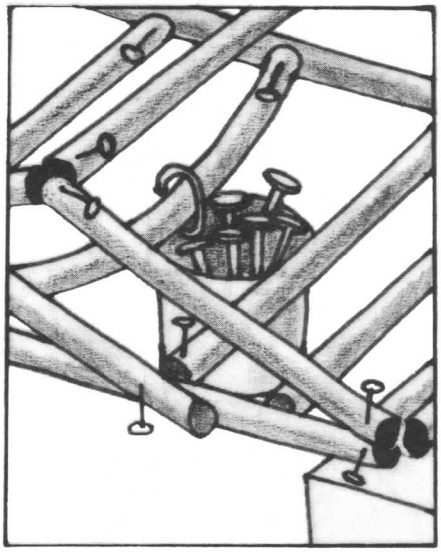


Recall your experiences using diagonal and triangular arrangements with the house. Remember that triangles are very rigid and strong.

As you build you can get some idea of how the structure will react to weights on it by pressing gently in the middle of it. Bending straws will show what parts of the structure are most in danger of failing.

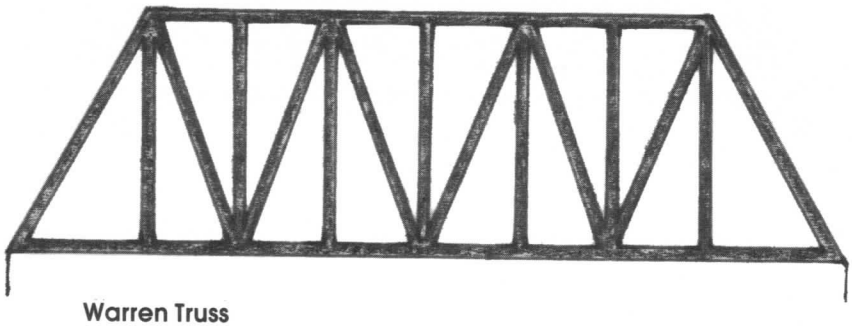


In testing do not add all 50 nails at once. Instead, count one at a time into the hanging container. Look for straws that are bending. You may have to add extra supports at that point to prevent a collapse. Once you have reached 50 nails and the bridge is still standing, keep on adding more. Can you reach 100? 200? As you do this you may have to add a few more straws for reinforcement.

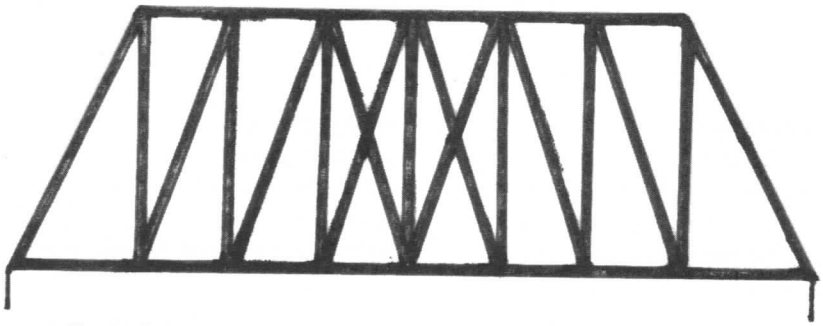


Discussion and Analysis

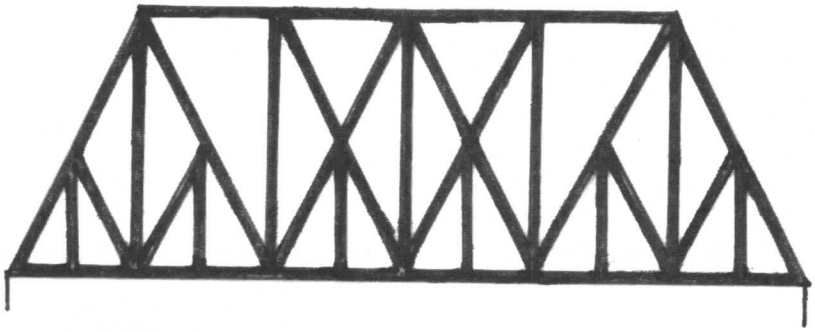
- As you did with the model houses, compare your final structure to others in your class. Have others built a triangular shape or structures that are a series of triangles for the sides of their bridges?
- Try to determine the minimum number of pins and straws needed to span the required distance. How many straws can you take off your completed model and still support the weight of 50 nails?
- Many short span bridges today, such as railroad bridges, have a structure that is like a series of connected triangles. Can you build a bridge where each side of the structure is a single triangle? How many nails will it support before it fails? Where could you add one extra straw on each side of the structure that would make a difference in how much weight it will support?
- Can you build any kind of rectangular bridge that will support many nails?



Warren Truss



Howe Truss



Baltimore Truss

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