Spaghetti bridge

Materials: 40 spaghettis, 1 hot glue stick, 1 m of string, scissors

GROUPS

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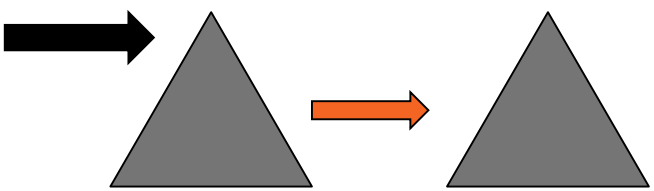
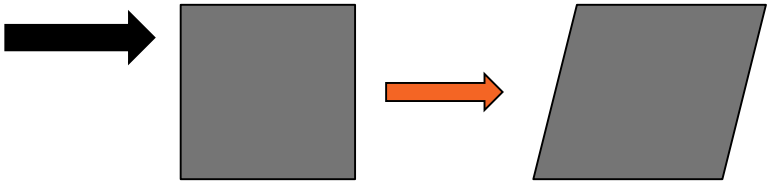
Task

- Bridge has to cover a gap of 20 cm
- You have to able to roll an object sized 3X3X3 cm through your bridge
- Gaps wider than 2 mm in the lane of your bridge are not allowed
- Your construction needs to resemble a bridge

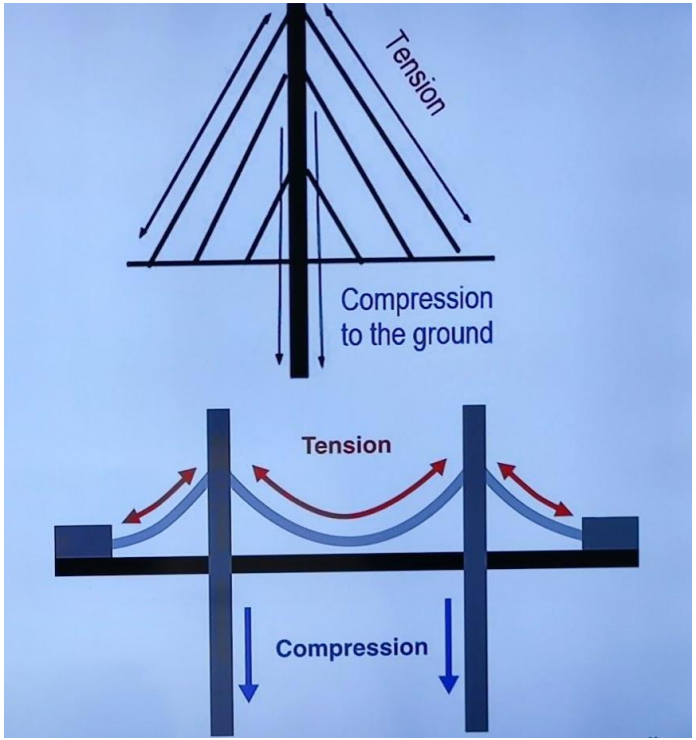
Geometry in building

- Shapes are important in building
- Different shapes act differently when a weight or force is applied from a different direction
- Triangles are popular in structures, because it retains its shape



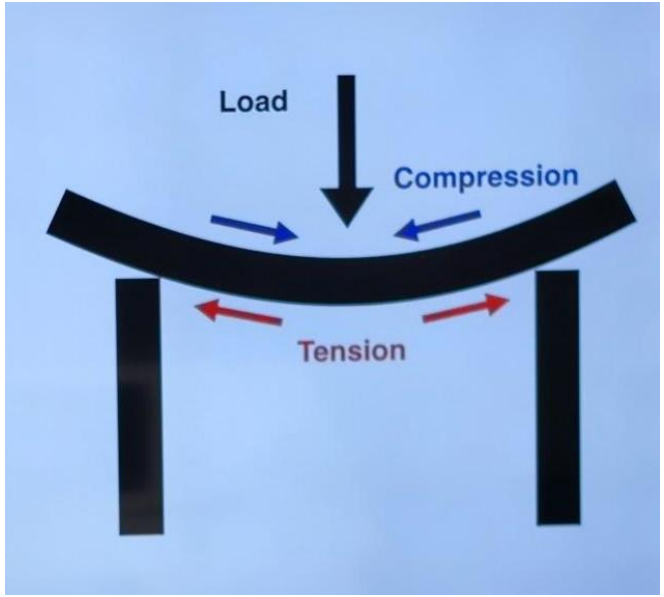


Compression and tension in different bridge types



- Compression and tension are exploited in different types of bridges in order to maximize their load
- Cable-stayed bridges and suspension bridges: Compression and tension produced by a load are transferred with cables from a weaker point to the support poles
- When a load is added to the bridge, the cables tighten, and force moves through the poles into the ground

How do bridges tolerate heavy loads?



