Lecture 1:
Introduction to concrete

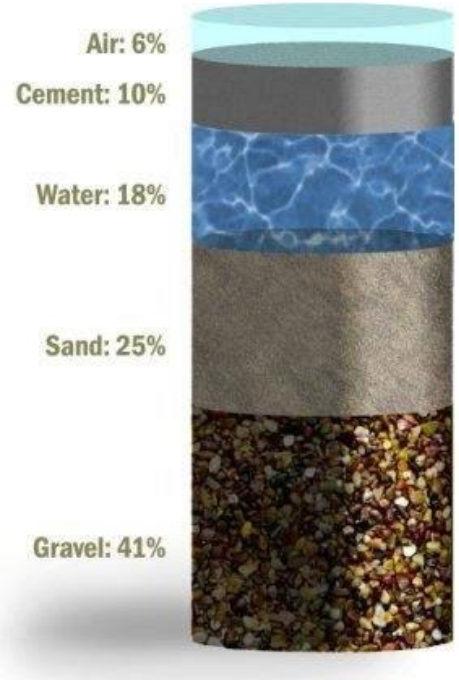
Engr. USAMA ALI

Contents

- What is concrete?
- History
- Components
- Properties
- Classification

What is Concrete?

- Concrete is a composite construction material composed primarily of aggregate, cement and water



What is Concrete?

- Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space among the aggregate particles and glues them together.
- Alternatively, we can say that concrete is a composite material that consists essentially of a binding medium in which their are embedded particles or fragments of aggregates.
- The simplest definition of concrete can be written as concrete = filler + binder

History

- The word concrete comes from the Latin word "concretus" (meaning compact or condensed)

- During the Roman Empire, Roman concrete was made from quicklime, pozzolana and an aggregate of pumice.

- An analysis of mortar from the Great Pyramid showed that it contained 81.5 per cent calcium sulphate and only 9.5 per cent carbonate.

History (Cont'd)

In Serbia, remains of a hut dating from 5600 BC have been found, with a floor made of red lime, sand, and gravel. (3000BC)

Cementing material, used in the construction of the cities of Harappa and Mohenjadaro. (3300–1300 BC)

History (Cont'd)

Hadrian's Pantheon in Rome is an example of Roman concrete construction. 126AD

The multiple arches of the Pont du Gard, in Roman Gaul. Its lower tiers carry a road across the river, and the upper tiers support an aqueduct conduit that carried water to Nimes (300AD)

History (Cont'd)

- The first recorded fact points to the year 1756 when John Smeaton, an engineer made the present day concrete by mixing coarse aggregate (pebbles) and powered brick and mixed it with cement.

- In 1793, he built the Eddystone Lighthouse in Cornwall, England with the use of hydraulic cement.

- Another major development took place in the year 1824. An English inventor Joseph Aspdin invented Portland cement. He made cement by burning grounded chalk and finely crushed clay in a limekiln till the carbon dioxide evaporated, resulting in strong cement.

History (Cont'd)

- There has been no looking back for concrete since its modern development. Known as the strongest building material, concrete has found major uses in dams, highways, buildings and many different kinds of building and construction.

- As of 2006, about seven billion cubic meters of concrete are made each year, more than one cubic meter for every person on Earth. Concrete powers a $US 35-billion industry which employs more than two million workers in the United States alone. More than 55,000 miles of highways in America are paved with this material.

History (Cont'd)

- The People's Republic of China currently consumes 40% of the world's cement/concrete production.



