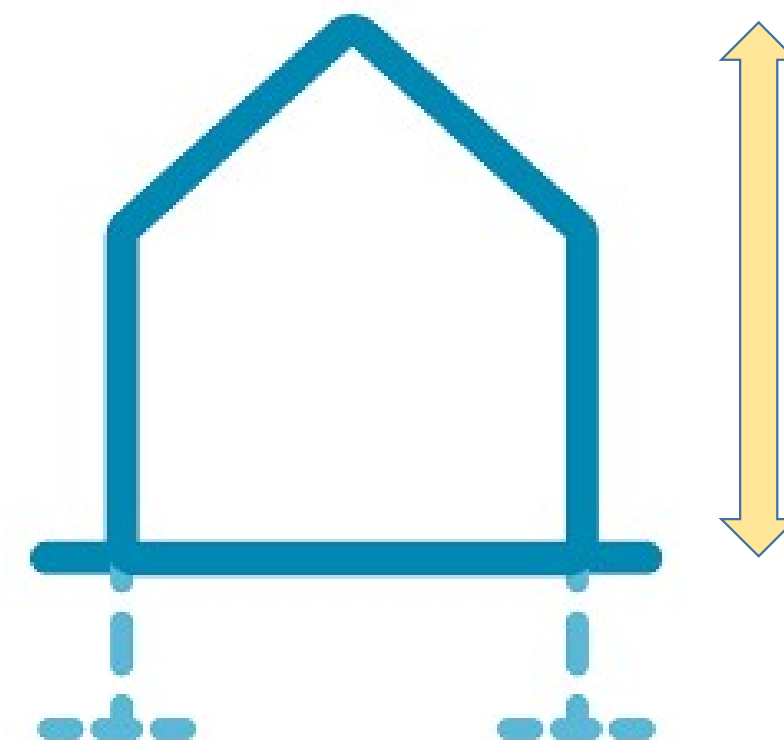


Superstructure : Fundamentals of Construction Technology



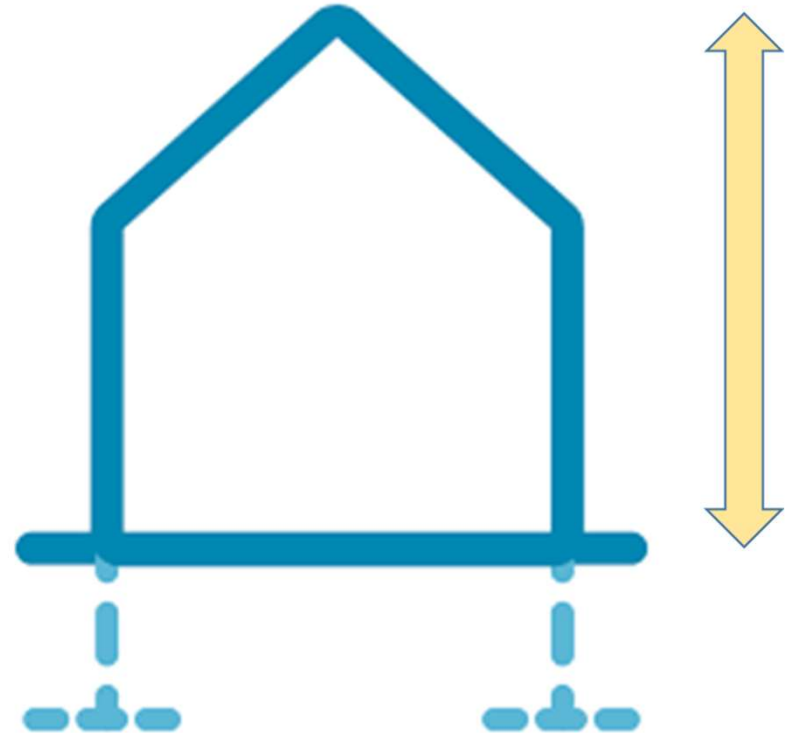
Week 5&6:

Structures

- Forces – Stress – Balance
- Types of structure

Structural Frames

- Timber
- Steel
- Concrete
- Mixed



The use of buildings to house people, equipment and processes have resulted in the development of buildings that can control these internal environments with greater accuracy.

