
VDOT
Virginia Department of Transportation

VDOT - BRIDGE BUILDING

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TOPICS WE'LL COVER

1. VDOT
2. BRIDGE DEFINITION
3. TYPES OF BRIDGES
4. BRIDGE TYPE SELECTION
5. PARTS OF BRIDGES
6. LOADS
7. PAPER BRIDGE ACTIVITY
8. BUILDING YOUR OWN BRIDGE

What does the Virginia Department of Transportation do?

We are responsible for ...

designing,
building,
maintaining, and
operating the state's roads,
bridges and tunnels

We oversee *57,867* miles of road

and more than *21,000* bridges and structures

BRIDGE

a structure carrying a pathway or roadway over a depression or obstacle

–Miriam Webster Dictionary

Why do we build bridges?

- To travel over waterways
- To travel over low areas (steep ravines)
- To shorten travel distances
- To provide a path for rail traffic

For accessibility !!

Woodrow Wilson Bridge

We build some bridges that open so ships can go through them.

Route 17 over York River

Some boats are so big we build tunnels so the cars can go under the water.

Monitor Merrimac Bridge Tunnel

Hampton Roads Bridge Tunnel

Chesapeake Bay Bridge Tunnel

Interstate 895 over James River

Some bridges are built tall enough for ships to go under them.

Gov. Harry W. Nice Bridge

Route 301 over Rappahannock River

Interstate 295

over James River

SOME BRIDGE TYPES

- Truss
- Cable-stayed
- Suspension
- Girder
- Box Girder
- Beam
- Arch
- Moveable

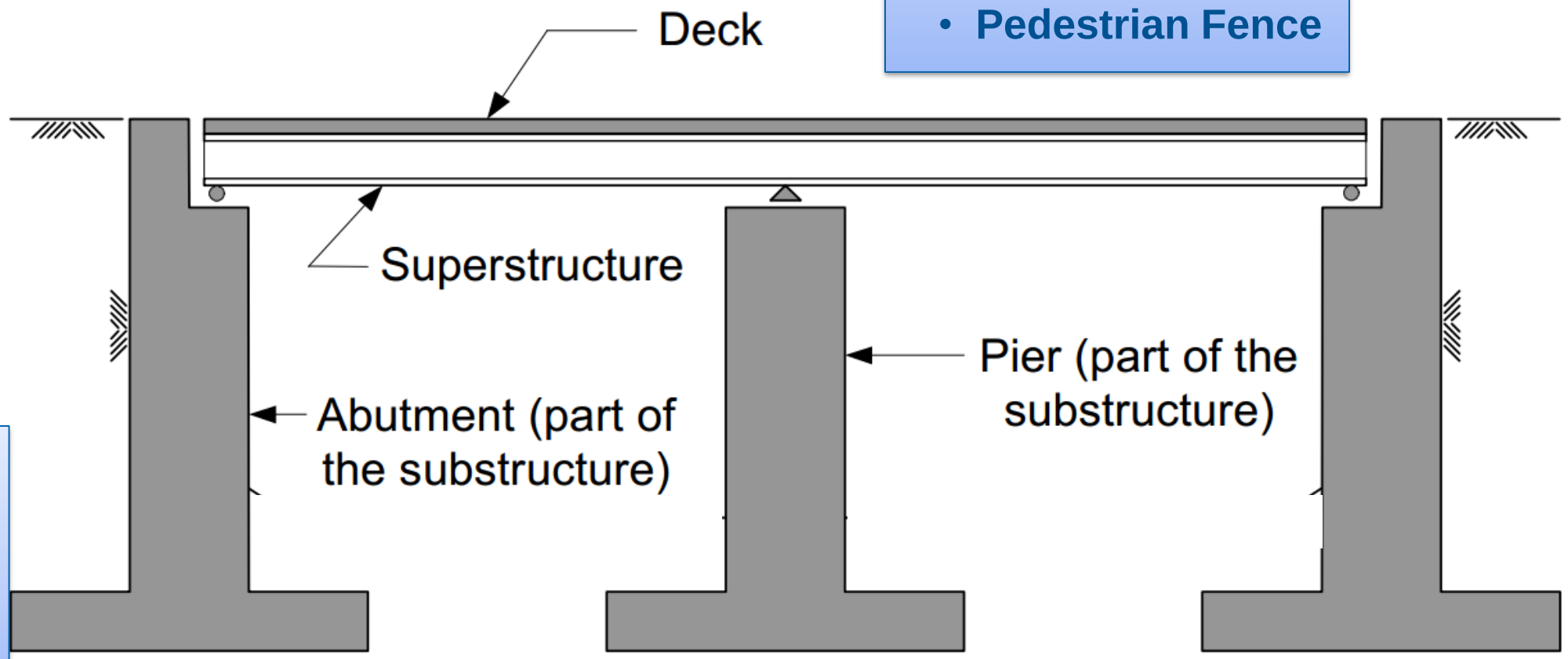
BRIDGE TYPE SELECTION

Based upon:

- Crossing type (highway, waterway, railroad)
- Geometry
- Geology
- Volume of traffic
- Users (bicycles, pedestrians)
- Environmental concerns
- Budget
- Long-term maintenance

PARTS OF A BRIDGE

Superstructure
- Deck slab
- Beams/girders
- Railing
- Sidewalk
- Pedestrian Fence



Substructure
- Abutment
- Piers/Bents
- Foundations
- Bearings

LOADS

DEAD LOADS: Weight of all permanently attached materials that make up the structure.

- Weight of the bridge itself
- Utilities
- Future wearing surfaces

LIVE LOADS: Variable weight of all other forces acting on the bridge.