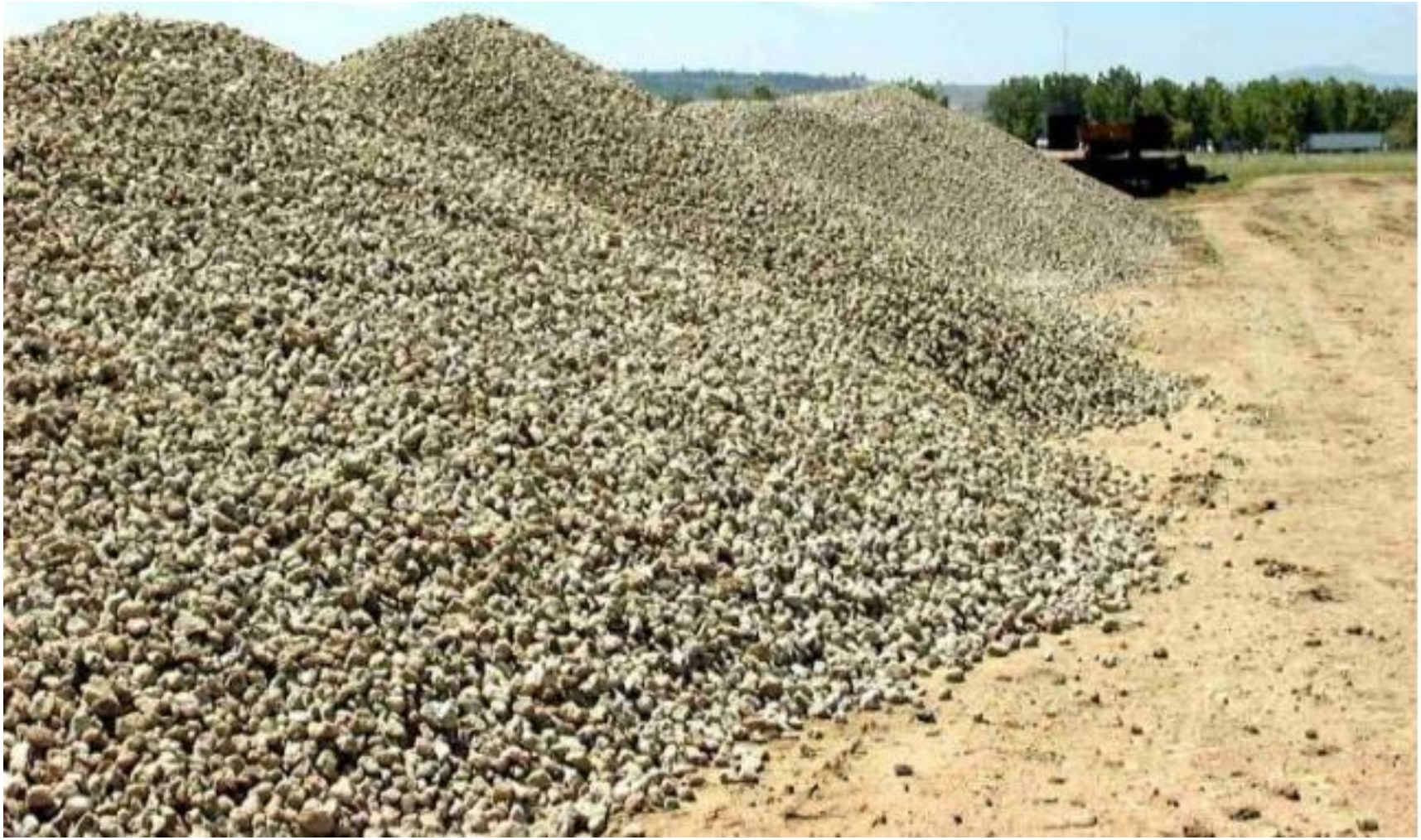

Components of Concrete

- Cement
- Aggregates
  - Fine Aggregates
  - Coarse Aggregates
- Water

Cement

Fine Aggregates

Coarse Aggregates



Classification of concrete

- Classification according to binding material
- Classification according to design
- Classification according to purpose

Classification according to binding material

1. **Cement Concrete:** In this type, cement is used as a binding material, sand as fine aggregates and gravel, crushed stones as coarse aggregates. In cement concrete useful proportions of its ingredients are

1 part cement: 1-8 part sand: 2-16 parts coarse aggregates.

