Science Olympiad Summer Institute

MYSTERY ARCHITECTURE

Sample List of Materials

This list of Materials

20 - #32 Rubber Bands, Brown

20 – Small Rubber Bands, assorted size/colors

1 - Roll Scotch Tape

4 – 5 oz. Plastic Cups

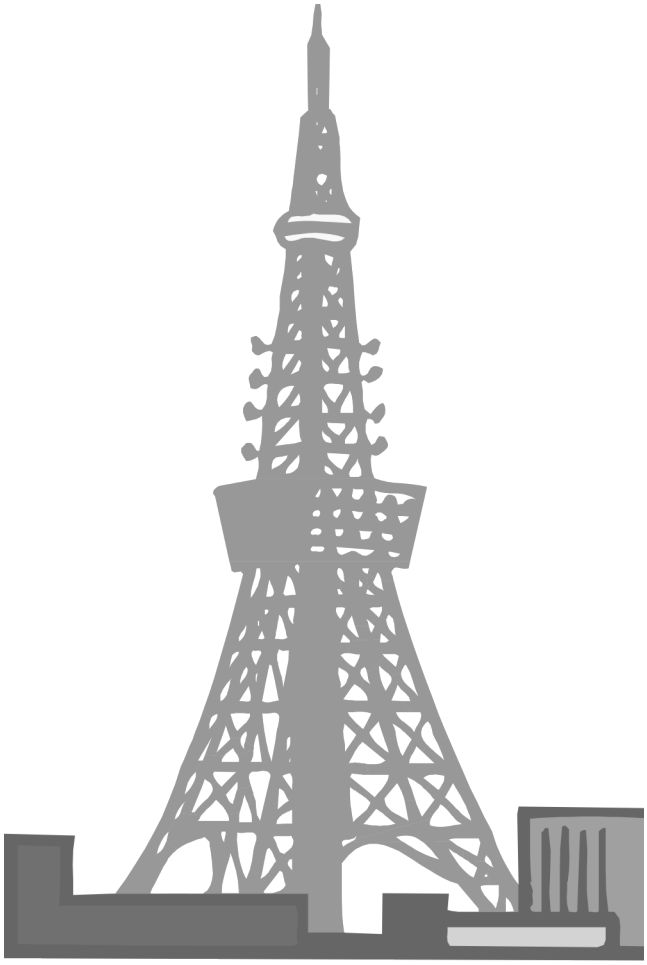
20 – Pipe Cleaners, assorted colors

10 – 10 inch Bamboo Skewers

10 – 12 inch Bamboo Skewers

20 – Drinking Straws

5 - 5 x 8 index cards



By

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Mystery Architecture 2003

Object

To build a device that can be tested in performing a given task.

Example Devices

Tower – Support a given load at the greatest possible height above its base.

Bridge – Support a given load between two supports the greatest possible Distance (span) apart..

Cantilever – Support a given load the greatest possible distance beyond a support.

Testing

Support a load for the specified time

If a load is required it will be available to each contestant while building the device.

The load may consist of only the mass of the device. (No load supplied)

This is a Pass / Fail measurement. All devices that support the load will be ranked above those that do not.

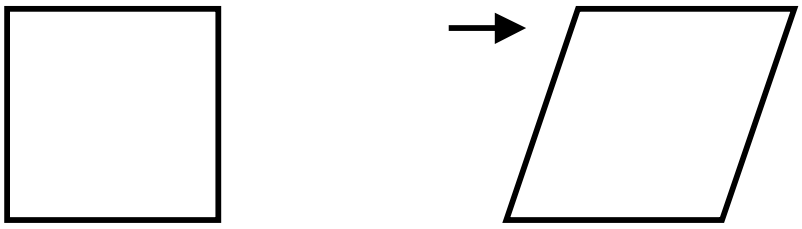
Measurement of device

Primary Dimension – Used to determine score as specified in task definition. Devices with larger dimension are ranked above those with smaller dimension.

Secondary Dimension – Used to break ties if two devices have the same Pertinent Dimension. Smallest dimension wins tie.

