Module # 1

After completion of lecture the student will have depth knowledge about following topics:

1. Introduction to concrete
2. Definition of Concrete
3. Types of concrete
4. Advantages of Concrete
5. Disadvantages of Concrete

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1. Introduction to Concrete

Introduction to concrete

- Concrete is the most widely used material in the world. It plays an important role in infrastructure and buildings construction. Understanding the basic behaviors of concrete is essential for civil engineering students to become civil engineering professionals.
- Today, the rate at which concrete is used is much higher than it was 40 years ago.
- It is estimated that the present consumption of concrete in the world is of the order of 11 billion metric tones every year.

Introduction to concrete Continued

- Concrete is neither as strong nor as tough as steel, so why is it the most widely used engineering material ??

Introduction to concrete Continued

There are at least three primary reasons

- **First**, concrete possesses excellent resistance to water. Unlike wood and ordinary steel, the ability of concrete to withstand the action of water without serious deterioration makes it an ideal material for building structures to control, store, and transport water.
- The **second reason** for the widespread use of concrete is the ease with which structural concrete elements can be formed into a variety of shapes and sizes. This is because freshly made concrete is of a plastic nature, which enables the material to flow into preinstalled formwork. After a number of hours when the concrete has solidified and hardened to a strong mass, the formwork can be removed for reuse.
- The **third reason** for the popularity of concrete with engineers is that it is usually the **cheapest** and **most readily available material** on the job. The principal components for making concrete, namely aggregate, water, and Portland cement are relatively inexpensive and are commonly available in most parts of the world.

2. Definition of Concrete

Definition of concrete

- Concrete is a manmade building material that looks like stone. The word "concrete" is derived from the Latin "concretus", meaning "to grow together."
- 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

Definition of concrete Continued

- Components of concrete are cement, sand, aggregates and water. Mixture of Portland cement and water is called as paste. So, concrete can be called as a mixture of paste, sand and aggregates. Sometimes rocks are used instead of aggregates.
- The cement paste coats the surface of the fine and coarse aggregates when mixed thoroughly and binds them. Soon after mixing the components, hydration reaction starts which provides strength and a rock solid concrete is obtained.
- Concrete is generally used in two types of construction, i.e. plain concrete construction and reinforced concrete construction. In PCC, it is poured and casted without use of any reinforcement. This is used when the structural member is subjected only to the compressive forces and not bending.

Definition of concrete Continued

- When a structural member is subjected to bending, reinforcements are required to withstand tension forces structural member as it is very weak in tension compared to compression. Generally, strength of concrete in tension is only 10% of its strength in compression.
- It is used as a construction material for almost all types of structures such as residential concrete buildings, industrial structures, dams, roads, tunnels, multistory buildings, skyscrapers, bridges, sidewalks and superhighways etc.
- Example of famous and large structures made with concrete are Hoover Dam, Panama Canal and Roman Pantheon. It is the largest human made building materials used for construction.

3. Types of Concrete

Types of concrete

- **1. Normal Strength Concrete**

The concrete that is obtained by mixing the basic ingredients cement, water and aggregate will give us normal strength concrete. The strength of these type of concrete will vary from 10 MPa to 40MPa.

The normal strength concrete has an initial setting time of 30 to 90 minutes that is dependent on the cement properties and the weather conditions of the construction site.

- The strength of concrete is commonly stated, in metric, in **megapascals** (MPa).
- 1 MPa = 1,000,000 Pa = 1,000,000 Newtons / meter ^{2}
- Pressure = force per area
- Pressure can be measured in **pascals** (Pa). 1 Pa = 1 N / meter ^{2}

Types of concrete Continued

2. Plain Concrete

The plain concrete will have no reinforcement in it. The main constituents are the cement, aggregates, and water. Most commonly used mix design is 1:2:4 which is the normal mix design.

The density of the plain concrete will vary between 2200 and 2500 Kg/meter cube. The compressive strength is 200 to 500 kg/cm2.

These types of concrete are mainly used in the construction of the pavements and the buildings, especially in areas where there is less demand of high tensile strength. The durability given by these type of concrete is satisfactory.

Types of concrete Continued

3. Reinforced Concrete

The reinforced cement concrete is defined as the concrete to which reinforcement is introduced to bear the tensile strength. Plain concrete is weak in tension and good in compression.

Hence the placement of reinforcement will take up the responsibility of bearing the tensile stresses. R.C.C works with the combined action of the plain concrete and the reinforcement.

The steel reinforcement used in the concrete can be in the form of rods, bars or in the form of meshes. Now fibers are also developed as reinforcement.

Types of concrete Continued

4. Pre-stressed Concrete

Most of the mega concrete projects are carried out through pre-stressed concrete units. This is a special technique in which the bars or the tendons used in the concrete is stressed before the actual service load application.

During the mixing and the placing of the concrete, these tensioned bars placed firmly and held from each end of the structural unit. Once the concrete sets and harden, the structural unit will be put in negative force.

This phenomenon of pre-stressing will make the lower section of the concrete member to be stronger against the tension.

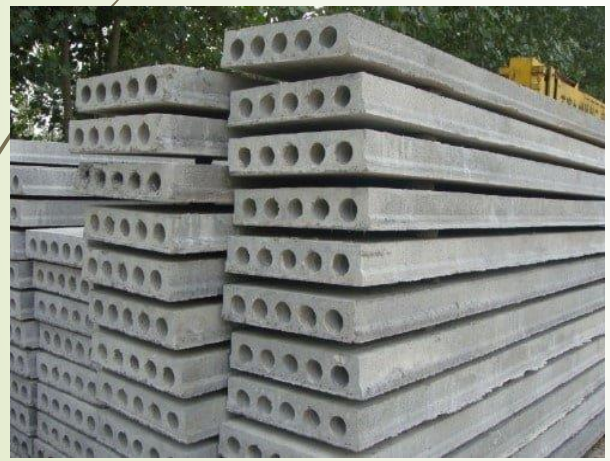
The process of prestressing will require heavy equipment and labor skill (jacks and equipment for tensioning). These are used in the application of bridges, heavy loaded structures, and roof with longer spans.