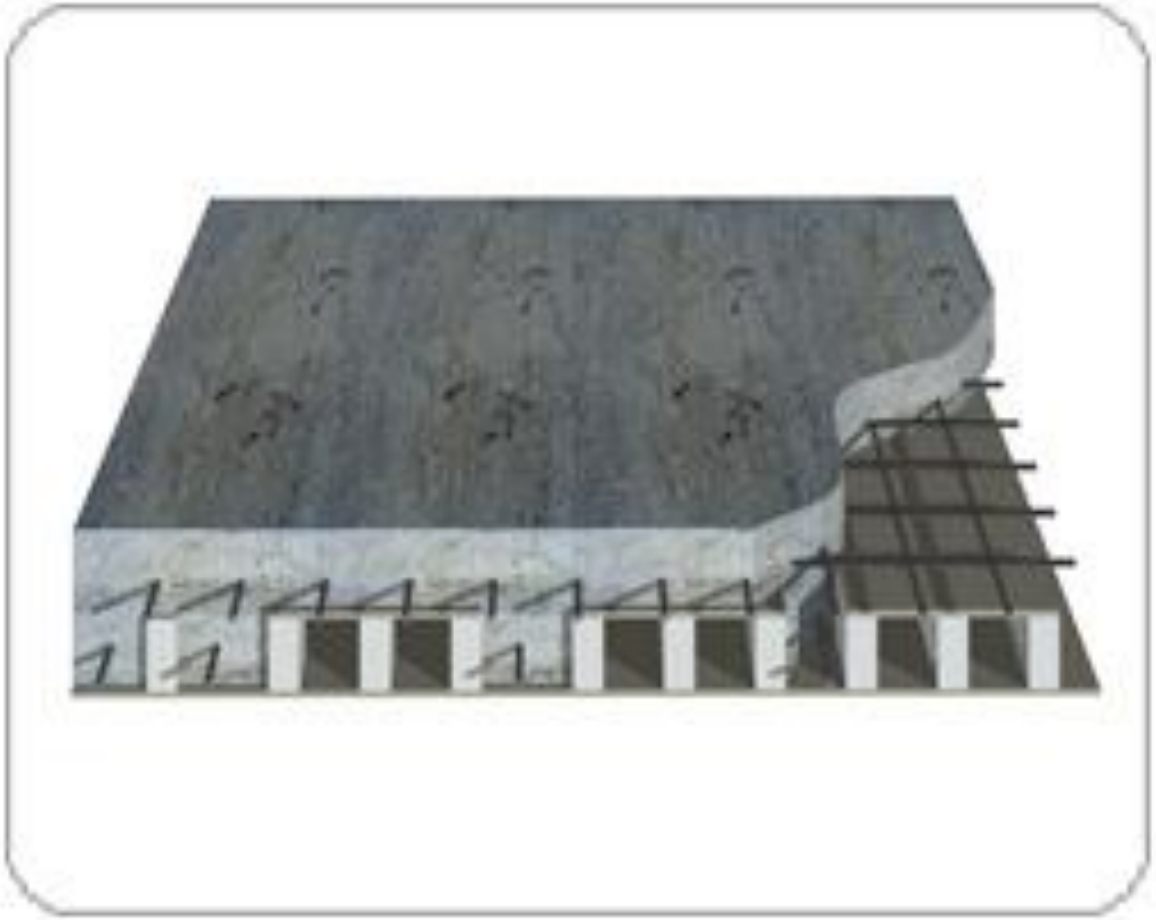
2. **Lime Concrete:** In this type of concrete hydraulic lime is generally used as a binding material, sand and cinder are used as fine aggregates and broken bricks, gravel can be used as coarse aggregates

Classification according to design

1. **Plain Cement Concrete:** The cement concrete in which no reinforcement is provided is called plain cement concrete .This type of concrete is strong in taking compressive stresses but weak in taking tensile stresses. Commonly used for foundation work and flooring of buildings

2. **Reinforced Cement Concrete:** The cement concrete in which reinforcement is embedded for taking tensile stress is called reinforced cement concrete. RCC is commonly used for construction of slabs, beams and columns, Usual proportions of ingredients in a reinforced concrete are 1part of cement:1-2parts of sand:2-4parts of crushed stones or gravel.

Reinforced Cement Concrete (RCC)



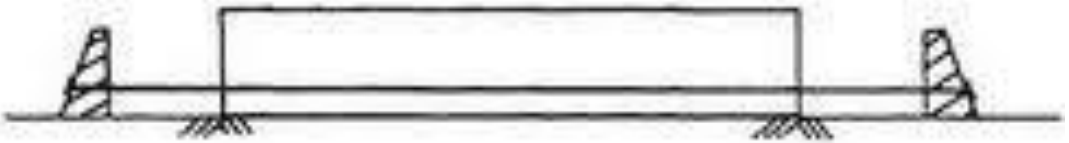
Classification according to design (Cont'd)

3. **Pre-Stressed Cement Concrete:** The cement concrete in which high compressive stresses are artificially induced before their actual use is called pre-stresses cement concrete.

   in this type of cement concrete, the high compressive stresses are induced by pre-tensioning the reinforcement before placing the concrete, and the reinforcement is released when final setting of the concrete take place. This concrete can take up high tensile and compressive stresses without development of cracks. The quantity of reinforcement can be considerably reduced by using this concrete

PRE-STRESSED CEMENT CONCRETE (PCC)

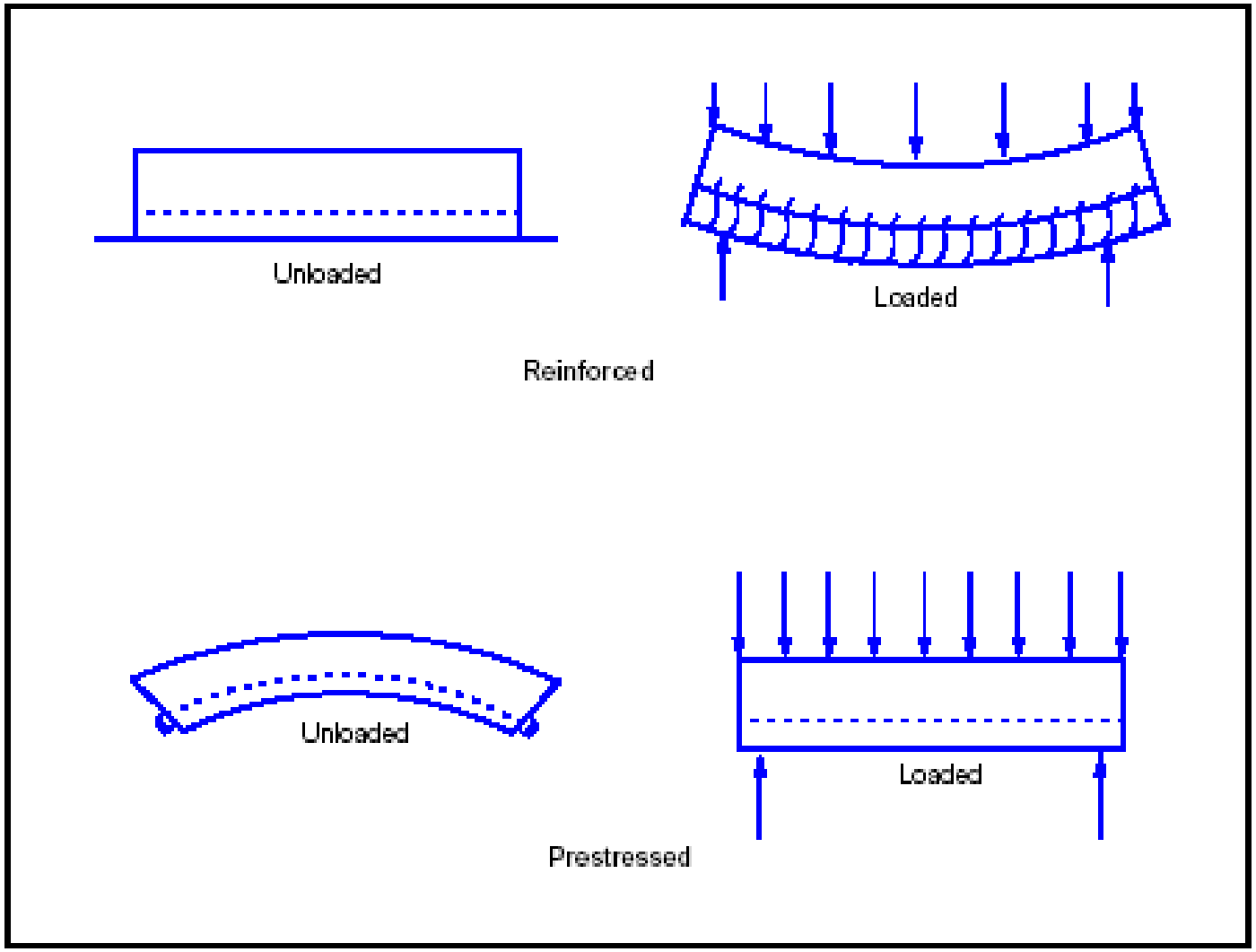
(a) Tendons stressed between abutments



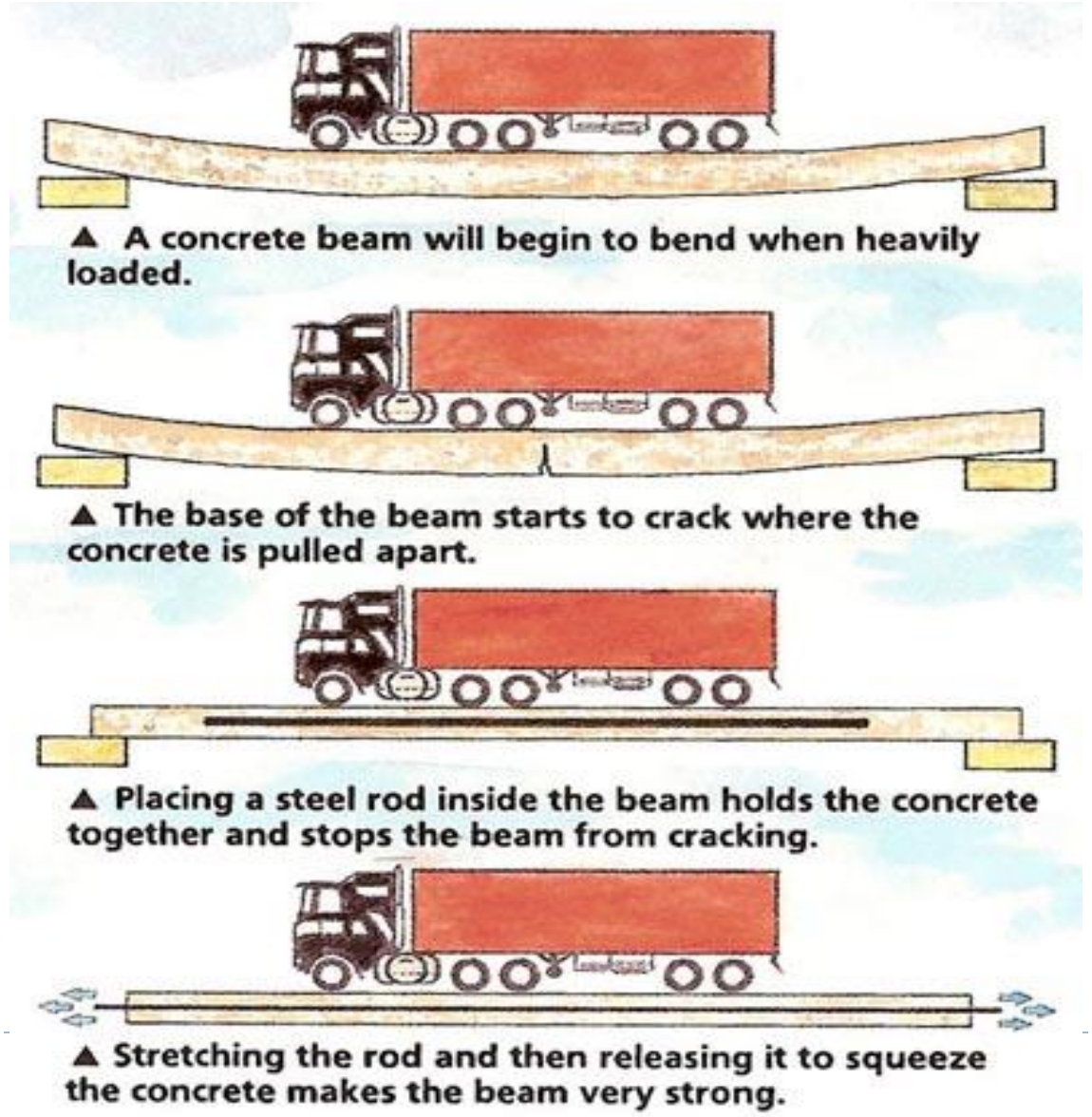
(b) Concrete cast and cured

(c) Tendons released and prestress transferred

PRE-STRESSED CEMENT CONCRETE (PCC)



PRE-STRESSED CEMENT CONCRETE (PCC)



▲ A concrete beam will begin to bend when heavily loaded.