As well as protection and enclosure we can now consider:

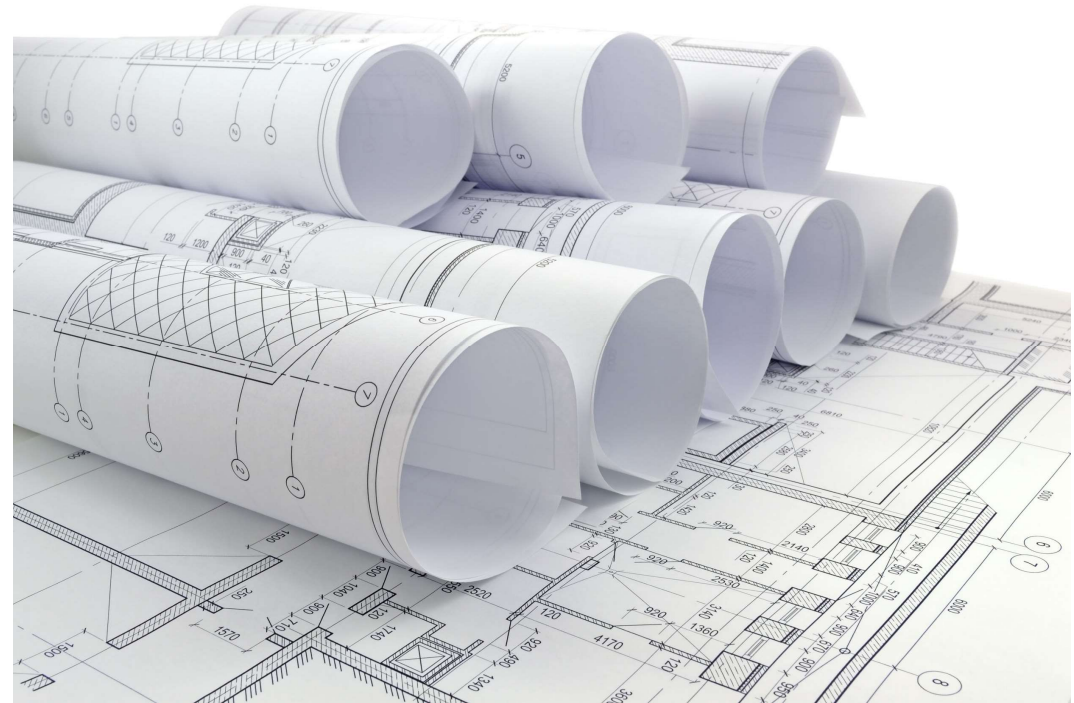
- Thermal Insulation and temperature control
- Acoustic insulation
- Provision of Light (natural and artificial)
- Controls for humidity and ventilation
- Exclusion of contaminants.



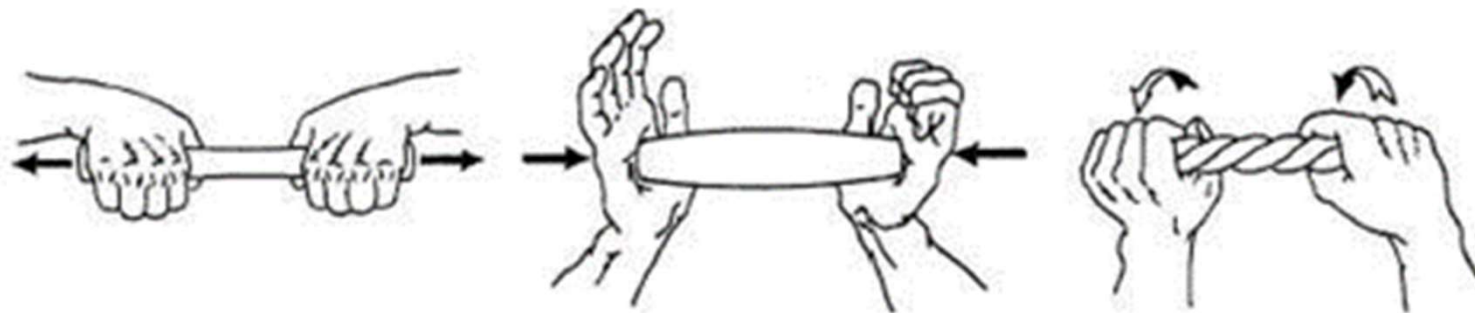
Performance Requirements of the Building Fabric

What are the key drivers in providing a building that is suitable for the need?