- Weight of people, vehicles, etc.
- Impacts

OTHER LOADS

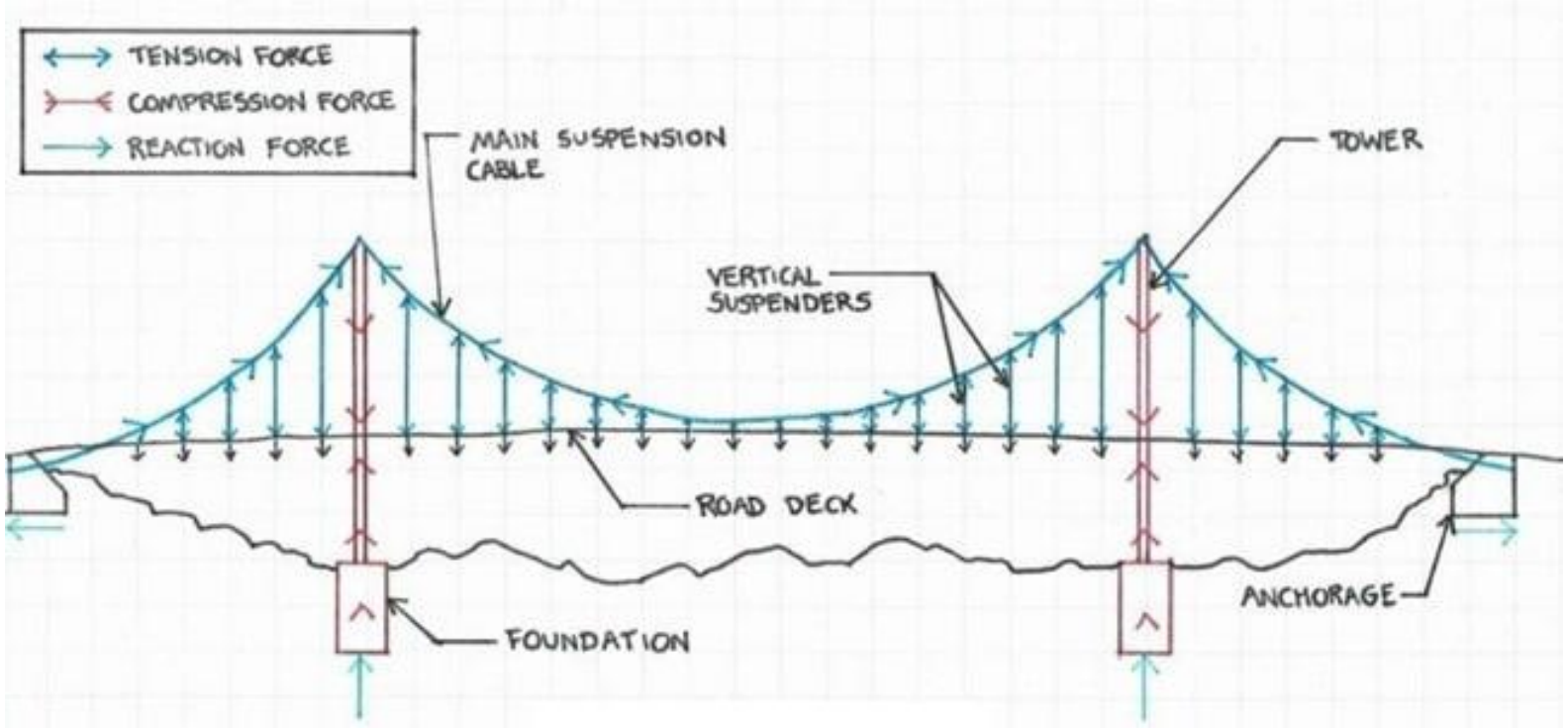
- Earth pressure
- Wind
- Wind on live load
- Longitudinal force
- Thermal force
- Settlement Load

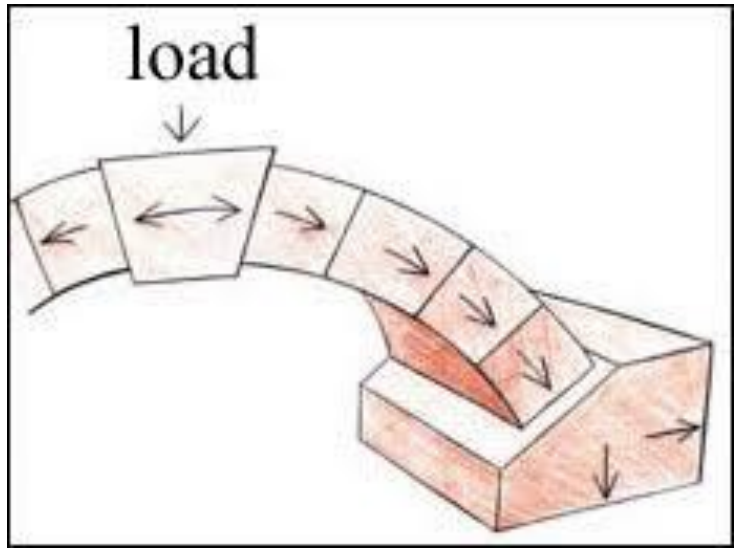
- Stream flow
- Buoyancy
- Ice flow
- Earthquake
- Centrifugal force

How does a bridge hold all that weight?

