

REVIEW ... Key Concepts

Unit 4 – Structures and Forces

1.0 Natural and man-made (Manufactured)

- ❖ Structural forms can be **shells, frames** or **solids**
- ❖ Each structure performs a specific function and can vary in its design
- ❖ Climate, culture, tradition, technology and economics influence the design of a structure

2.0 External and Internal Forces act on structures

- ❖ Effect of a force on a structure depends on **magnitude, direction** and **location** of the force
- ❖ **External** force is applied on the outside of a structure
- ❖ **Stability** is affected by the changes in the mass distribution and the design of its foundation
- ❖ A structure's ability to withstand a load depends on its overall strength and stability
- ❖ Performance standards are included in the overall structural design
- ❖ **Internal** forces include **compression, tension** and **shear**.
- ❖ Material shape and properties determine resistance to internal forces acting on them
- ❖ Structures undergo **structural stress, fatigue** and **failure**

3.0 Strength and Stability

- ❖ Natural and synthetic materials are classified by a range of properties
- ❖ Strength and flexibility of materials can be tested – **deformation**
- ❖ **Joints** – fixed or movable – friction, bonding or flexibility
- ❖ **Stability, strength** and **function** rely on the proper use of materials

4.0 Designing, Evaluating and Improving to Meet Human Needs

- ❖ Environmental factors can affect the stability and safety of a structure
- ❖ **Corrugation** and **Lamination** can strengthen materials
- ❖ Structural evaluation criteria: **costs, benefits, safety** and **potential environmental impact**

1.0 Natural and man-made (Manufactured)

❖ Structural forms can be **shells, frames** or **solids**

Describe the characteristics of each of the structural forms.

Shell



Frame



Solid



Mass

What kind of structure is the Calgary **Pengrowth Saddledome**?



❖ Each structure performs a specific function and can vary in its design



This is **INUKSHUIT** – What is its function?



These glass pyramids have several functions.
Describe the functions of the **Muttart Conservatory** in Edmonton

Describe how an everyday task such as **'painting a wall'** can become a technological problem solution that was transformed into a *new technique to paint the same wall* in less time.

Identify a specific **function** each of the following structures was designed to meet.



Stonehenge



Chunnel Tunnel



Crash Test Dummy



'Firth of Forth' Bridge



Bedouin Tent



Ancient Seismograph

What **natural structure** is each of the following structures modeling?







What is meant by **esthetics**? Give 2 examples of how aesthetics has been used to get approval for designing a particular structure in a specific environment.

❖ Climate, culture, tradition, technology and economics influence the design of a structure

Describe or illustrate a **specific traditional structure**, built somewhere in the world, whose design was influenced by ...

<i>Illustration</i>	<i>Influence</i>	<i>Name of Traditional Structure – Where it is located</i>
	Cultural	<hr/> <hr/>
	Climate	<hr/> <hr/>
	Tradition	<hr/> <hr/>
	Technology	<hr/> <hr/>
	Economics	<hr/> <hr/>

2.0 External and Internal Forces act on structures

❖ Effect of a force on a structure

The **actual effect of a force on a structure** depends on what three things?

For each of the pictures below, use **force arrows** to show the forces at work on the structure.