- **Structurally Stable**
- Durability
- Thermal insulation
- Protection from weather and exclusion of moisture
- Acoustic performance
- Flexibility to change to changing needs
- Aesthetics
- Buildability
- Sustainability



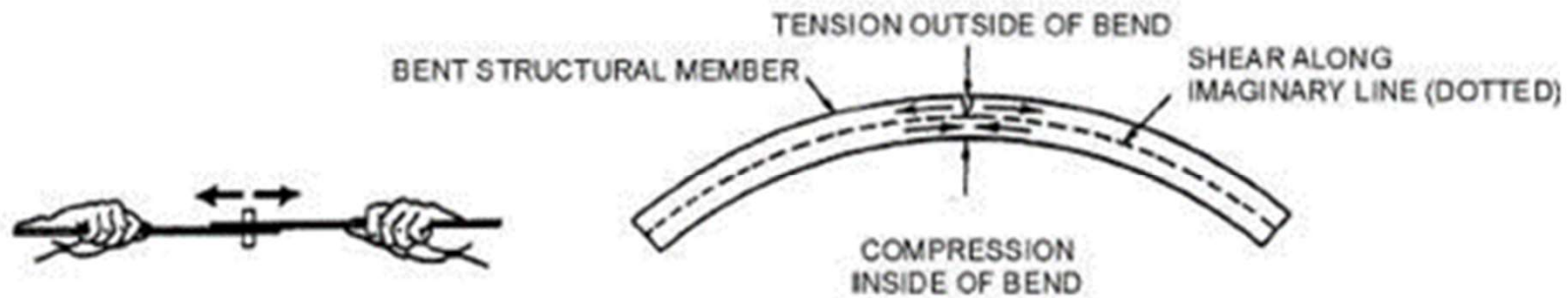
STRUCTURES



(A) TENSION

(B) COMPRESSION

(C) TORSIONAL



(D) SHEAR

(E) BENDING (THE COMBINATION STRESS)

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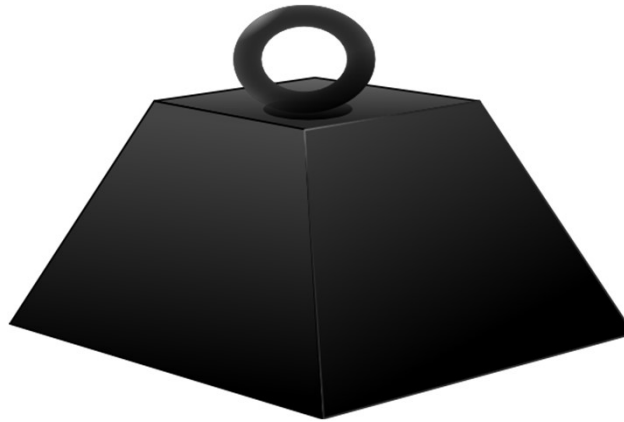
Loads/Forces on Building Frames

Structural loads or **actions** are forces, deformations, or accelerations applied to a structure or its components

Loads cause stresses, deformations, and displacements in structures. Assessment of their effects is carried out by the methods of structural analysis. Excess load or overloading may cause structural failure, and hence such possibility should be either considered in the design or strictly controlled.

Dead load is the load from the self weight of the structure and whatever is permanently attached to it.

Permanent Loads (Eurocodes)



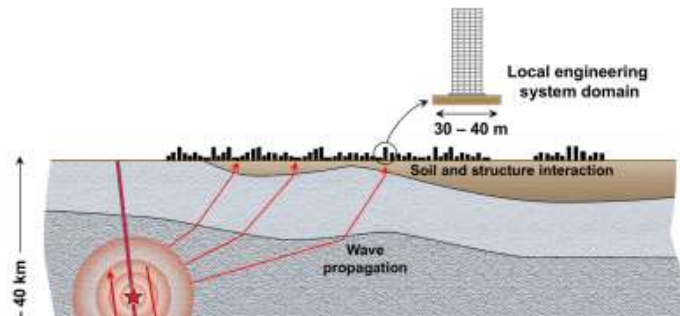
Live loads are loads that may or may not act, fully or partially, and vary with time and exact location on the structure.

