

## 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**



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**Frame**



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**Solid**



**Mass**

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



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



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

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

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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.

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



**Stonehenge**

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**Chunnel Tunnel**

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**Crash Test Dummy**

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**'Firth of Forth' Bridge**

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**Bedouin Tent**

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**Ancient Seismograph**

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



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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.

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❖ 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>
	<b>Cultural</b>	<hr/> <hr/>
	<b>Climate</b>	<hr/> <hr/>
	<b>Tradition</b>	<hr/> <hr/>
	<b>Technology</b>	<hr/> <hr/>
	<b>Economics</b>	<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?

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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**?

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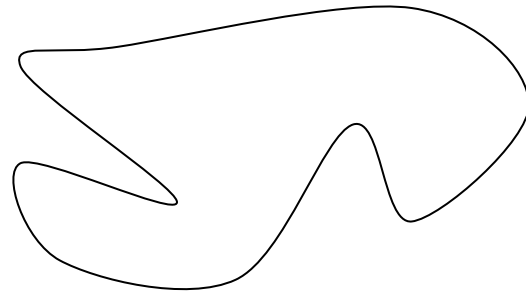
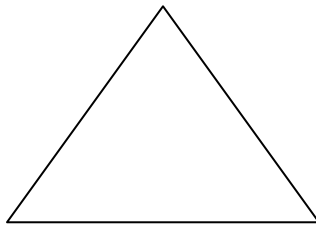
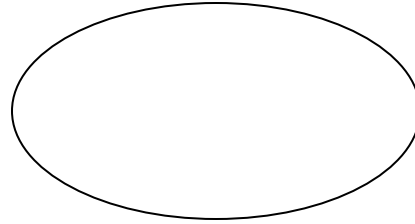
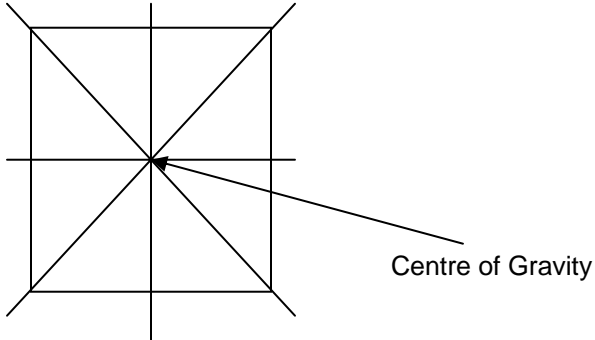
What role do **mass** and **distance** play in the **Law of Gravitation** – developed by Sir Isaac Newton?

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❖ **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. \_\_\_\_\_

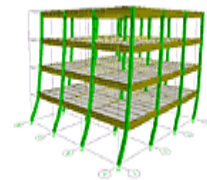
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❖ **Stability**

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?

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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**?

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

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❖ **Internal forces**

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

compression		squeezing / pushing together
_____		_____
_____		_____
_____		_____

Describe and illustrate **complimentary forces**

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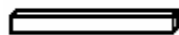
❖ **Material shape and properties determine resistance to internal forces acting on them**

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

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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**

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**Shearing**

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**Separation**

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**Deformation**

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What forces are acting on this hang glider?

External Forces

Internal Forces



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### 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?

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What other considerations are taken into account?

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

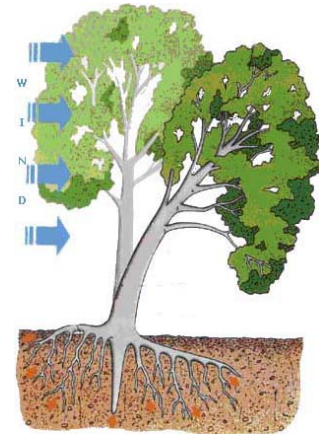
What is **deformation**?

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

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

Describe the various types of joints that rely on:

**Friction**

**Bonding**

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

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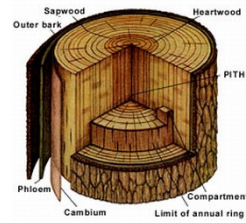
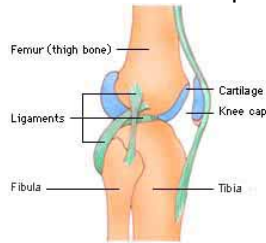
❖ **Stability, strength and function** rely on the proper use of materials

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

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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 \_\_\_\_\_

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#### 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**?

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How is safety maintained?

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

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

Describe the processes of corrugation and lamination

corrugation \_\_\_\_\_  
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lamination \_\_\_\_\_  
\_\_\_\_\_

In what other ways can materials be strengthened?

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❖ **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?

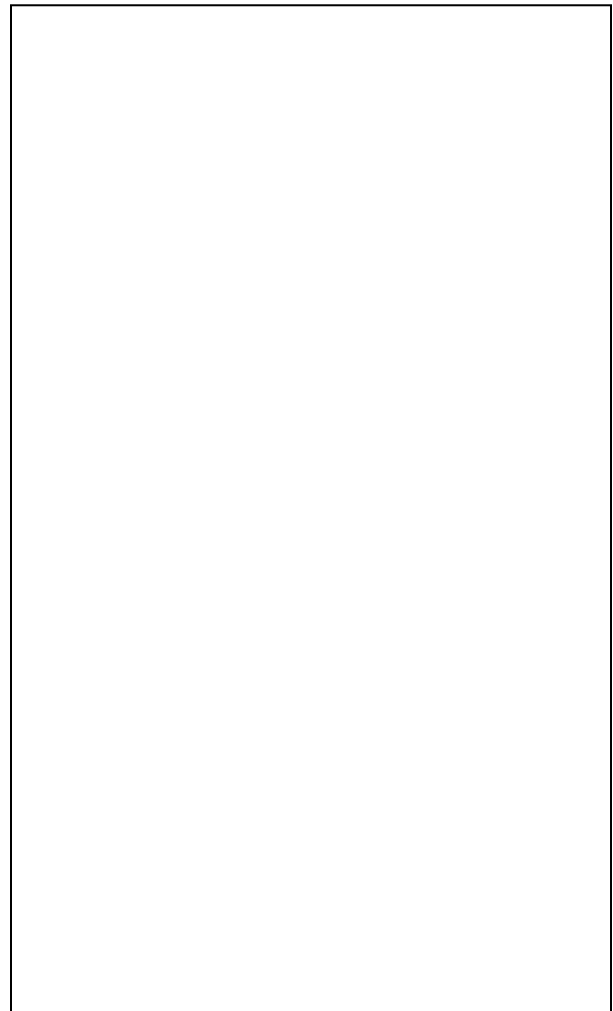
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**Environmental Impact** - What could be done to prevent harm to the environment?

\_\_\_\_\_

How will the structure operate?

\_\_\_\_\_



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