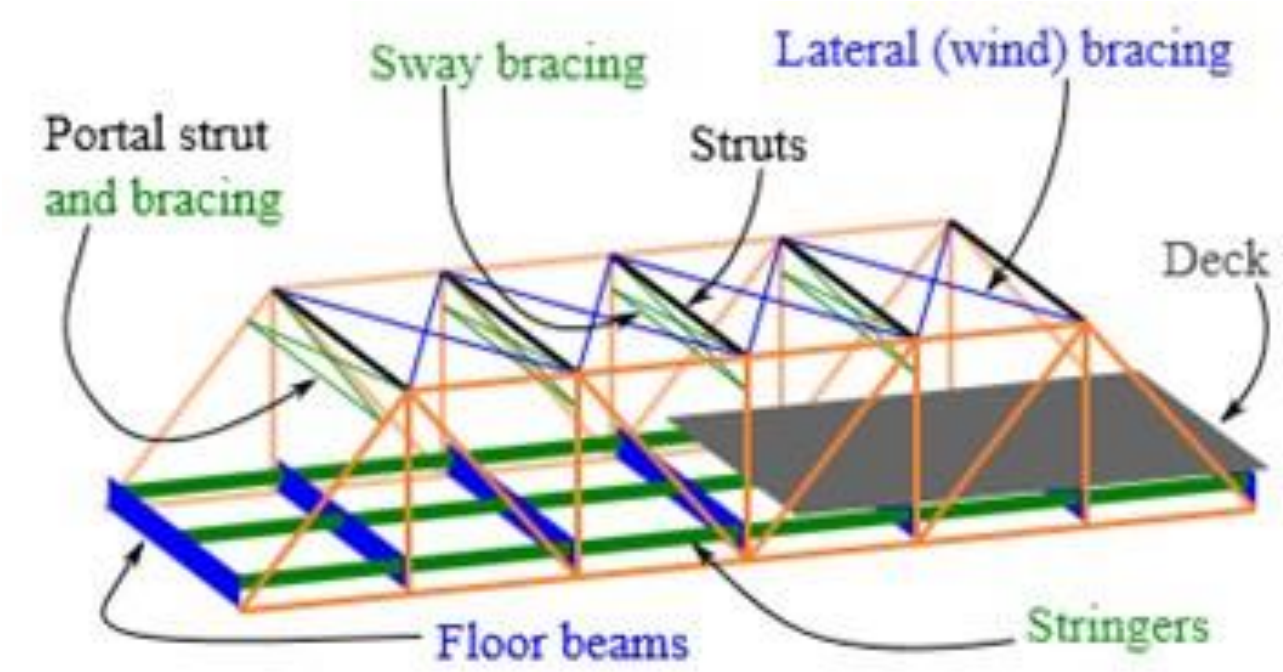
LOAD DISTRIBUTION

A properly designed structure distributes the loads acting on the structure to the supporting earth surrounding it.