Variable Loads (Eurocodes)

Live Loads/Imposed/Transient



Environmental Loads



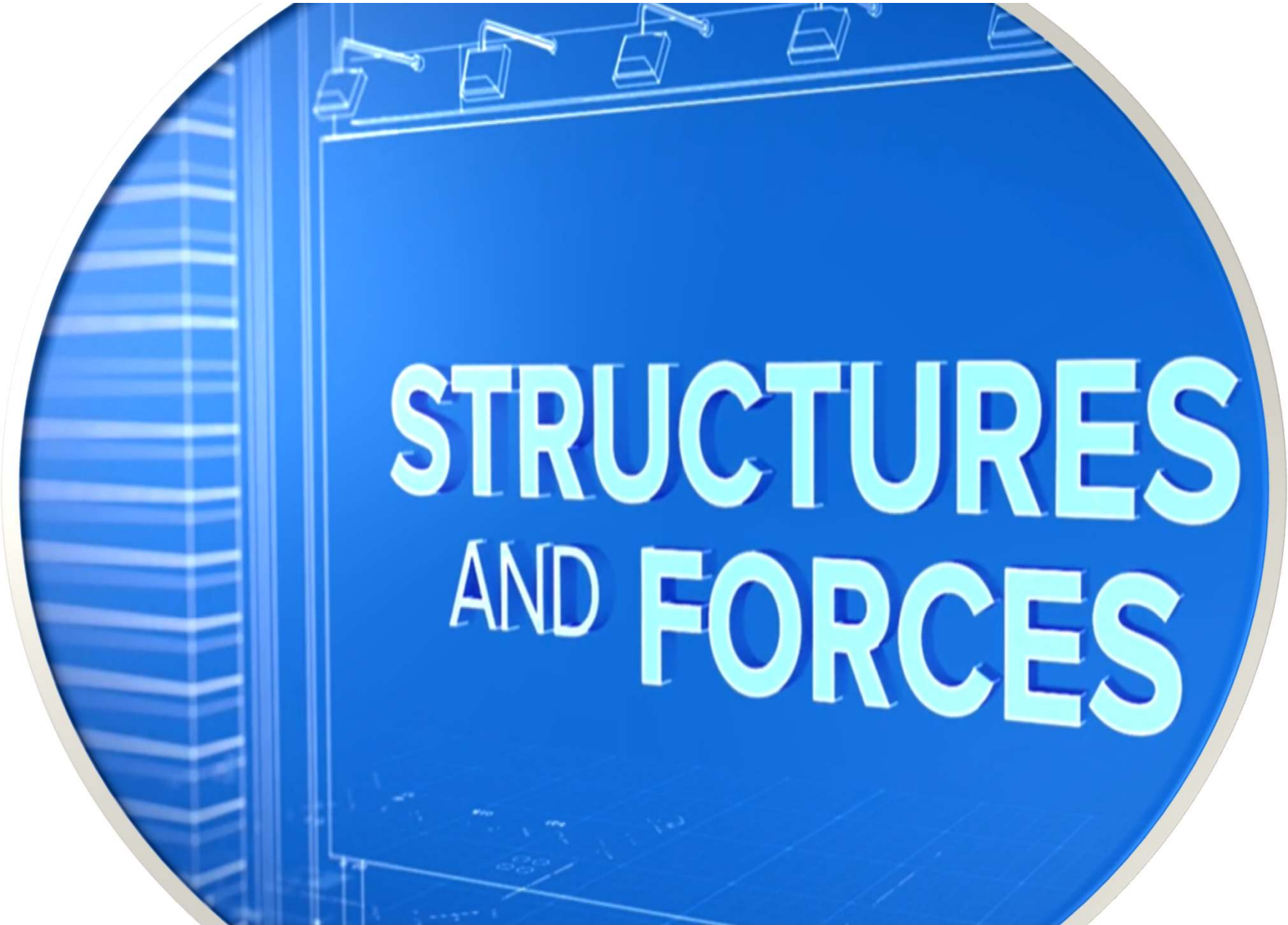
[Types Of Loads On A Structure In Accordance To Eurocode 1 | \(civilsguide.com\)](#)

Structures: Forces – Stress – Balance

On Teams review the 3 videos

- Structures and Forces
- Structures and Stress
- Structures and Balance

Answer the questions on each
Video saved in the lecture notes
under 'Files'



STRUCTURES AND FORCES

Structures and Forces:

1. Match the types of forces to the statements that best describe them by writing the letter in the corresponding box.

A. Tension B. Compression C. Shear D. Torsion

- ☐ A force pushing a body in a sideways direction.
- ☐ A force stretching a body from end to end.
- ☐ A force squeezing or squashing a body.
- ☐ A force twisting a body.

