Properties of various construction materials

You need to have a good understanding of different construction materials when you design a structure. A variety of materials with different properties are required for different types of structures. Specific materials are used for buildings, bridges and roads. Various materials, such as bricks, timber, cement, steel and plastics, are used for different types of engineering.

You can only select the correct construction materials when you understand the different properties of materials. The most important properties of building materials are:

Group	Properties
Physical	Mass, density
Mechanical	Hardness, stiffness, flexibility, ductility
Chemical	Corrosion resistance and prevention of corrosion

When you select a material for a particular application, it has to be suitable for the challenges it will be subjected to. You therefore need to understand and apply the properties shown above.

3.1 Physical properties: mass, weight and density

Now we are going to study the physical properties of mass, weight and density.

3.1.1 Mass and weight

Mass and weight are not the same thing, yet people often confuse them.

Mass is a measure of the quantity (amount) of matter an object contains. All matter is made of particles. The mass of an object can be worked out directly from the combined mass of every particle that the object contains.

So mass does not change with a body's position, movement or shape. Unless particles are added or removed, the mass of an object stays the same. The standard unit for mass is the kilogram (abbreviation kg), but it can also be measured in grams (g), milligrams (mg), or tonnes (= 1 000 kg).

In science, weight is a force caused by the attraction of two objects that each have mass. The weight of an object on Earth (w) equals the mass of that object (m) times the acceleration due to gravity on Earth (g), i.e: $w = mg$. Because weight is a force it is measured in $kg.m/s^2$ or newtons (N).

If you were to leave the earth and go to the moon, your weight would change, because the acceleration due to gravity on the moon is smaller, but your mass would remain the same, because you would still be made of the same number and type of particles as you are on Earth.

3.1.2 Density

We can define density as the relative heaviness of objects with a constant volume. For example, a rock has more density than a crumpled piece of paper of the same size.

Density may also refer to how closely packed the material appears to be. Think of a cup made of Styrofoam and a ceramic cup. Which cup is heavier?

All structures on earth have weight, mass and density. When designing a structure, keep in mind that the weight is the measure of the gravitation towards the centre of the earth. All material used, however, also has density. This plays an important role in building a structure.

3.2 Mechanical properties: hardness, ductility, stiffness and flexibility

We need to take mechanical properties into account when designing and building structures. If any of the mechanical properties are ignored, designers of structures will run into serious trouble.

3.2.1 Hardness

Hardness refers to the property of a material that enables it to resist being deformed. The term hardness may, however, also refer to resistance to bending, scratching, abrasion or cutting. Hardness also depends on the strength and toughness of the metal. Examples of hard materials are ceramics, concrete, some metals and very hard plastics.

3.2.2 Ductility

The ductility of a metal refers to how easy it is to shape the metal into sheets or wires. Other words that we can use in place of ductility are elasticity or

3.2.3 Stiffness

Stiffness is the physical property of being inflexible and hard to bend.

When we design a structure, we need to remember that the structure must be able to control the resistance it deflects when a load is applied. **FIGURE 28** shows some examples of how objects do this.

FIGURE 28 Objects control the resistance they deflect when a load is applied

Activity 4 Properties

Complete the table below in your workbook. Tick off on the grid the physical, mechanical and chemical properties that you can identify in the windmill.

Properties	Physical	Mechanical	Chemical
Mass			
Density			
Hardness			
Stiffness			
Flexibility			
Corrosion resistance and prevention of corrosion			

FIGURE 29 This structure is firmly anchored

oxidise – to combine with oxygen

oxidants – a substance that causes another substance to combine with oxygen

rust – red or orange coating that forms on the surface of iron when it is exposed to air and moisture

exposed – regularly come into contact with something

3.3 Chemical: corrosion resistance and prevention of corrosion

Steel is possibly the most important engineering and construction material in the world because of its properties. The most important properties of steel are:

- formability and durability
- good tensile strength
- good thermal conductivity
- resistance to corrosion in stainless steels.

The biggest threat to this excellent building material is corrosion. Corrosion happens when a material, such as steel, breaks down due to chemical reactions in its surroundings. This happens when metals oxidise. Metals oxidise when they come into contact with oxidants, such as oxygen.

Corrosion occurs on surfaces that are exposed to oxidants such as oxygen. Rust is another word for corrosion. We can use different methods to reduce rust. If we reduce rust, we can increase a material's resistance to corrosion.

1 Explain the meaning of the following properties of various construction materials:
   a mass
   b density
   c hardness
   d stiffness
   e flexibility
   f corrosion resistance and prevention of corrosion.
2 Group, in table form, the most important properties of building materials.
3 Why are the results of the nails experiment valuable when considering building a structure?

Answers

1a.

B,

c.

d.

e.

f.

2.

3.