Simple Structures

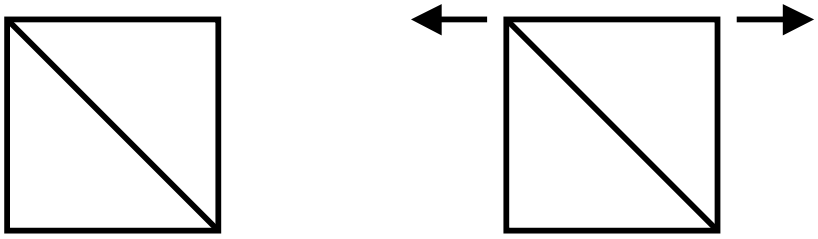
Square



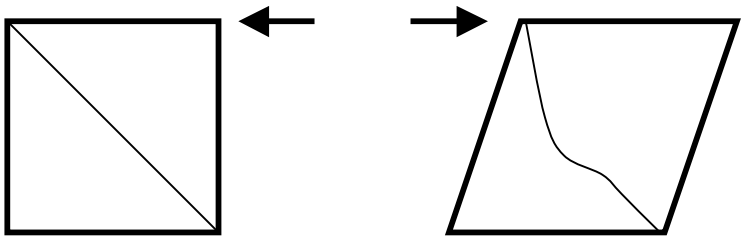
Use 4 pipe cleaners and 4 drinking straws to form a square. Insert the pipe cleaners through the straws and twist them together at the corners. Stand the square on edge and apply a downward force to the top of it. The square deforms easily due to the weakness (in rotation) of the corner joints.

Triangle

Make a triangle in the same manner using 3 pipe cleaners and straws and test it as you did the square. The triangle won't change shape unless you push hard enough for either a joint or one of the straws to break.



Fortunately a 4-sided figure can be changed into 2 triangles by connecting 2 opposite corners together. Add a rigid cross brace to the square and test it again. Now it is much stronger.



Remove the rigid cross brace and replace it with a piece of string. Now you can deform the square in one direction easily but not the other. If you connect the remaining 2 corners with another string the square will be rigid in both directions again. By using these principles you can build a larger structure that is strong and rigid.

Analysis of Structures

Definitions

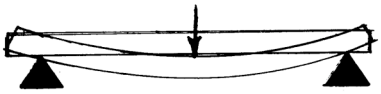
Joint – The place where 2 or more members are connected together.

Member – A part of a structure that connects 2 joints.

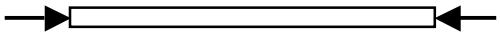
Strain – The deformation or change of shape that is the result of applied stress.

Stress – The force applied to an object that tries to change its shape. There are 5 different forms of stress.

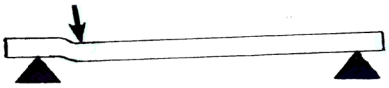
Bending – Stress that tends to deform an object from a straight line.



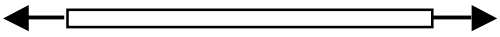
Compression – Stress that tends to compress an object together.



Shear – Stress that tends to make two parts of an object slide past each other.



Tension – Stress that tends to pull an object apart.



Torsion – Stress that tends to twist an object around an axis.

For our simplified analysis we will only consider bending, compression, and tension.