2. Fill in the missing words in the sentence below.

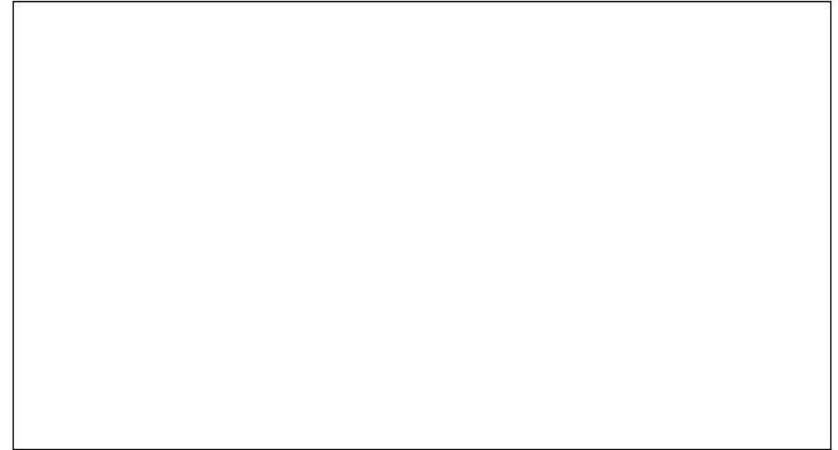
A key part of good design is being able to identify the acting on structures and how to or counteract them.

3. Which of the following are examples of tension at work? Select all that apply.

- ☐ a) Inflating a balloon
- ☐ b) Pulling back an archer's bow
- ☐ c) Wringing out wet clothing
- ☐ d) Erecting a tent

4. Using power lines as an example, explain how a catenary curve is formed.

5. Draw or attach an image of an arched structure that evenly shares four loads between five members. Label each load.



6. In Roman times, arched structures were often built from stone without the need for cement. Explain how compression forces allowed this to happen.

7. If you were to remove half the spokes on a bicycle wheel, explain, in terms of forces, what would happen when the bike is ridden.

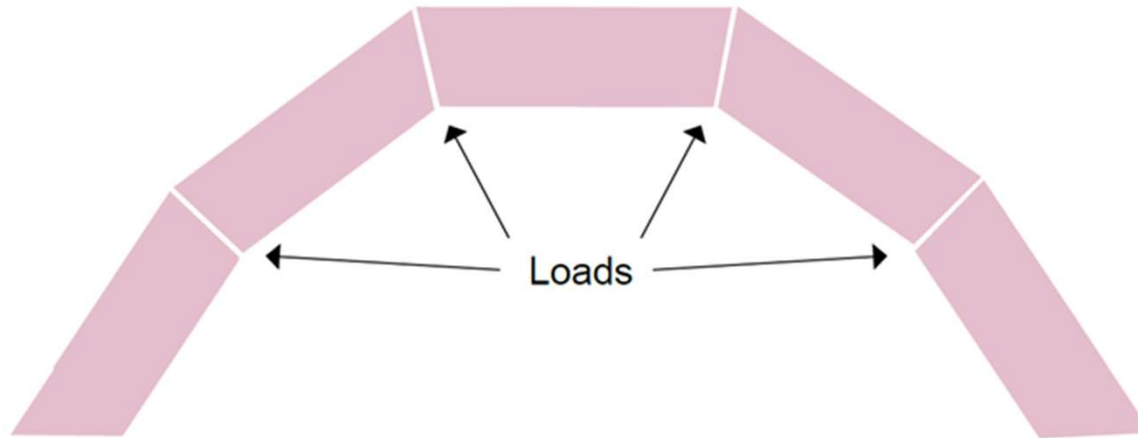
8. Even though our understanding of forces has grown over time, ancient ruins prove that there was a basic understanding of forces thousands of years ago.

☐ True ☐ False

Structures and Forces:

1. ☐ C A force pushing a body in a sideways direction. (*Shear*)
☐ A A force stretching a body from end to end. (*Tension*)
☐ B A force squeezing or squashing a body. (*Compression*)
☐ D A force twisting a body. (*Torsion*)
2. A key part of good design is being able to identify the **forces** acting on structures and how to **balance** or counteract them.
3. a) Inflating a balloon; b) Pulling back an archer's bow; d) Erecting a tent
4. A power line is supported only at its ends by two power poles. There is tension on the cable, as it is stretching from one pole to the other. It doesn't matter how far the poles are apart, gravity will always cause the cable to sag in the middle, creating a catenary curve.

5.



6. Arches form when compression forces are distributed evenly throughout the material. The Romans leaned stones against each other, using compression forces to hold them in place. The heavier the load, the tighter the stones pressed together, creating a stable arch without cement.
7. The weight of the load on a bicycle (i.e. the rider) needs to be counteracted by the tension of the spokes on the wheels. If some spokes are removed, the remaining ones will be put under more compression force by the rider and may fail.
8. True



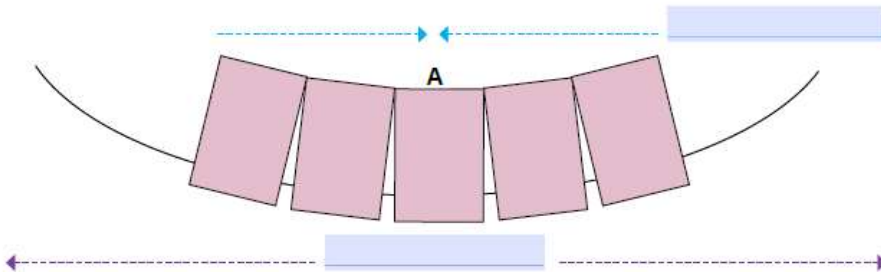
STRUCTURES AND STRESS

Structures and Stress:

1. Fill in the missing words in the sentence below.

Bending occurs when a _____ force is applied to an object along its longitudinal axis, or along its _____ dimension.

2. Label the two forces at play in the diagram below when a perpendicular force is applied at point A.



3. A material often used to reinforce structural beams is:

- ☐ a) rope.
- ☐ b) aluminium.
- ☐ c) rubber.
- ☐ d) steel.

4. There are two ways to strengthen a reinforced structural beam.

- a) Tightening the reinforcements to compress a material, such as concrete, before putting it in place is called _____.
- b) Tightening the reinforcements after a structure has been built is called _____.

5. The bridge shown below has two supports. Select the curve that the steel cables should follow to best reinforce the concrete.



- ☐ a) 
- ☐ b) 
- ☐ c) 
- ☐ d) 

6. Justify your answer to Question 5.

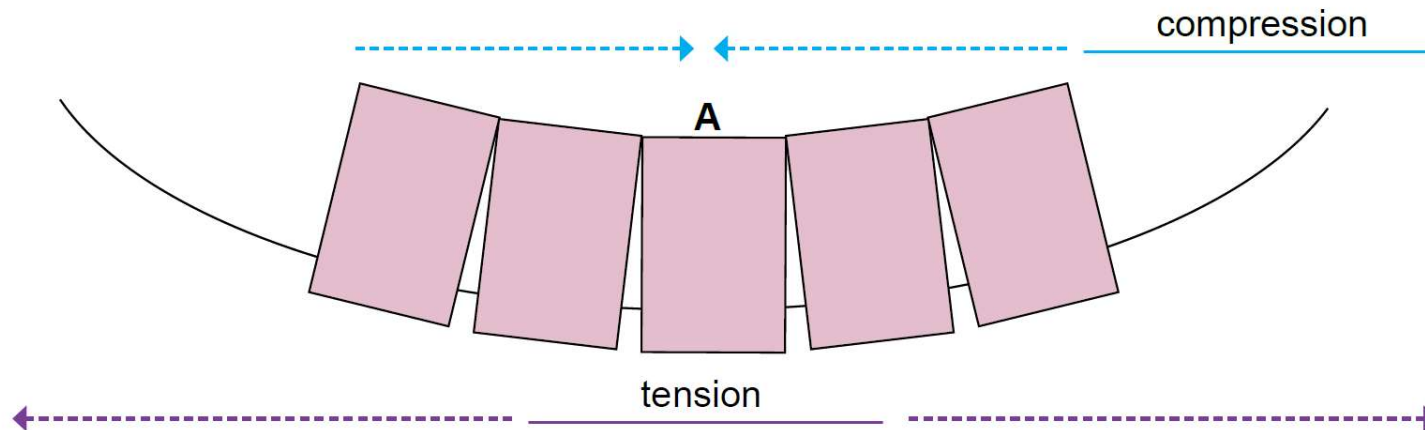
7. Explain what could happen to a poorly structured bridge in high winds, and why.