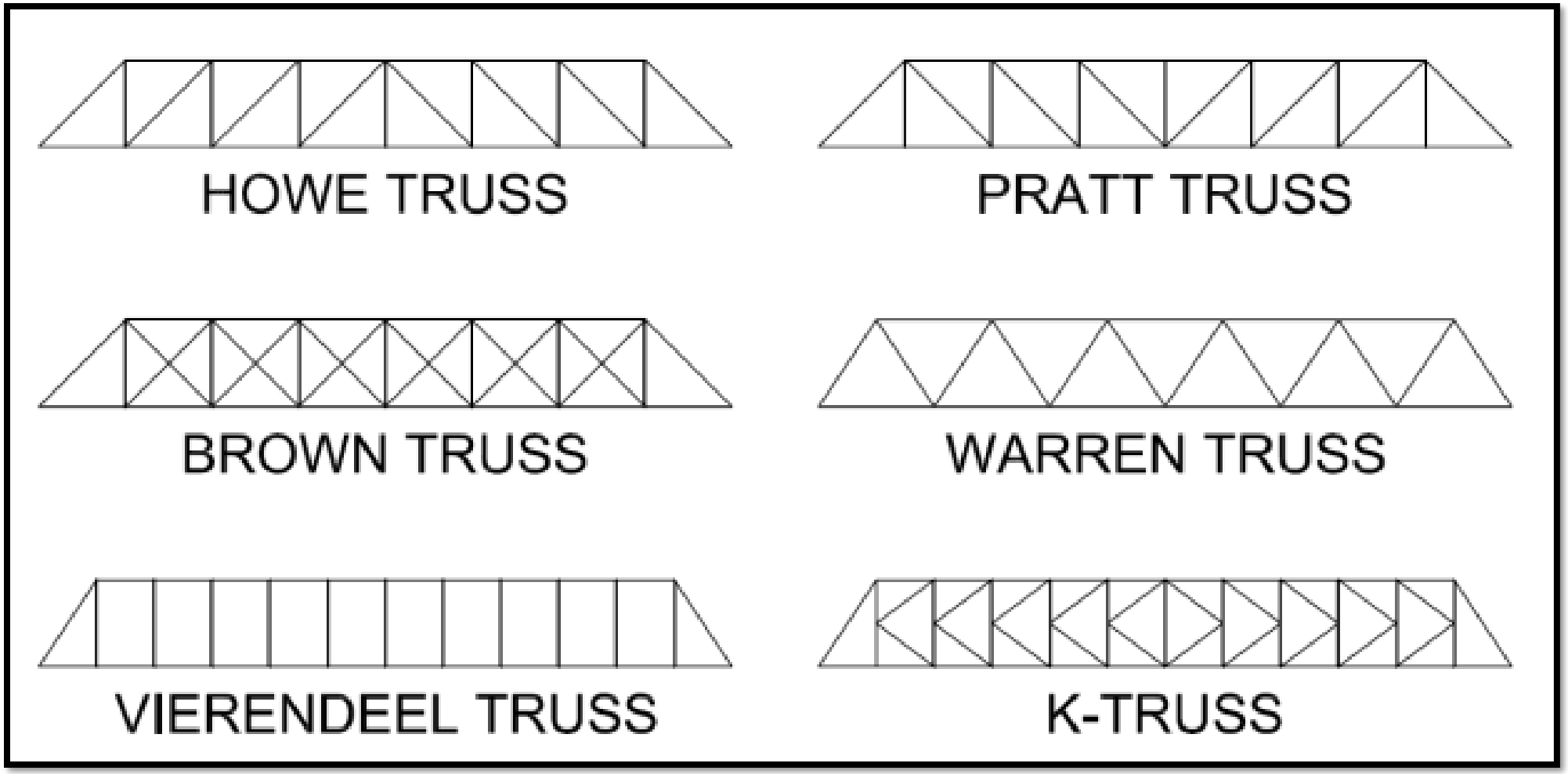


TRUSS

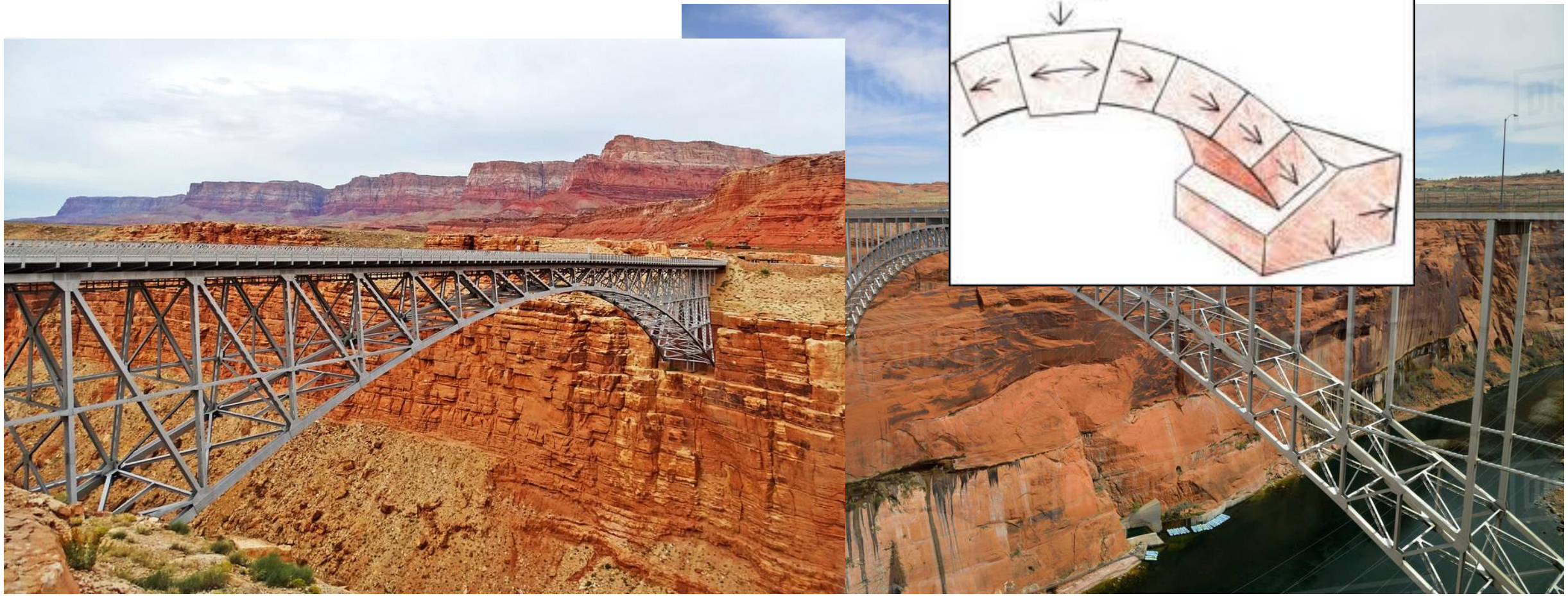


- Made of many parts, usually an assembly of triangles, focusing load to specific points
- More likely to find older bridges that are trusses
- Some types of movable spans are also trusses

TRUSS


HOWE TRUSS
PRATT TRUSS
BROWN TRUSS
WARREN TRUSS
VIERENDEEL TRUSS
K-TRUSS

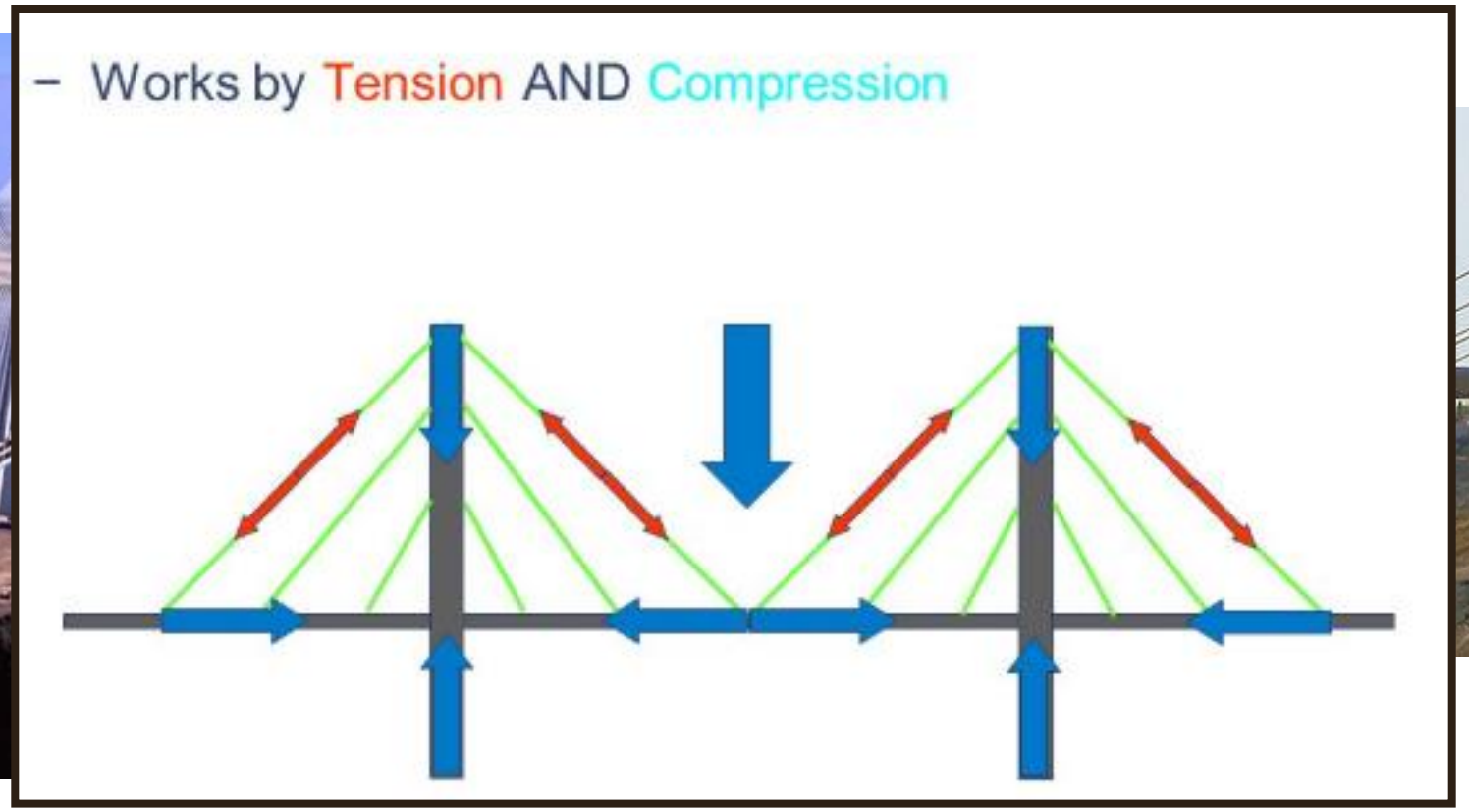
DECK ARCH TRUSS



Has great natural strength, distributing load to the end point of the arch.

DECK ARCH

CABLE-STAYED BRIDGE



Cables transfer loads to the towers.

https://prezi.com/-dflg65rcghb/cable-stayed-bridge/

Questions ?

PAPER BRIDGE

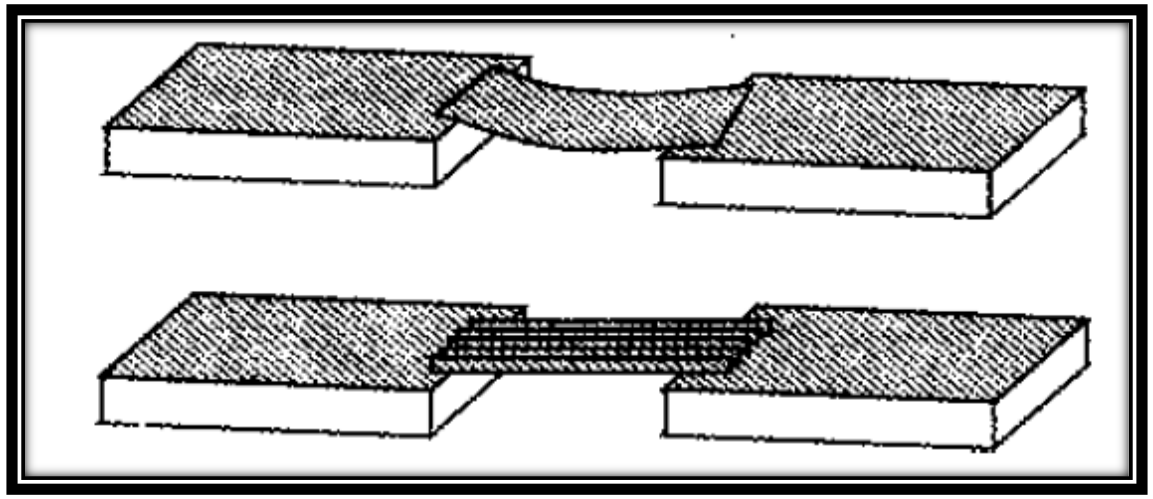
Materials:

- *(2) sheets of notebook paper*
- *2 books*

Directions:

- *Place sheet of plain paper such that it is supported by 2 books. What do you notice?*
- *Fold 2nd sheet of paper in a fan-fold manner at least 4 times; support the paper between the two books. What do you notice now?*

How can you apply what you've learned to a bridge design?