▲ The base of the beam starts to crack where the concrete is pulled apart.

▲ Placing a steel rod inside the beam holds the concrete together and stops the beam from cracking.

▲ Stretching the rod and then releasing it to squeeze the concrete makes the beam very strong.

Classification according to purpose

1. Normal concrete
2. High Performance Concrete
3. High Density Concrete
4. Fiber Reinforced Concrete
5. Air Entrained Concrete
6. Light Weight Concrete
7. Self Compacting Concrete
8. Shotcrete
9. Pervious Concrete
10. Roller Compacted Concrete

Advantages of concrete

1. Economical:

Concrete is the most inexpensive and the most readily available material in the world. The cost of production of concrete is low compared with other engineered construction materials. The three major components in concrete are water, aggregate, and cement. Compared with steels, plastics, and polymers, these components are the most inexpensive, and are available in every corner of the world. This enables concrete to be produced worldwide at very low cost for local markets.

2. Ambient temperature-hardened material:

Because cement is a low-temperature bonded inorganic material and its reaction occurs at room temperature, concrete can gain its strength at ambient temperature. No high temperature is needed.

3. Ability to be cast:

Fresh concrete is flow able like a liquid and hence can be poured into various formworks to form different desired shapes and sizes right on a construction site. Hence, concrete can be cast into many different configurations

Advantages of concrete

4. Energy efficient:

Compared with steel, the energy consumption of concrete production is low. The energy required to produce plain concrete is only 450–750 kW/ton and that of reinforced concrete is 800–3200 kW/ton, while structural steel requires 8000 kW/ton or more to make

5. Excellent resistance to water:

Unlike wood (timber) and steel, concrete can be hardened in water and can withstand the action of water without serious deterioration, which makes concrete an ideal material for building structures to control, store, and transport water, such as pipelines, dams, and submarine structures.

6. High-temperature resistance:

Concrete conducts heat slowly and is able to store considerable quantities of heat from the environment.

Advantages of concrete.

7. Ability to consume waste:

With the development of industry, more and more by-products or waste has been generated, causing a serious environmental pollution problem. To solve the problem, people have to find a way to consume such wastes. It has been found that many industrial wastes can be recycled as a substitute (replacement) for cement or aggregate, such as fly ash, slag (GGBFS = ground granulated blast-furnaces slag), waste glass, and ground vehicle tires in concrete. Production of concrete with the incorporation of industrial waste not only provides an effective way to protect our environment, but also leads to better performance of a concrete structure. Due to the large amount of concrete produced annually, it is possible to completely consume most of industry waste in the world.

Advantages of concrete

9. Less maintenance required:

Under normal conditions, concrete structures do not need coating or painting as protection for weathering, while for a steel or wooden structure, it is necessary. Moreover, the coatings and paintings have to be replaced few years. Thus, the maintenance cost for concrete structures is much lower than that for steel or wooden structures.

Disadvantages of concrete

Following are the disadvantages of concrete:

1. **Low tensile strength:** The tensile strength of reinforced concrete is about one-tenth of its compressive strength.
2. **Brittle Material:** Easily breakable like glass. Less or no Elasticity
3. **Formwork is needed:** Fresh concrete is in a liquid state and needs formwork to hold its shape and to support its weight. Formwork can be made of steel or wood.
4. **Long curing time:** Strength Development need proper curing.
5. **Cracks Occurring:** Shrinkage causes crack development and strength loss.
6. **Demands Strict Quality Control:** Concrete demands strict quality control and skilled labor during mixing, placing and curing of concrete. This is important for superior quality of concrete. If not, concrete is viable to poor strength, durability and performance issues.

THANK YOU