Chapter 01: **Concrete and steel as construction materials**

II. STEEL

Steel is an alloy of iron and carbon containing less than 2% carbon and 1% manganese and small amounts of silicon, phosphorus, sulphur and oxygen. Steel is the world's most important engineering and construction material. It is used in every aspect of our lives; in cars and construction products, refrigerators and washing machines, cargo ships and surgical scalpels.

It can be recycled over and over again without loss of property.

II. 1 **Properties of steel**

Steel has a number of properties, including: hardness, toughness, tensile strength, yield strength, elongation, fatigue strength, corrosion, plasticity, malleability and creep.

- **HARDNESS**

is the material's abilit y to withstand friction and abrasion. It is worth noting that, while it may mean the same as strength and toughness in colloquial language, this is very different from strength and toughness in the context of metal properties.

- **TOUGHNESS**

is difficult to define but generally is the ability to absorb energy without fracturing or rupturing. It is also defined as a material's resistance to fracture when stressed. It is usually measured in foot lbs. per sq. in or Joules per sq. centimetre. It is important to distinguish this from hardness as a material that severely deforms without breaking, could be considered extremely tough, but not hard.

- **YEILD**

strength is a measurement of the force required to start the deformation of the material (i.e. bending or warping).

- **TENSILE**

strength is a measurement of the force required to break the material.

- **ELONGATION**

(or Ductilit y) is the "Degree" to which the material can be stretched or compressed before it breaks. It is expressed as a percent of the length being tested and is between the tensile strength and yield strength (i.e. what percent does the material bend beforebreaking).

- **FATIGUE**

strength is the highest stress that a material can withstand for a given number of cycles without breaking.

- **CORROSION**

is the irreversible deterioration and destruction of the steel material and its vital properties due to the electrochemical or chemical reaction of its surface to environmental factors such as :

acids, moisture and oxygen.

- **PLASTICITY**

is the deformation of a material undergoing non-reversible changes of shape in response to applied forces.

- **MALLEABILITY**

describes the property of a metal's ability to be distorted below compression. It is a physical property of metals by which they can be hammered, shaped and rolled into a very thin sheet without rupturing.

- CREEP

is a type of metal deformation that occurs at stresses below the yield strength of a metal, generally at elevated temperatures.

II. 2. Uses of steel:

- Steel is environment-friendly & sustainable. It posses great durability.
- Compared to other materials, steel requires a low amount of energy to produce lightweight steel construction.
- Steel is the world's most recycled material which can be recycled very easily. Its unique magnetic properties make it an easy material to recover from stream to be recycled.
- Steel can be designed into various forms. It gives better shape and edge than iron which is used to make weapons.
- Engineering steels are used for general engineering and manufacturing sectors.
- Steel is highly used in the automobile industry. Different types of steels are used in a car body, doors, engine, suspension, and interior. The average 50% of a car is made of steel.
- Steel reduces CO_2 emissions.
- All types of energy sectors demand steel for infrastructure and resource extraction.
- Stainless steels are used to produce offshore platforms and pipelines.
- Steels are used for packaging and protecting goods from water, air and light exposure.
- Most of the household appliances like fridge, TV, oven, sinks, etc are made of steel.
- Steels are used for producing industrial goodies like farm vehicles and machines.
- Stainless steel is used as a cutlery material.
- Because of its easily welding capability and attractive finishing, steel has become a prominent feature in modern architecture.
- Stainless steel gives a hygienic environment. That's why it is used for surgical implants.
- Steel has a wider range of temperature which is used to make large sheets.
- Renewable energy resources like solar, hydro and wind power use the stainless steel components.
- Mild steel is used for building construction. It is also a highly favoured building frame material.

II. 3. Various tests done on STEEL REBAR

1. Tensile test
2. Compression test
3. Bending test
4. Brinell hardness test
5. Rockwell hardness test
6. Impact test
7. Torsion test

1. TENSILE TEST:

This tensile test process is one of the important tests of the steel bars. A tension test of steel materials is a damaging procedure that gives data about the elasticity, tensile strength and yieldstrength of the sample. This tensile test is done to decide how the material responds when youapply a force to it. Generally, by pulling the metal, one has to recognize the material's rigidity,yield quality just as the amount it will extend. Tension test is the basic criteria where onepresent a steel bar test to tension which is under control until failure stage.

2. COMPRESSION TEST:

The compressive quality is the most extreme compressive stress a material is equipped for withstanding without crack. Brittle materials crack during testing and have a definite compressive strength value. The compressive strength of flexible materials is dictated by theirlevel of bending during testing. Compressive quality test, mechanical test estimating the greatest measure of compressive burden a material can tolerate before breaking.

3. BENDING TEST

Bend testing a material takes into consideration that materials resistance to fracture, ductility, fracture strength and bend strength. These qualities can be utilized to decide if a material will fail under pressure and are important in any construction procedure including ductile materials loaded with bending forces. If a material starts to break or totally cracks during a bend test it is valid to accept that the material will fail under a similar in any application, which may prompt to catastrophic failure.

4. BRINELL HARDNESS TEST

The Brinell test was the first broadly utilized standardised steel hardness test. It requires a huge test piece and leaves a huge space; hence, it is constrained in its usefulness. Actually brinelling has come to mean the permanent indentation of any hard surface. These Brinell hardness test involves a large, heavy ball, which is pushed against steel at a predetermined level of force.

5. ROCKWELL HARDNESS TEST

The Rockwell test is commonly simpler to perform, and more exact than different kinds of hardness testing techniques. The Rockwell steel test strategy is utilized on all kinds of metals, with the exception of in conditions where the test metal structure or surface conditions would present an excessive amount of varieties; where the indentations would be unreasonably enormous for the application; or where the sample size or test shape forbids using.

6. IMPACT TEST

Impact test decides the amount of energy consumed by a material during crack. This absorbed energy is a measure of a given material's strength and goes about as a device to consider temperature-dependent weak flexible progress. It is to decide if the material is fragile or malleable in nature. Impact testing of metals is performed to decide the effect opposition or durability of materials by figuring the measure of energy absorbed during fracture. The impact test is performed at different temperatures to reveal any consequences on impact energy. These services give test results that can be helpful in evaluating the suitability of a material for a specific application and in predicting its expected service life.

7. TORSION TEST

The reason for a torsion test is to decide the behaviour a material or test shows when turned or under torsional forces because of applied moments that cause shear stress about the axis. Measurable values include: the modulus of ductility, ultimate shear strength, elasticity in shear modulus of rupture in shear, yield shear strength and torsional fatigue life. These values are similar but not the same as those measured by a tensile test and are significant in assembling as they might be utilized to simulate the service conditions, check the item's quality and structure, and guarantee that it was made effectively.

II. 4. CAST IRON:

Cast iron is a group of iron-carbon alloys with a carbon content of more than 2%. Its usefulness derives from its relatively low melting temperature. Iron alloys with lower carbon content are known as steel. Cast iron tends to be brittle, except for malleable cast irons.
Use of cast iron:

- It is used in making pipes, to carry suitable fluids.
- It is used in making different machines.
- It is used in making automotive parts.
- It is used in making pots pans and utensils.
- It is used in making anchor for ships.

5. WROUGHT IRON

Wrought iron is a soft, ductile, fibrous variety that is produced from a semi-fused mass of relatively pure iron globules partially surrounded by slag. It usually contains less than 0.1 percent carbon and 1 or 2 percent slag. It is superior for most purposes to cast iron, which is overly hard and brittle owing to its high carbon content.

Use of wrought iron:

- It is used to make decor items like table base, candle holder, curtain rods etc.
- It is used in making pipes.
- It is used in making fences and gates.
- It is used in making nuts, bolts, rivets etc.
- It is used in making chains.

- It is used in making crane hooks.
- It is used in making plates.
- It is used in making handrails.
- It is used in making carpenter tools.
- It is used in general forging applications.
- It is used in making railway couplings.