This first one is done for you



Helicopter taking off



The Leaning Tower of Pisa



Taking a wrist shot



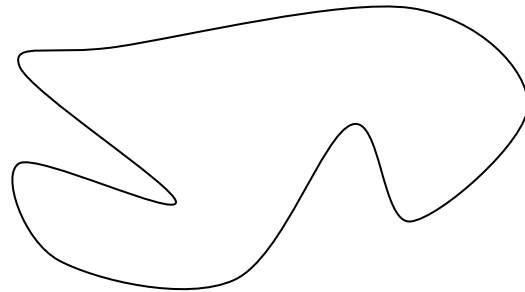
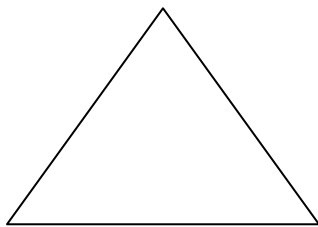
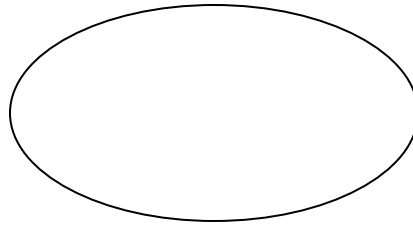
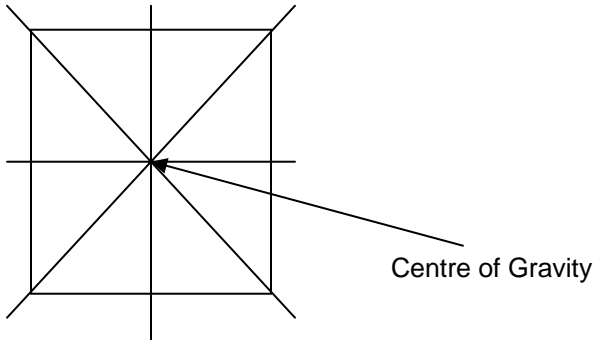
Windsurfing on a big wave

How are forces **measured**?

What role do **mass** and **distance** play in the **Law of Gravitation** – developed by Sir Isaac Newton?

❖ **External force is applied on the outside of a structure**

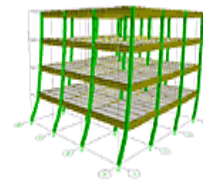
Gravity acts on every structure. It is the downward force (pull) of the Earth on mass. The greater the mass, the greater the gravitational pull. This gravitational pull acts on the **center of gravity** within the structure. When a structure is supported in its center of gravity, it will be stable and stay balanced. Find the center of gravity for the following structures:



Describe what symmetry is. _____

❖ **Stability**

What two things must occur for a structure to be stable ...



❖ **A structure's ability to withstand a load depends on its overall strength and stability**

Explain the difference between a **static load** and a **dynamic load**.

Identify the loads present in the following situation

Train crossing a bridge



Static Loads	Live loads

What are the two conditions that engineers use to decide which type of bridge should be built in a particular situation?

For each type of bridge, sketch a simple diagram showing where the forces are applied in the bridge.

Type of Bridge



Beam Bridge



Truss Bridge



Suspension Bridge



Arch Bridge





❖ Performance standards are included in the overall structural design

What are **performance requirements**?

How would you **compare** the performance of one structure compared to another?

❖ **Internal forces**

Identify the type of **internal force** illustrated and the action it makes.

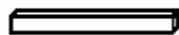
compression		squeezing / pushing together
_____		_____
_____		_____
_____		_____

Describe and illustrate **complimentary forces**

❖ **Material shape and properties determine resistance to internal forces acting on them**

How does the shape of a structure affect its overall strength? Illustrate the strongest shape.

Describe a specific structural characteristic for each of the following structural components.



_____	_____	_____	_____
_____	_____	_____	_____

❖ Structures undergo **structural stress, fatigue and failure**

To avoid failure, a structure needs _____ and _____

When a combination of internal and external forces is too much for a structure, stress, fatigue and failure can occur. Describe and illustrate if you can each of the different forms of structural failure.

Buckling	_____ _____	
Shearing	_____ _____	
Separation	_____ _____	
Deformation	_____ _____	

What forces are acting on this hang glider?

External Forces

Internal Forces



3.0 Strength and Stability

❖ Natural and synthetic materials are classified by a range of properties

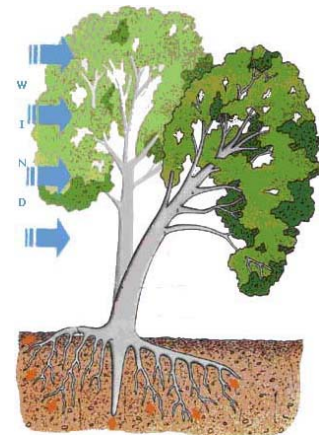
What are the properties that help to identify what materials should be used when a structure is constructed?

What other considerations are taken into account?

❖ Strength and flexibility of materials can be tested – **deformation**

What is **deformation**?

When the wind acts on the tree, what **complimentary internal forces** demonstrate the **flexibility** of the tree?



❖ **Joints** – fixed or movable – friction, bonding or flexibility

Describe the various types of joints that rely on:

Friction

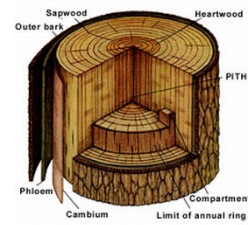
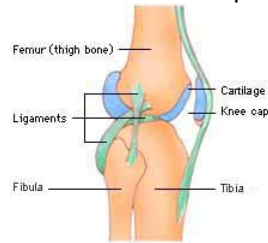
Bonding

Explain the difference between **fixed** and **movable** joints.

❖ **Stability, strength and function** rely on the proper use of materials

When a structure is stable, its materials strong, but its joints weak or not suited to long time use, what will happen?

Describe the **function** of the unique materials that make up the **human frame structure** and a **tree**.



Bones _____

Bark _____

Ligaments _____

Woody layer _____

Cartilage _____

Heartwood _____

Muscles _____

Sapwood _____

Tendons _____

Vascular cambium _____

Joints _____

Bones _____

4.0 Designing, Evaluating and Improving to Meet Human Needs

❖ Environmental factors can affect the stability and safety of a structure

What is meant by **margin of safety**?

How is safety maintained?

What factors in the environment can affect the margin of safety and how are they taken into account when designing a structure?

❖ **Corrugation** and **Lamination** can strengthen materials

Describe the processes of corrugation and lamination

corrugation _____

lamination _____

In what other ways can materials be strengthened?

❖ **Structural evaluation criteria: costs, benefits, safety and potential environmental impact**

Waste disposal is a growing problem for many towns and cities. Design a community waste disposal structure that would revolutionize the collection and disposal of household waste. Answer the questions about your design and then illustrate it.

Cost - How much will the structure cost to build, operate and maintain?

This is what the
Community Waste Disposal Structure
would look like

Is it affordable?

Benefits - What are the benefits of having this structure?

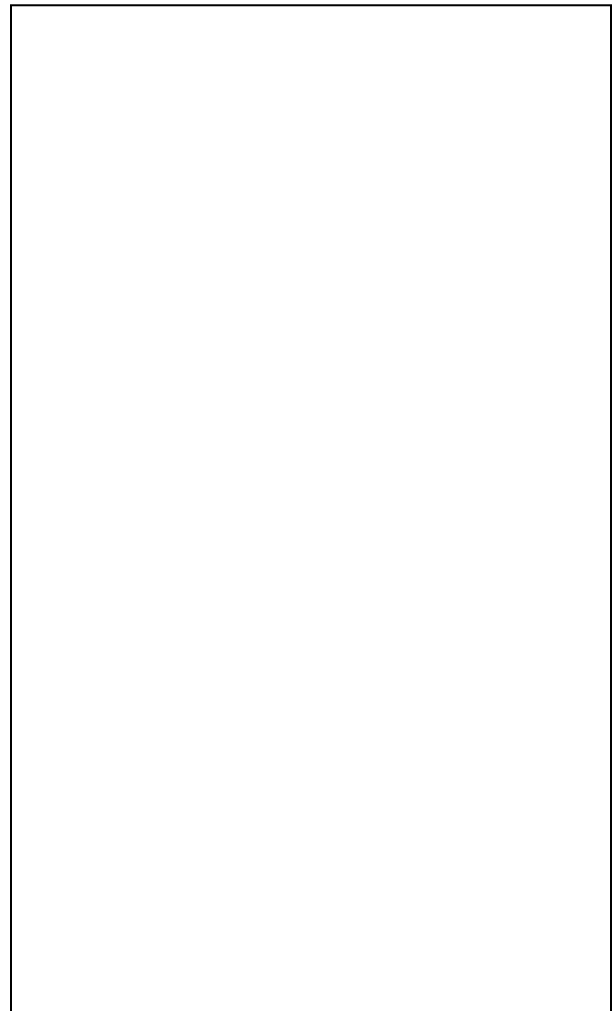
Who will enjoy those benefits?

Safety - Is there a safety hazard?

Who and what could be affected by the risks of this structure?

Environmental Impact - What could be done to prevent harm to the environment?

How will the structure operate?



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