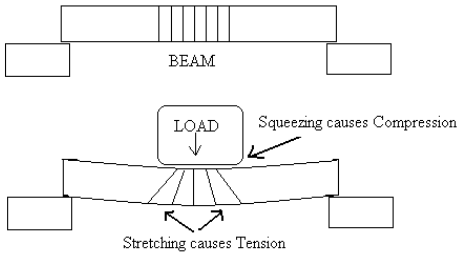
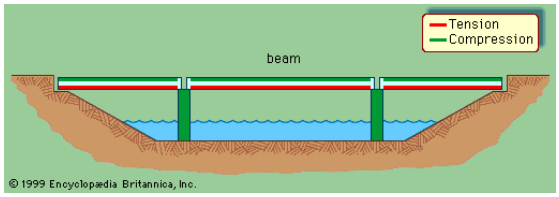
Bridge Basics

Bridges can be designed in different ways and from different materials to withstand certain loads and potentially destructive forces.

1. **Bridges** are elevated structures designed to support the movement of objects over a **span**. **Span** can describe the distance the bridge covers or the unsupported distance between **supports** or **piers** that are attached to the ground. Bridges must support their own weight (**dead load**) and the weight of those objects that will cross over them or other forces that will act on them from time to time, such as wind, snow and ice (**live load**). Bridges are kept stable by balancing the load forces with the supporting forces of the structure. These forces can cause parts of the bridge structure to push together (**compression**) or pull apart (**tension**).



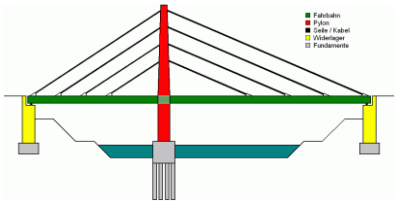
2. Different bridge designs distribute tension and compression forces in different ways, depending on the shapes of the parts of the structure. The biggest difference among bridge designs is the distances they can cross in a single span. Shapes commonly used in bridge design include arches, triangles and rectangles.
3. Bridges are constructed of different materials whose properties and costs vary. Some materials are strong against compression forces but weak against tension forces; some materials resist fire, corrosion or weathering. Materials commonly used in bridge design include wood, rope, aluminum, concrete and steel.
4. A **beam bridge** balances the load by concentrating it entirely onto the two **piers** that support the bridge at either end, or sometimes on **piers** distributed throughout the span. When a force pushes down on the beam, the beam bends. Its top edge is pushed together (compression), and its bottom edge is pulled apart (tension). The amount of bend depends on the length of the beam. Beam bridges are cheap and simple, but they can only span short distances unsupported.

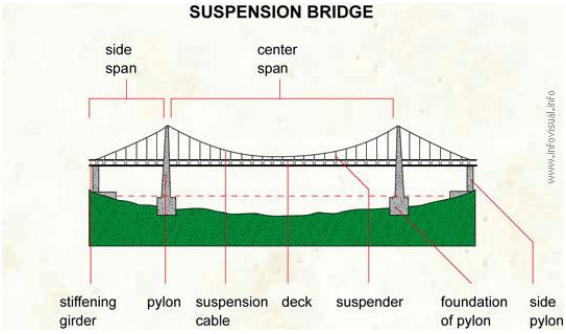


5. A **truss bridge** is a beam bridge with extra supports above the main beams. It uses rigid, interlocking **members** to form a system of triangles that distribute the load among all parts of the structure, increasing the structural strength of the bridge. Truss bridges can span longer distances than beam bridges can because the trusses support the beams.

6. A **suspension** bridge or **cable-stayed** bridge uses cables (steel ropes) suspended from tall towers to hold up the **deck** and distribute the load. The tension and compression forces acting on the beam are distributed among the cables (tension) and the towers (compression).

   The **suspension bridge** has two sets of **cables**: a pair of thicker cables that runs horizontally and is attached to the towers and the land at the ends of the bridge and a thinner set of many cables that hangs the bridge from the thicker set. The **cable-stayed bridge** has only one set of cables that attach the deck directly to the towers. Suspension and cable stayed bridges can span the longest distances.





7. Engineers build models of bridges, conduct controlled experiments to learn how they will withstand various stresses, and consider the benefits and trade-offs of various design alternatives.
8. Bridge design is influenced by the length of the span, the properties of the materials, and environmental conditions, as well as by practical considerations, such as the bridge's appearance, cost of materials or construction site challenges.
9. Bridges can fail because they have faulty parts, are used in ways that exceed what was intended by the design, or were poorly designed to begin with. Most commonly, bridges fail because they have been **poorly maintained**—rusted steel or cracking concrete piers.

Bridge Basics Questions

1. Compare and contrast beam and truss bridges.
2. Compare and contrast truss and suspension bridges.
3. Explain the forces acting on the different parts of a loaded beam.
4. Which force do piers normally have to withstand?
5. What are the advantages and disadvantages of each bridge type?(beam, truss, suspension)
6. What are some materials that are used to make bridges and what are the advantages and disadvantages of each?
7. What are some things that builders and designers have to consider when building and designing bridges?
8. Why do bridges fail?
9. On the picture of the suspension bridge and truss bridges, label one place where there is tension and one place where there is compression.

1. Both beam and truss bridges are relatively cheap to build, cross smaller spans, and are made up of beams. The beam bridge only has beams going across the bottom though, while the truss bridge has beams along the sides and across the top, so it can span a longer distance between piers.
2. Both truss and suspension bridges have supported beams that allow them to span farther than a simple beam bridge can.
3. As a beam bends or deflects under a load, the top of the beam is under compression while the bottom of the beam is under tension.
4. Compression.
5. Beam is cheap, easy, and quick to build, but it has a limited pier to pier span.
   Truss has a longer pier to pier span than beam does, but is costlier, more time consuming, and more difficult to make. It is cheaper and easier to make than a suspension or cable stayed bridge, but it spans much less. Suspension is the most complex and expensive type, and it requires the most maintenance, but it can span the longest distance.
6. Rope is light, cheap, and easy to work with. It handles tension well but not compression. It is delicate and stretchy. Wood is light, strong, and cheap, but it is flammable and it rots. Concrete is cheap and reasonably easy to work with, but it is heavy and it handles compression very well but handles tension poorly. Steel is strong and flexible, and good under both tension and compression. It's expensive to work with though, and it rusts if not painted frequently. Aluminum is light and corrosion resistant but expensive and soft.
7. Engineers have to consider access (what equipment can they get to the site), span, substrate (the ground under the footings), water, availability of materials locally vs. shipping, live load, and appearance.
8. Neglect, misuse, bad design, materials flaws.

Name_____ Date_____ Per_____

BRIDGE MINI-QUIZ

Write the correct letter of the answer on the space provided.

1 _____Bridge with a single or a few main beams only

2 _____A push or pull acting on an object

3 _____Distance between two supports

4 _____Bridge where deck is held by cables

5 _____Vertical supports between the bridge and the ground

6 _____Pulling force

7 _____Weight of objects that will cross over the bridge

8 _____Squeezing force

9 _____Bridge with many beams connected together in a frame

10 _____Weight of the bridge itself

A Span

B Dead load

C Live load

D Compression

E Tension

F Force

G Beam bridge

H Suspension bridge

I Truss bridge

J Piers