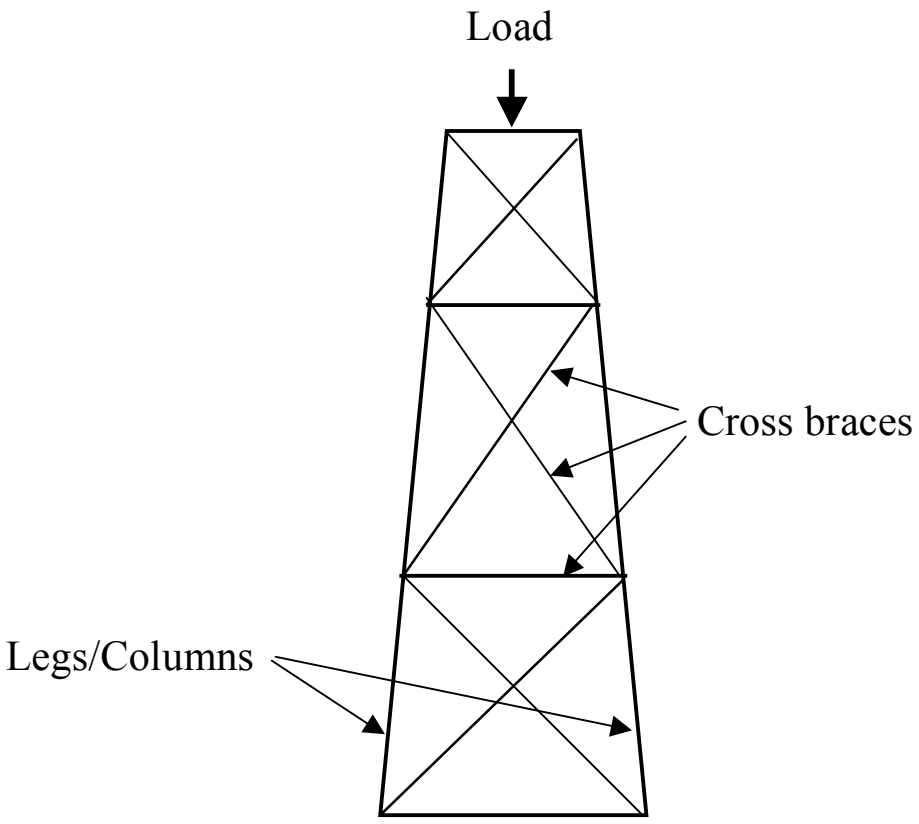
Towers

The object is to support a load at some height above the base.

A tower is made up of:

Legs or Columns –Vertical members
- Extend from the base to the top of the tower
- Support the load
- Need to be strong in compression.
- Bend easily because they are long and slender.

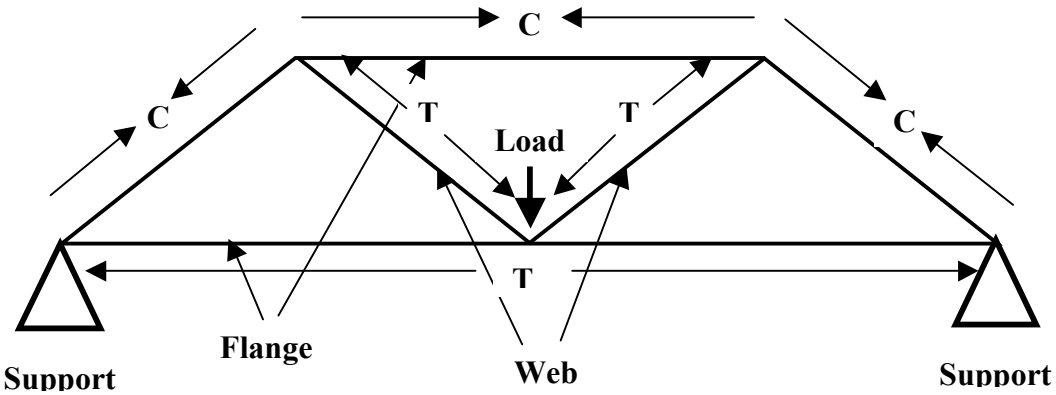
Cross Braces – Horizontal/Diagonal members
- Connect one leg to another
- "Break" the legs up into shorter/stiffer members
- Prevent the legs from bending
- May be under compression or tension
- Have very little stress as long as the legs remain straight.



Bridges

The object is to support a load between two supports.

T = Tension C = Compression



A Bridge is usually made up of two or more trusses which contain:

Flanges – Horizontal /Diagonal members
- Transfer the force generated by the load to the supports
- Top flange is under compression
- The bottom flange is under tension
- Need to be strong in compression/tension
- Bend easily because they are long and slender

Web – Vertical/Diagonal members
- Help carry the load to the supports
- Hold the flanges apart
- Need to be strong in compression/tension
- "Break" the flanges into shorter/stiffer members
- Keep the flanges from bending

