

Materials fail (break, stop working) for three main reasons.

They Shear

Nearly all solid materials actually have tiny cracks or parts that are weak (nothing is perfect!). When solid materials are put under pressure, sometimes these tiny cracks become longer and then the solid piece is cut in a way that it can slide apart. For example, the dirt under a building gets compressed or shaken by an earthquake and then a section of it slides away and causes the building to slide and fall.

They Buckle

Buckling is when a structure bends in on itself because of pressure applied to it (e.g., heavy weight). Thin materials have a habit of buckling under pressure.

They Twist

Some materials (like ropes and cables) are made by twisting materials together. These materials can take some twisting before the parts begin to snap, but solid objects like pipes can take very little twisting before they snap.

Hint: Think of stretching and snapping, shearing, twisting, buckling, shaking, separating, and crumbling.

Answer the following questions using the information you have learned about bridge structures.

1. What is the **load** that a bridge supports?

2. Describe two ways that bridges can be made stronger (able to support a heavier load).

3. Compression in structures happens when the load (weight) squeezes the parts together. Which bridge(s) involves compression? Explain your answer.

4. Flexibility is the ability to bend without breaking. Which bridge designs involve flexibility? Explain your answer.

5. Why do you think a suspension bridge is able to support a heavier load than a cable-stay bridge?

6. Tension is a pulling force. Tension is the force of two connected things that are trying to separate from each other (pull apart). Which bridge designs involve tension? Explain your answer.

7. For each bridge design, consider and explain how you think the design could fail. Consider which part of each bridge takes the load and what would happen to those parts.

a. **Beam Bridge**

b. **Truss Bridge**

c. **Arch Bridge**