Types of concrete Continued

5. Precast Concrete

Various structural elements can be made and cast in the factory as per the specifications and bought to the site at the time of assembly. Such concrete units are called as the precast concrete.

The examples of precast concrete units are concrete blocks, the staircase units, precast walls and poles, concrete lintels and many other elements. These units have the advantage of acquiring speedy construction as only assemblage is necessary. As the manufacturing is done at site, quality is assured. The only precaution taken is for their transportation.



Types of concrete Continued

6. Lightweight Concrete

Concrete that have a density lesser than 1920kg/m3 will be categorized as lightweight concrete. The use of lightweight aggregates in concrete design will give us lightweight aggregates.

Aggregates are the important element that contributes to the density of the concrete.

Types of concrete Continued

7. High-Density Concrete

The concretes that have densities ranging between 3000 to 4000 kg/m^3 can be called as the heavyweight concrete. Here heavy weight aggregates are used.

The crushed rocks are used as the coarse aggregates. The most commonly used heavy weight aggregates is Barytes.

These types of aggregates are most commonly used in the construction of atomic power plants and for similar projects. The heavy weight aggregate will help the structure to resist all possible type of radiations.

Types of concrete Continued

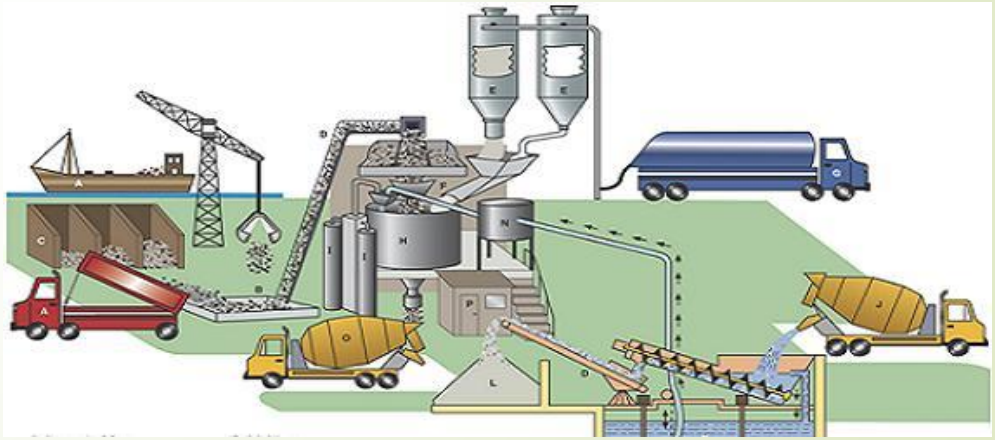
8. Air Entrained Concrete

- These are concrete types into which air is intentionally entrained for an amount of 3 to 6% of the concrete. The air entrainment in the concrete is achieved by the addition of foams or gas – foaming agents.
- Some examples of air entraining agents are resins, alcohols, and fatty acids.

Types of concrete Continued

9. Ready Mix Concrete

- The concrete that mix and bathed in a central mixing plant is called as ready-mix concrete. The mixed concrete is brought to the site with the help of a truck-mounted transit mixer. This once reached in the site can be used directly without any further treatment.
- The manufacture of these concrete will require a centralized mixing plant. These plants will be located at an adjustable distance from the construction site. If the transportation is too long then it will result in setting of concrete. Such issues of time delay are cope up with the use retarding agents that delays the setting.



Types of concrete Continued

10. Self – Consolidated Concrete

- The concrete mix when placed will compact by its own weight is regarded as self-consolidated concrete.
- No vibration must be provided for the same separately.
- This mix has a higher workability.
- This concrete due to its higher workability is also called as flowing concrete.
- The areas where there is thick reinforcement, self – consolidating concrete works best.

Types of concrete Continued

11. Pervious Concrete

- Pervious or permeable concrete are concrete that are designed such a way that it allows the water to pass through it. These types of concrete will have 15 to 20% voids of the volume of the concrete when they are designed.
- The pervious concrete is created by unique mixing process, performance, application methods etc. These are used in the construction of pavements and driveways where storm water issues persist. The storm water will pass through these pervious concrete pavements and reach the groundwater. Hence most of the drainage issues is solved.

Types of concrete Continued

12. Vacuum Concrete

- Concrete with water content more than required quantity is poured into the formwork. The excess water is then removed out with the help of a vacuum pump without waiting for the concrete to undergo setting.
- Hence the concrete structure or the platform will be ready to use earlier when compared with normal construction technique.
- These concretes will attain their 28 days compressive strength within a period of 10 days and the crushing strength of these structure is 25 % greater compared with the conventional concrete types.

Types of concrete Continued

12. Rapid Strength Concrete

- As the name implies these concretes will acquire strength with few hours after its manufacture. Hence the formwork removal is made easy and hence the building construction is covered fast.
- These have a wide spread application in the road repairs as they can be reused after few hours.

4. Advantages of 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 Continued

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 Continued

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 Continued

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.

5. Disadvantages of Concrete

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.


The End