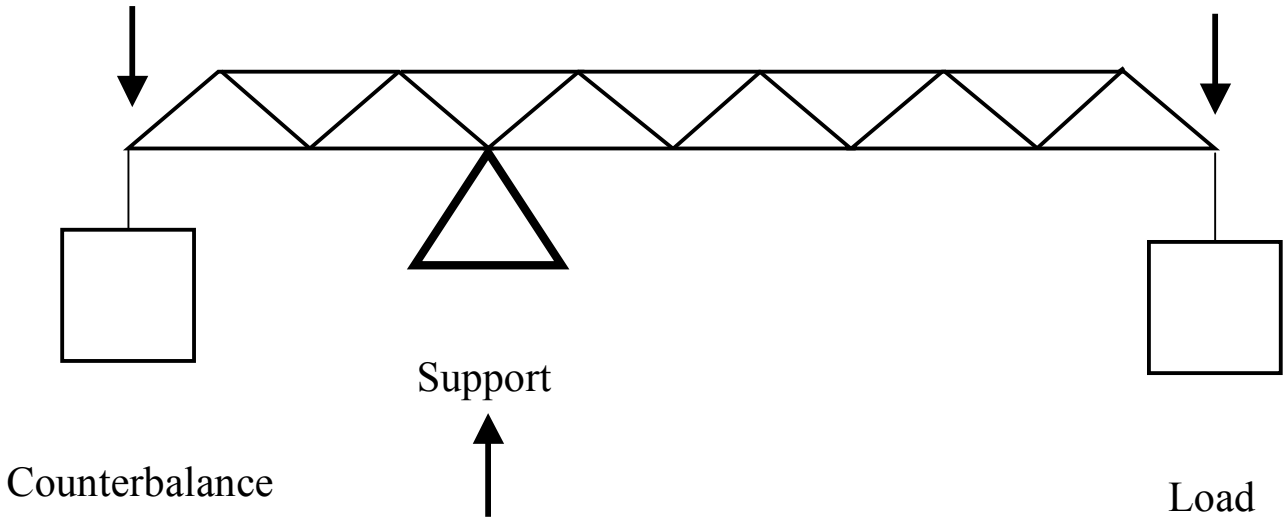
Cross Bracing – Connects the trusses together
- Keep the trusses from bending sideways (laterally)
- Have very little stress as long as the flanges are straight

Cantilever

The object is to support a load at a horizontal distance from a support.

A Cantilever is similar to a bridge except:

- The support is in the center of the lever.
- The is a load at one end of the lever
- The counterbalance is at the other end of the cantilever
- The top flange is in tension
- The bottom flange is in compression

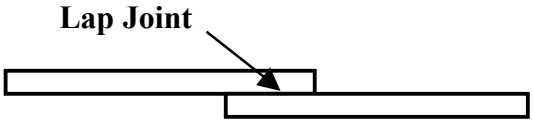


Joints

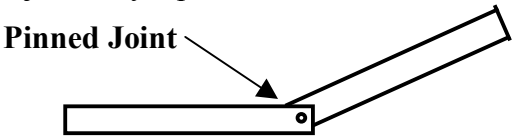
A joint is where 2 or more members are joined together

Butt Joint – pieces are joined end to end

Lap Joint – Pieces are overlapped



Pinned/Hinge Joint – Pieces joined by a pin



The strength depends on the type of joint and material used to hold it together.

You can use Tape to hold butt and lap joints together. When you wrap a butt joint with tape it technically becomes a lap joint.

A lap joint can be held together with string or tape used as glue.

Strength of Joints

Butt Joint
- Bending – Weak
- Compression – Strong
- Tension – Weak

Lap Joint
- Bending – Strong
- Compression – Medium
- Tension – Medium

Pinned Joint
- Bending – Weak
- Compression – Medium
- Tension – Medium

Materials

Before you start building, inspect the materials provided. Try to match their properties to those required where it will be used.

Properties

Drinking Straws
- Bending – Strong
- Compression – Medium
- Tension – Strong

Bamboo Skewers
- Bending – Strong
- Compression – Strong
- Tension – Strong

Index cards
- Bending – Weak
- Compression – Weak
- Tension – Strong

String
- Bending – Weak
- Compression – Weak
- Tension – Strong

Tape – Its stickiness is good for holding joints together.
- Bending – Weak
- Compression – Weak
- Tension – Medium

Rubber Bands – Elasticity makes them useful for holding joints together
- Bending – Weak
- Compression – Weak
- Tension – Elastic

Sources of information

Great Buildings of the World - Bridges, Derrick Beckett, 1969, Hamlin Publishing Group Ltd., SBN 600 01640 4

Engineering For Young Scientists, Peter H. Goodwin, 1987, Peter H. Goodwin, ISBN 0-531-10339-0

Messing Around With Drinking Straw Construction, Bernie Zubrowski

Structures, The Way Things Are Built, Nigel Hawkes

MYSTERY ARCHITECTURE

Team #: _____

School: _____

District: _____

Name: _____

Name: _____

Scheduled Time: _____

---------- Do Not Write Below this line ----------

Start Time: _____ Stop Time: _____

Primary Dimension:	Secondary Dimension:	Place:	Points: