# Reinforced Concrete Structures

## INTRODUCTION

### Concrete Materials:

*Concrete* is a mixture of sand, gravel, crushed rock, or other aggregates held together in a rocklike mass with a paste of cement and water. Sometimes one or more admixtures are added to change certain characteristics of the concrete such as its workability, durability, and time of hardening.

- Cement: (Ordinary Portland Cement, Sulphate Resistance Cement, Low Heat Cement ... etc.)
- Water.
- Coarse and Fine Aggregate: (Gravels + Sand), 75 % of concrete mix.
- Admixtures: (Water-reducing Admixtures, Accelerating Admixtures, Coloring Admixtures ... etc.)

### Types of Concrete:

Plain Concrete, Reinforced Concrete, Lightweight Concrete, High-Density Concrete Precast Concrete, Pre-stressed Concrete, Glass Concrete, Rapid Hardening, Asphalt, Roller Compacted, Vacuum, Self-Consolidated.

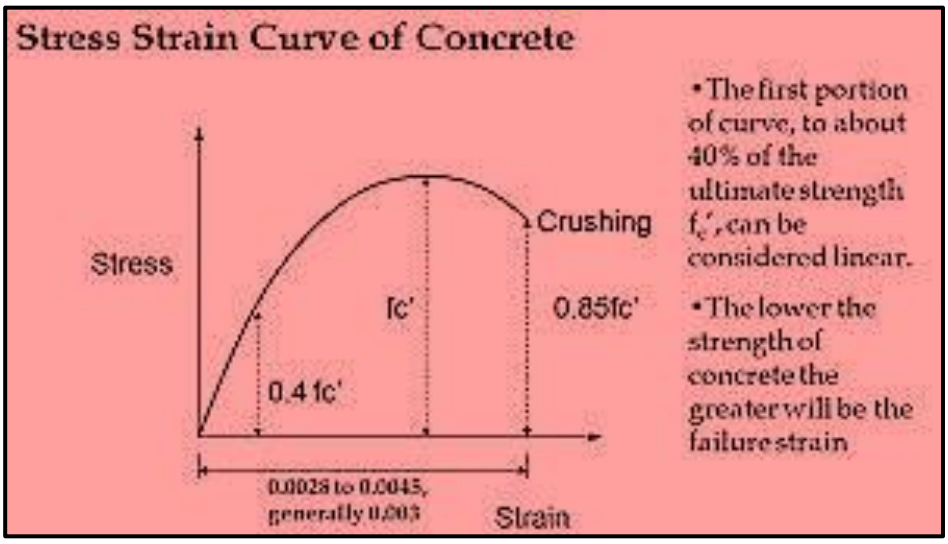
### Mechanical Properties of Concrete:

1- **Compressive Strength**: For designers, compressive strength is one of the most important engineering properties of concrete. It is a standard industrial practice that the concrete is classified based on grades. This grade is nothing but the Compressive Strength of the concrete cube or cylinder. Cube or Cylinder samples are usually tested under a compression testing machine (7 and 28 days curing) to obtain the compressive strength of concrete.

2- **Tensile Strength:** Also important because it effect on cracks that occurred in structures. It's very low in concrete about (10 – 15 %) compared with compressive strength. There are two ways to test the tensile strength in concrete:
   - Splitting Cylinder Test.

- Modulus of Rupture.

Stress - Strain Curve for Concrete :




3- **Modulus of Elasticity for Concrete:** Modulus of Elasticity of Concrete can be defined as the slope of the line drawn from a stress of zero to a compressive stress of **0.45f'c.** As concrete is a heterogeneous material. The strength of concrete is dependent on the relative proportion and modulus of elasticity of the aggregate.

According to ACI 318-08 section 8.5, Modulus of elasticity for concrete,

$$\mathbf{Ec = w^{1.5}\,(0.043\sqrt{fc'})}\ \text{MPa}$$

For normal-weight concrete (2300 Kg/m3),

$$\mathbf{Ec = 4700\sqrt{f'c}\ MPa}$$

**Reinforced concrete (RC):** is a composite material in which concrete's relatively low tensile strength and ductility are counteracted by the inclusion of reinforcement having higher tensile strength or ductility.

★ **The overall goal is to be able to design reinforced concrete structures that are:**

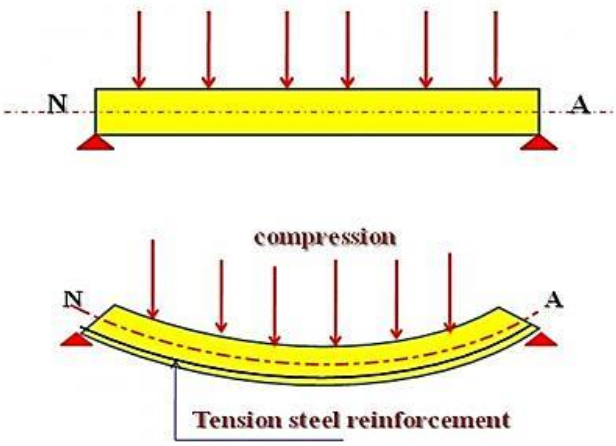
- Safe.
- Economical.
- Efficient.

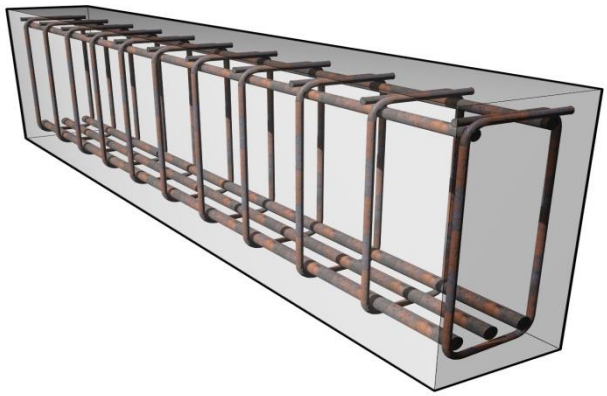
★ **Reinforced concrete is one of the principal building materials used in engineered structures because:**

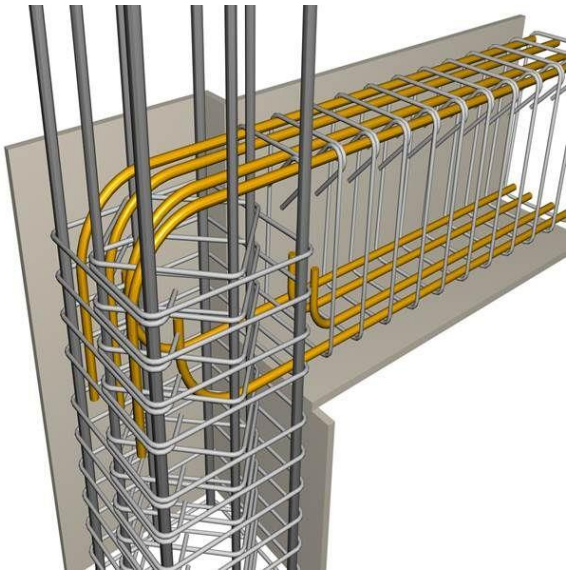
- Low cost.
- Weathering and fire resistance.
- Good compressive strength.
- Formability.

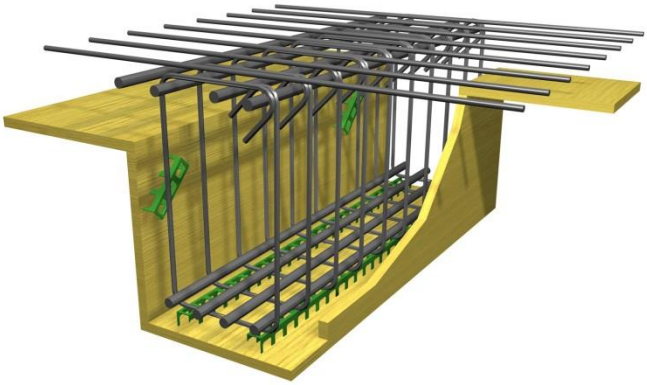
Reinforcing schemes are generally designed to resist tensile stresses in particular regions of the concrete that might cause unacceptable cracking and/or structural failure. Modern reinforced concrete can contain varied reinforcing materials made of steel, polymers or alternate composite material in conjunction with bars or not.

★Steel Location: "Place reinforcing steel where the concrete is in tension"

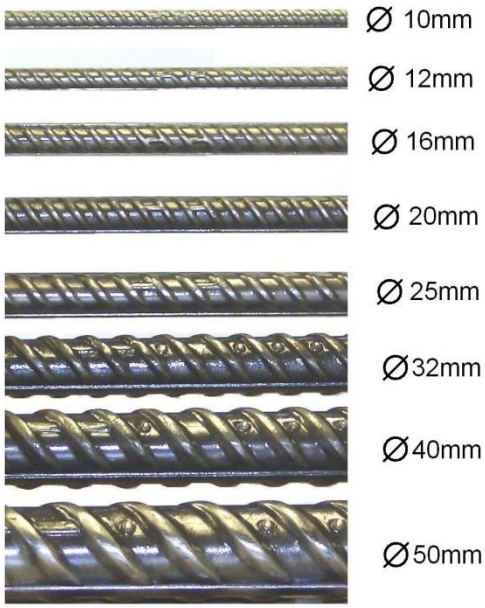






## ★Steel Bars Sizes:




## ★Grades: (fy / fu in N/mm²):

240/360, 280/420, 350/520 and 400/600

**fy :** Steel Yield Strength

**fu:** Steel Ultimate Strength

| Bar Diameter (mm) | Unit Weight (kg/m) | Sectional Area (mm2) |
|---|---|---|
| 6 | 0.222 | 28.3 |
| 8 | 0.395 | 50.3 |
| 10 | 0.617 | 78.5 |
| 12 | 0.888 | 113.1 |
| 16 | 1.578 | 201.1 |
| 20 | 2.466 | 314.2 |
| 25 | 3.853 | 490.9 |
| 32 | 6.313 | 804.2 |
| 40 | 9.864 | 1256.6 |