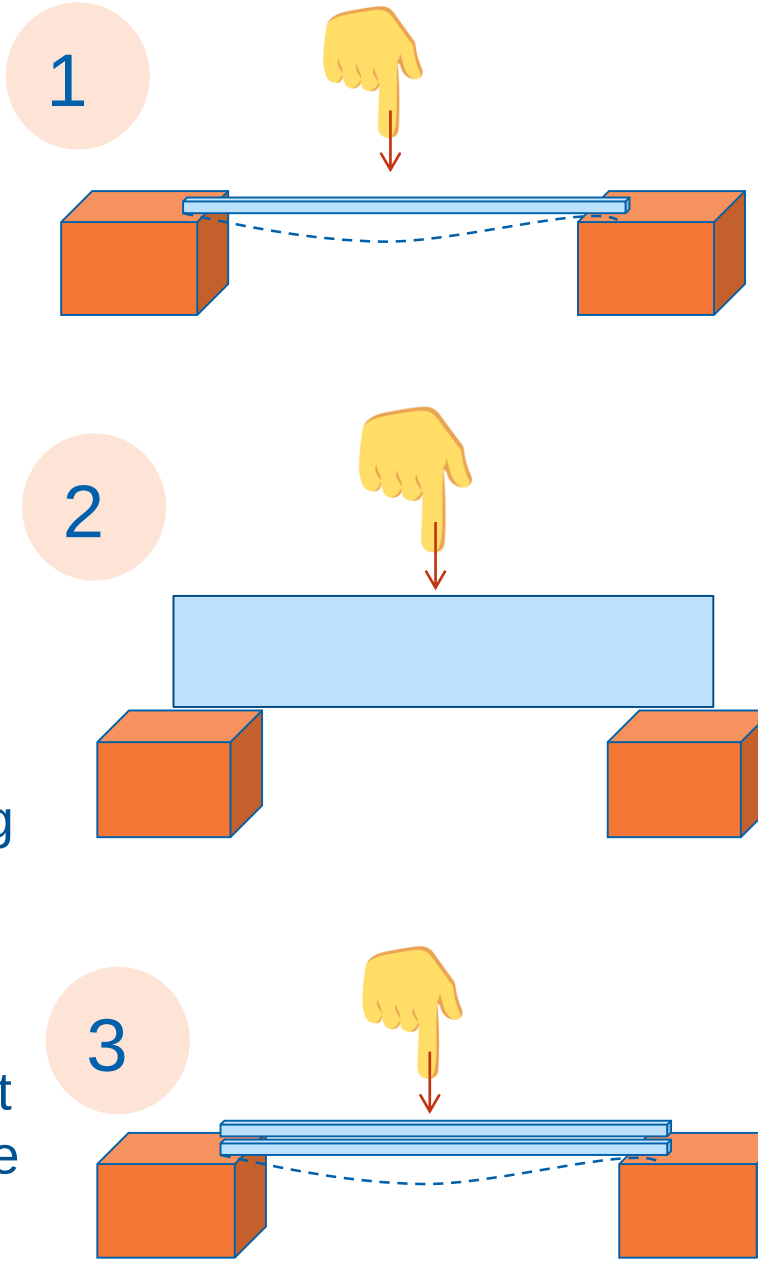
Beam Strength Exploration

Materials:

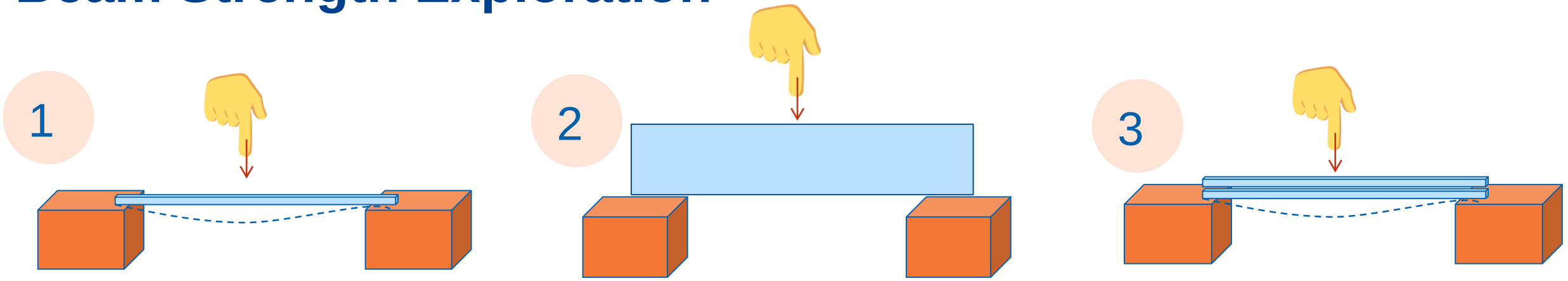
- 2 plastic rulers, popsicle sticks, or similar flexible “beams”
- 2 books

Directions:

1. Suspend one beam between the ends of two books so that the larger flat surface of the beam is facing up. Apply light pressure to the middle of the beam. Notice the deflection (bending) of the beam.
2. Turn the beam 90 degrees so that the larger flat surface is pointing left or right, not up or down. Apply the same amount of light pressure to the middle of the beam. Notice how the beam deflects in this orientation.
3. Now stack two beams directly on top of one another laying flat, not standing up. Apply the same amount of light pressure to the middle of the two beams together and notice the amount of deflection.