- Bridges are designed to handle loads by redirecting stress from weaker points to stronger ones.
- When you press an object: compressing force is created caring it to shorten. When you pull an object it becomes longer, and tension force is created. These forces must be in balance for a bridge to be durable.
- Load causes the bridge to curve, so that the top of the bridge shortens, and the bottom lengths. Compression and tension are created accordingly.
- Stress caused by the load gets redirected to poles attached firmly on the ground, allowing the bridge to tolerate it.

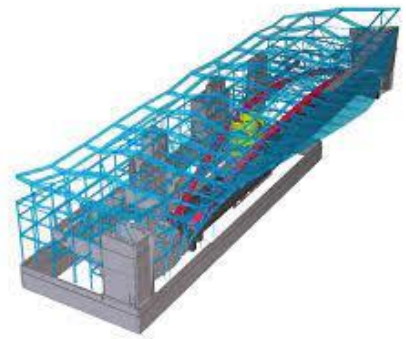
Different types of bridges

suspencion bridge

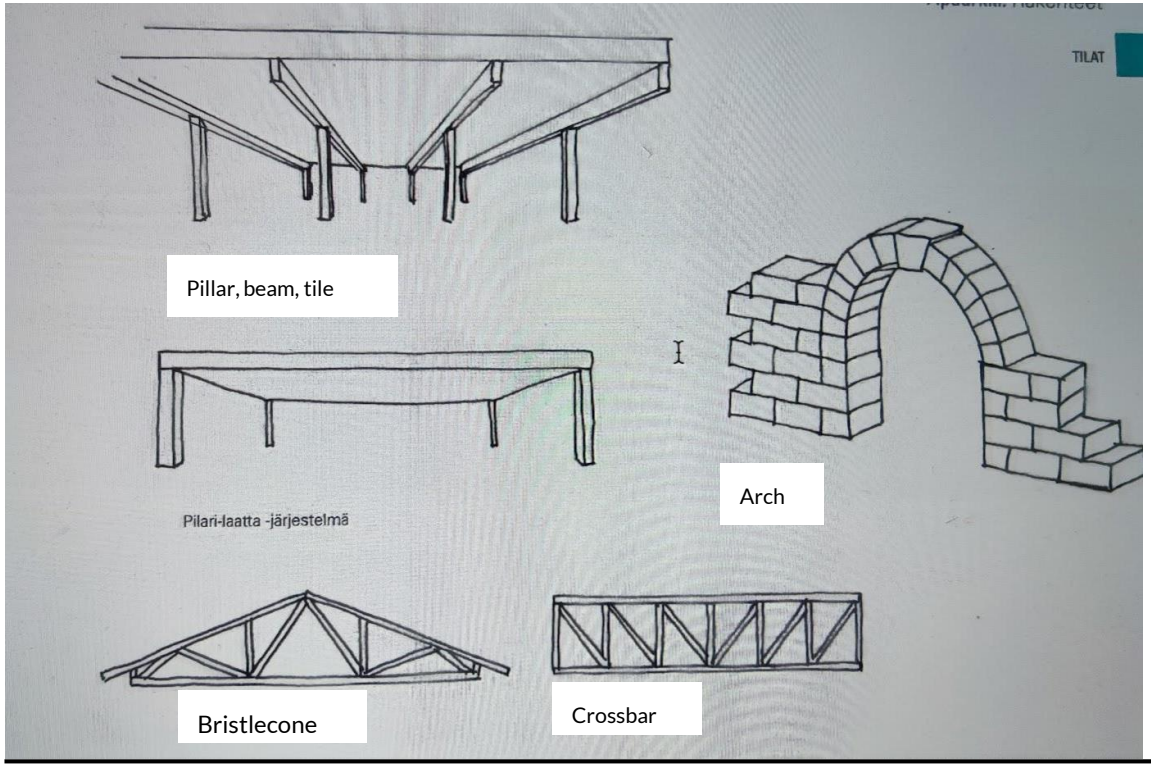
Cable bridge

arched bridge

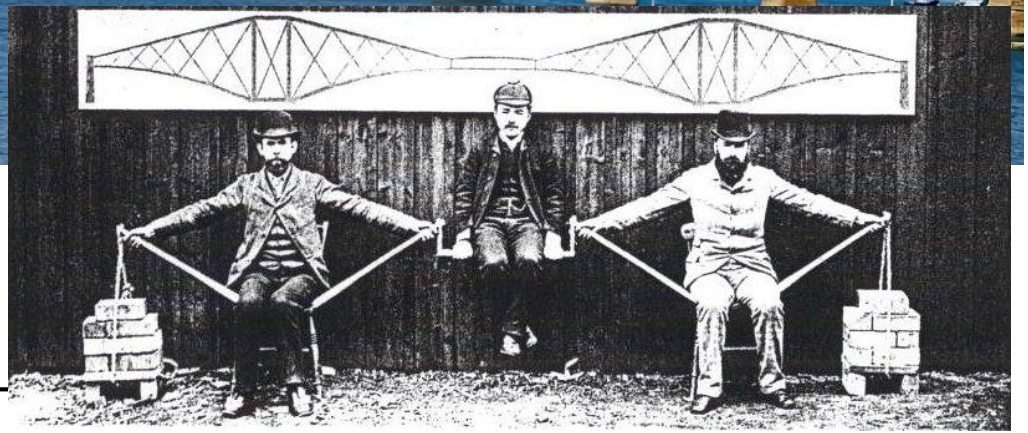
beam bridge



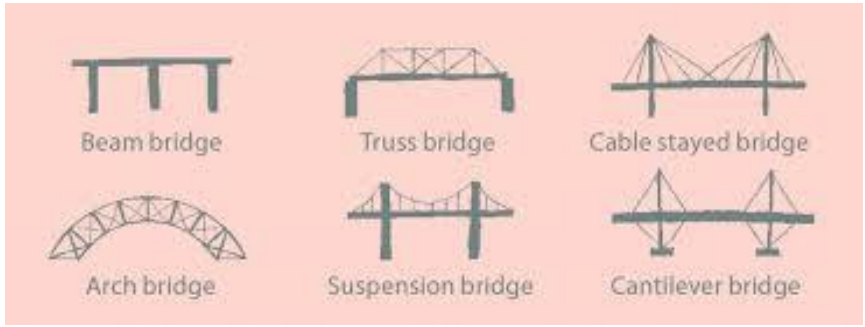
Structures


TILAT
Pillar, beam, tile
Arch
Pilari-laatta -järjestelmä
Bristlecone
Crossbar

The Firth of Forth 1883-1890




SPAGHETTI
ARCH
BRIDGE


Beam bridge
Truss bridge
Cable stayed bridge
Arch bridge
Suspension bridge
Cantilever bridge

Load

- The bridge must be able to withstand both static and dynamic load
- A static load is a constant and steady load.
  For example, you are standing on a bridge
- In a dynamic load, load changes in direction, position and magnitude creating varied forces on structure. For example, when you jump off a bridge
- When is the bridge more likely to break: when you place a weight on the bridge or when you drop a weight on the bridge?

Impulse principle

- If you drop a weight on top of your bridge, it will collapse easier than when you set a weight on a top of it.
- Momentum p is the product of the mass m and the velocity v → p=mv
- When object falls, it has a momentum. When that object hits the surface of the bridge, the momentum p changes because its velocity v changes.
- Change in the momentum Δp is called an impulse I. Impulse is force applied over time.
- The greater the velocity of a moving object, the stronger the loading force is when it hits the bridge

$$I=F\cdot\Delta t=ma\cdot\Delta t=m\cdot\frac{\Delta v}{\Delta t}\cdot\Delta t=m\cdot\Delta v=\Delta(m\cdot v)=\Delta p$$