8. Explain where metal shears got their name, and describe the force that they make use of.

Structures and Stress:

1. Bending occurs when a **perpendicular** force is applied to an object along its longitudinal axis, or along its **longest** dimension.

2.



3. d) steel.
4. a) Tightening the reinforcements to compress a material, such as concrete, before putting it in place is called **pre-stressing/pre-tensioning**.
b) Tightening the reinforcements after a structure has been built is called **post-tensioning**.

5. c)



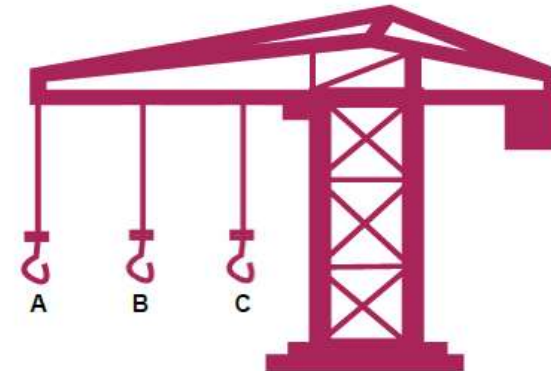
6. The steel reinforcing cables provide strength where the concrete is weak in tension. For example, the base of the bridge is under tension where it is between two supports, so the reinforcement needs to be along the base.
7. If a bridge is not reinforced for torsion, or a twisting force, it might twist in the wind and ultimately fail.
8. Shear is a pair of sideways forces going in opposite directions. This gives metal shears their name because they cause a material to break as the two blades apply shear force to whatever is in between them.

**STRUCTURES
AND BALANCE**

Structures and Balance:

1. A column is a , which sits on the ground or is partially buried in the foundation.
2. Explain what might happen when a load is added to a column at the top.
3. The more rigid the column:
☐ a) the less guy ropes are required.
☐ b) the more guy ropes are required.
☐ c) has no effect on the number of guy ropes required.
4. A cantilever is a type of with a long beam, or girder, that's fixed at .
5. When a cantilever is horizontal, the top of the beam is in **A** and the bottom is in **B**.
☐ a) **A** = compression **B** = tension
☐ b) **A** = tension **B** = compression
☐ c) **A** = tension **B** = bending force
6. Provide three (3) examples of cantilevers in everyday life.
 -
 -
 -

7. From which line could this crane take the heaviest load?



- ☐ a) A
☐ b) B
☐ c) C
8. Explain your response to Question 7.
9. Beams are and can take loads along their entire .
10. Draw or attach an image of the cross-section of an I-beam, and label the three plates.
11. Explain why I-beams are often preferred in construction over solid steel or timber beams.

Structures and Balance:

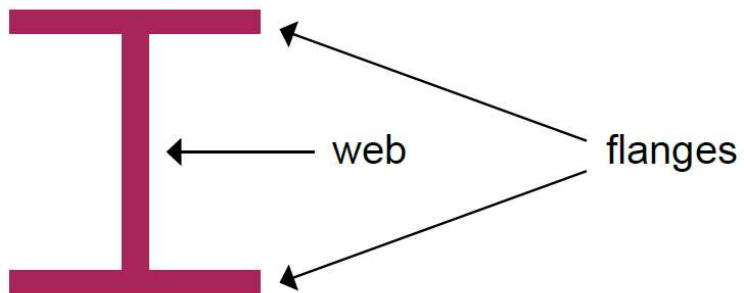
1. A column is a **vertical support**, which sits on the ground or is partially buried in the foundation.
2. When a load is added to the top of a column, it may buckle under the weight of the load if it is not rigid or braced enough using guy ropes.
3. a) the less guy ropes are required.
4. A cantilever is a type of **lever** with a long beam, or girder, that's fixed at **one end**.
5. b) **A** = tension **B** = compression
6. Student responses may vary, however examples mentioned in the video include (human) arms, street lamps, some street signs, cranes, cantilever bridges, aeroplane wings.

7. c) C

8. The very end of a cantilever arm cannot take heavy loads because of the leverage offered by the fulcrum, which is far away. The closer to the crane tower, the heavier the loads the crane can lift because the leverage offered by the fulcrum is less.

9. Beams are **horizontal** and can take loads along their entire **length**.

10.



11. I-beams use less steel or timber than solid beams, so they are lighter (and also therefore cheaper), but just as strong.