Beam Strength Exploration

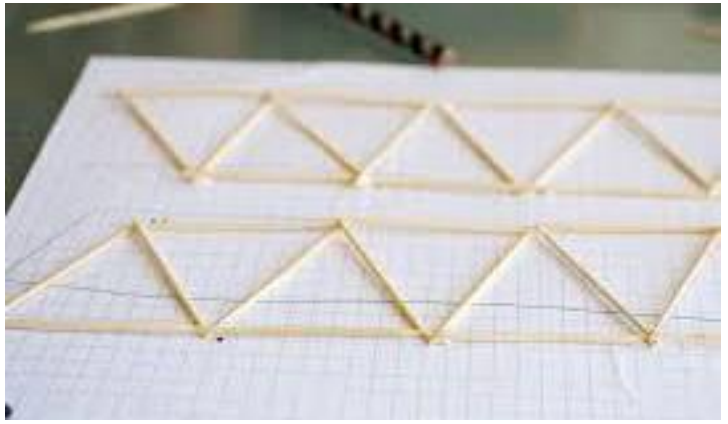


Questions

1. Which orientation of the beam allowed it to resist deflection better?

2. How can you apply what you've learned to bridge designs?

Time to Build a Bridge

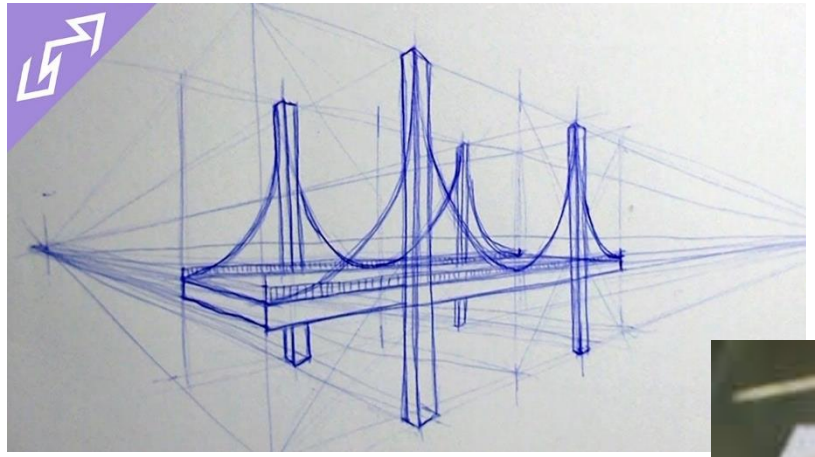


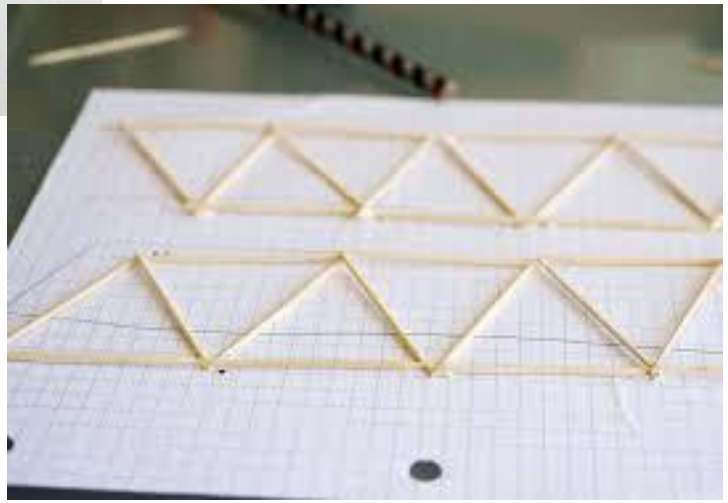
Possible Materials

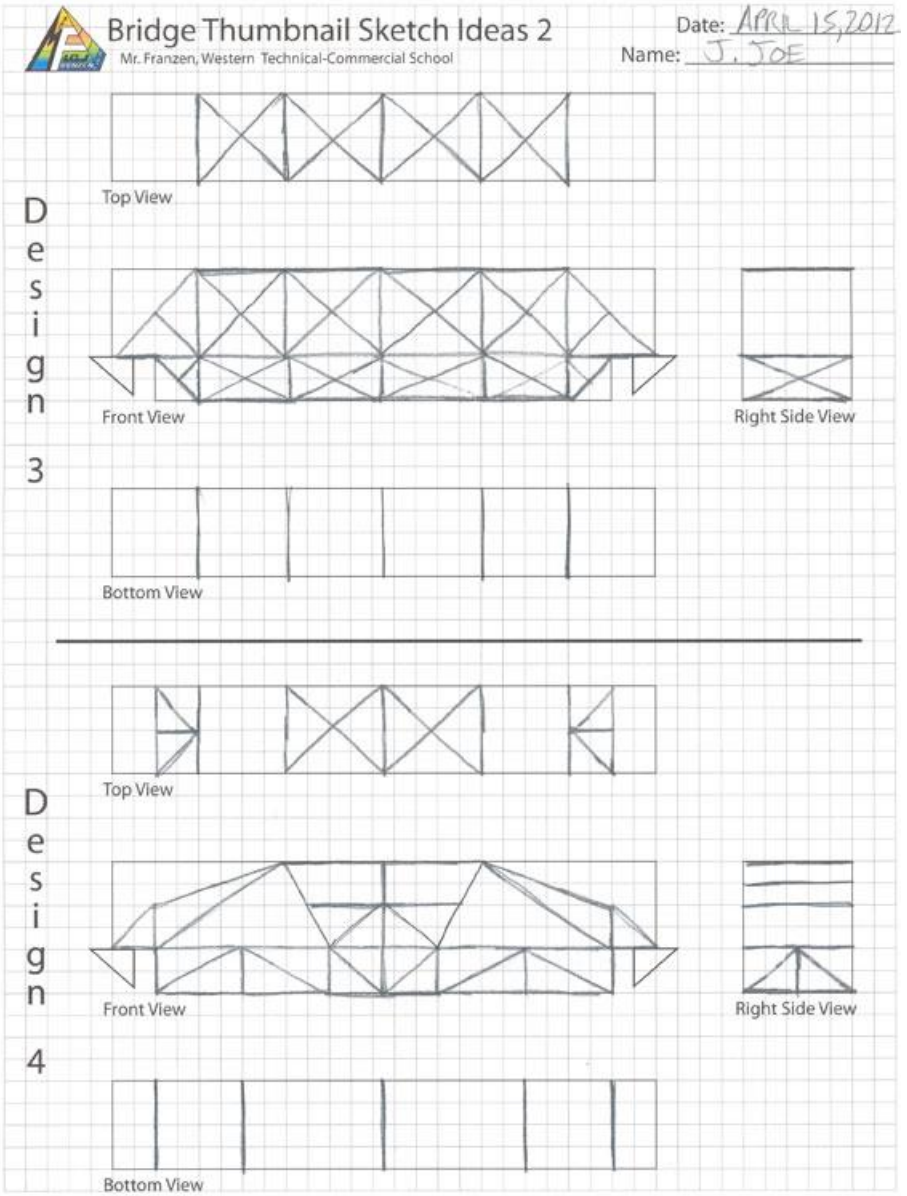
- Toothpicks with glue
- Toothpicks with gumdrops or marshmallows
- Legos™
- Popsicle sticks & glue
- Balsa wood (a very light and easily cut wood)

