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CTE Science Laboratory Investigation

BRIDGE CONSTRUCTION

**Introduction**

Bridges have been built for thousands of years, and while their purpose has remained the same, the scale and materials used have changed significantly. In early times, thick slabs of stone were placed on pylons to cross rivers. While these bridges were sturdy, they didn’t have the ability to span much distance due to the mass of the stones themselves. The Romans developed arches, which made it much easier to build longer and more elegant spans.

Indeed, the entire purpose of a bridge (from a physics standpoint), is to redirect the force placed upon it to something sturdy, like the banks of a river or the sides of a gorge. Bridges would be easy to build if the force placed upon them could be transferred straight down, but this is generally not the case. The trick to a good bridge is to take the force from the middle of the structure and efficiently transfer it to the outsides.

Bridges can be classified according to the type of bridge – suspension, truss, arch, etc., but it is more useful for our purposes to talk about a bridge in terms of the type of forces that it uses to hold itself up. These five main forces are: tension, compression, bending, torsion and sheer. They are defined below, although many bridges employ more than one of these forces at the same time.

1. Tension. Tension is a pulling force exerted on a structure. A suspension bridge employs tension in the cables, which are usually anchored in massive blocks of concrete at either end of the bridge. The tension in the cables is used to support the mass of the bridge deck.
2. Compression. Compression is the pushing force exerted on a structure from an outside object. Arch bridges use compression. They essentially squeeze the stones or blocks together to make a bridge. There must be something very massive on each side of the bridge to keep the pressure on them.
3. Bending. Bending can be used in many types of bridges, and allows the force created by the mass of the bridge to be directed in different directions. Steel arch bridges use bent beams to direct the force down to two points, generally the supports on either side of the bridge.
4. Torsion. Torsion is a twisting force, easily imagined as the force on a broomstick if you try and twist it in opposite directions with your hands. Torsion is generally employed in longer supports of a bridge.
5. Sheer. Sheer stress is applied along the same plane as the material. As an example, rubbing one sanding block along another one can cause the second to move, because of the sheer stress pulling on it. In bridges, sheer forces are usually found in elements of the road bed.

It will be your task to design a bridge that can withstand the most force out of all the bridges in the class. The force will be applied to the center of the bridge, so bear that in mind when designing and constructing your bridge. Your bridge must also be aesthetically pleasing, because it would be highly unlikely that any municipality would invest a large amount of money in a visual monstrosity. Therefore, make sure that you carefully read the rubric that will be provided to you.

**Procedures**

PART I – RESEARCH BRIDGE DESIGNS

In this section, you need to research and explore at least six different types of bridges. For each bridge, indicate its name, forces that are used, as well as any benefits or detriments that you can find. Also be sure to make a drawing of the elevation of the bridge.

1. Type: Forces used:

Benefits: Detriments:

Drawing:

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Drawing:

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Benefits: Detriments:

Drawing:

PART II – SELECT AND DESIGN YOUR BRIDGE

In this section, you can select one of the types you researched or combine several of them, or use a design of your own creation. But you need to make a scale drawing of the bridge using the scale:

**1 foot = 1/8 inch**

Once your drawing has been approved, you may proceed with construction. Use the space below to sketch your bridge, then use a slice of graph paper to make a scale drawing.