SKETCHES

You may want to draw a few design sketches to get ideas flowing.

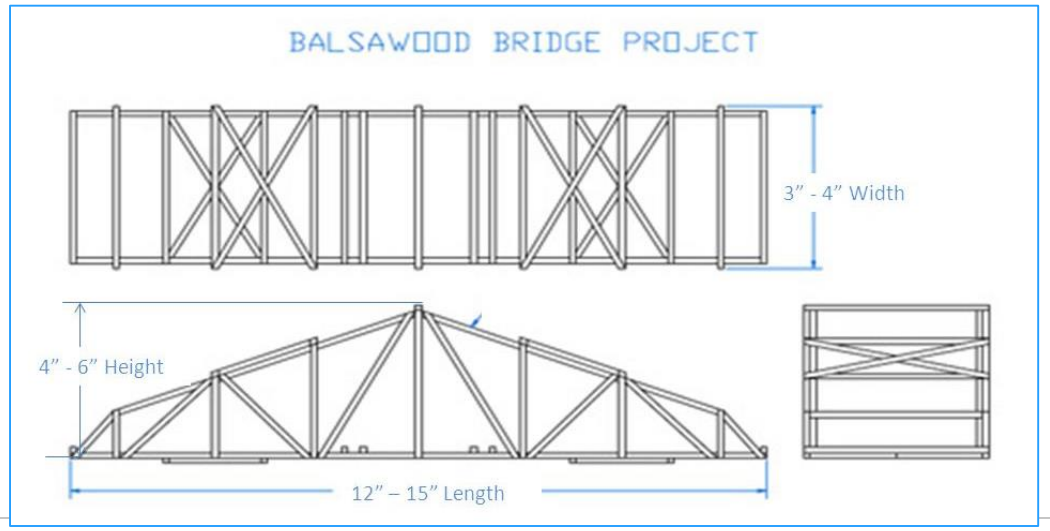


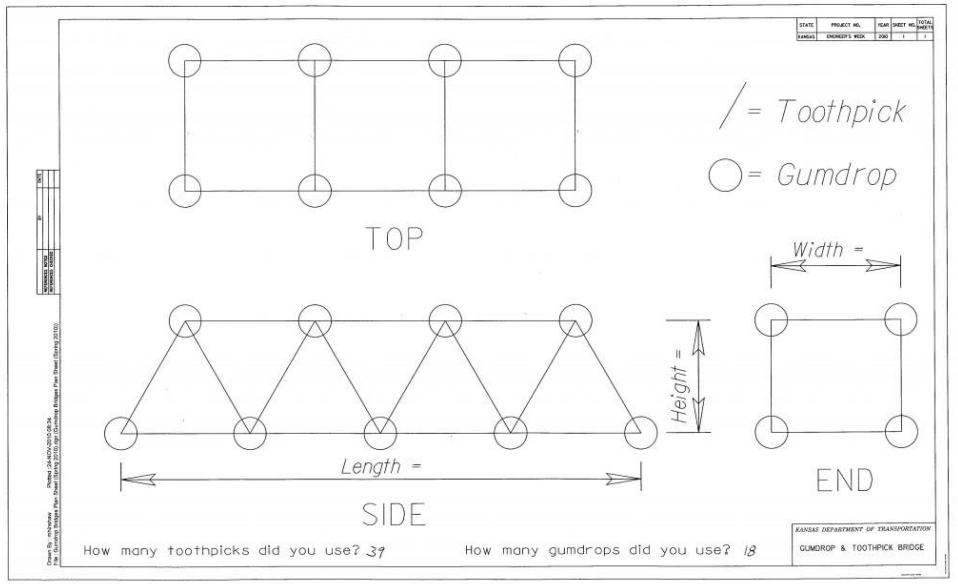




ASSEMBLY TIPS

- Have a plan (good ortho drawing will help)
- Gather materials
- If gluing, use minimal glue (more just makes it heavier, not stronger)
- Test a prototype then improve where it failed
- Pick the strongest pieces of material for the final bridge





TESTING

- You can use two books, tables, boxes, etc.
- Put a container on your bridge then add items to the container (marbles, toy cars, spice jars, silverware, etc.)

- How much weight can your bridge hold before failure occurs?
- How long can you build your bridge?

Additional Bridge Resources

https://www.garrettsbridges.com

World record LEGO bridge videos

https://www.ice.org.uk/events/exhibitions/ice-bridge-engineering-exhibition/building-the-lego-bridge