BASIC CIVIL ENGINEERING

CIVIL ENGINEERING

- First basic branch of engineering
- Engineering and tasks undertaken for the civil population
- Direct fulfillment of human needs
- **Civil engineering** is a professional engineering discipline that deals with the design, construction, and maintenance of the physical and naturally built environment.
- The earliest practice of civil engineering may have commenced between 4000 and 2000 BC
- Also known as the **mother of all engineering**

SCOPE OF CIVIL ENGINEERING

- GEOTECHNICAL ENGINEERING
- STRUCTURAL ENGINEERING
- TRANSPORTATION ENGINEERING
- WATER RESOURCE ENGINEERING
- ENVIRONMENTAL ENGINEERING
- PUBLIC HEALTH ENGINEERING
- SURVEY ENGNEERING
- CONSTRUCTION AND MANAGEMENT ENGINEERING

GEOTECHNICAL ENGINEERING

- also called soil mechanics
- It is a discipline in which the study of soil , its behavior on the application of load and its use as an engineering material is done
- Properties and strength characteristics of different types of soil are studied
- Used in design of dams, different pile foundations, buildings, foundations etc
- is the branch of civil engineering concerned with the engineering behavior of earth materials

- A typical geotechnical engineering project begins with a review of project needs to define the required material properties
- Then follows a site investigation of soil, rock, fault distribution and bedrock properties on and below an area of interest to determine their engineering properties including how they will interact with, on or in a proposed construction
- Site investigations are needed to gain an understanding of the area in or on which the engineering will take place
- Investigations can include the assessment of the risk to humans, property and the environment from natural hazards such
as earthquakes, landslides, sinkholes, soil liquefaction, debris flows and rock falls.

Role of civil engineer

- Primary duty of a geotech engineer is safety and economy It comes by taking specialized courses e.g. Geology, Soil Mechanics, Foundation Engineering, Structural Engineering etc.
- He determines and designs the type of foundations, earthworks, and/or pavement sub grades required for the intended man-made structures to be built

Boston's Big Dig presented geotechnical challenges in an urban environment

STRUCTURAL ENGINEERING

- **Structural engineering** is a field of engineering dealing with the analysis and design of structures that support or resist loads
- Structural engineers are most commonly involved in the design of buildings and large non building structures
- Structural engineering theory is based upon applied physical laws and empiricalknowledge of the structural performance of different materials and geometries.

- Structural engineering design utilizes a number of simple structural elements to build complex structural systems
- Structural engineering dates back to 2700 B.C.E
- Structural building engineering is primarily driven by the creative manipulation of materials and forms and the underlying mathematical and scientific ideas to achieve an end which fulfills its functional requirements and is structurally safe when subjected to all the loads it could reasonably be expected to experience.

Role of civil engineer

- Structural engineers are responsible for engineering design and analysis.
- structural design and integrity of an entire system, such as a building.
- design the individual structural elements of a structure, for example the beams, columns, and floors of a building
- the role of a structural engineer today involves a significant understanding of both static and dynamic loading, and the structures that are available to resist them
- They are master builders with high degree of creativity

Achievements of structural engineering

Eiffel tower

International space station is also done by structural engineers

SURVEY ENGINEERING

- technique, profession, and science of accurately determining the terrestrial or three-dimensional position of points and the distances and angles between them
- It is required in the planning and execution of nearly every form of Construction.
- Its most familiar modern uses are in the fields of transport, building and construction, communications, mapping, and the definition of legal boundaries for land ownership.

- Classified as plane and geodetic surveying
- In geodetic earth’s curvature of earth’s surface s taken into account which is unlike plane surveying
- It involves
  - Distance measurement
  - Angle measurement
  - Leveling
  - Determining Position
- Includes topographical, cadastral ,city and mine surveys.
- Many instruments like compass, satellite positioning systems, such as Global_Positioning System, electronic meters , tachometer etc are used.

Role of civil engineer

- Prepare plans which are projections of any object on the horizontal plane
- whenever there are roads, railways, reservoir, dams, pipeline, transports, retaining walls, bridges or residential areas to be built, surveyors help determine the placement of structures.
- provide advice and data for *geographical information systems* (GIS), computer databases that contain data on land features and boundaries.
- have a thorough knowledge of algebra, basic calculus, geometry, and trigonometry. They must also know the laws that deal with surveys, property, and contract.

Land surveying

CONSRTUCTION AND MANGEMENT ENGINEERING

- Deals with analysis and design of substructures as well as superstructure of building
- Study of different construction materials in respect of their properties and construction techniques.
- Buildings are classified in to different types by the engineers as-

- Residential
- Commercial
- Recreational
- hospital
- Public
- Industrial
- Educational
- Storage
- Special purpose and non conventional buildings

- Management involves commerce and economics involved in construction and also labor force.
- Ten M’s of construction management are
  - Money
  - Materials
  - Machines
  - Manpower
  - Methodologies
  - Maintenance
  - Modernization
  - Monitoring
  - Motivations
  - Management of overall project

Role of civil engineer

- Construction engineers are problem solvers, they help create infrastructure that best meets the unique demands of its environment. They must be able to understand infrastructure life cycles and have the perspective to solve technical challenges with clarity and imagination. Therefore individuals should have a strong understanding of maths and science, but many other skills are required, including critical and analytical thinking, time management, people management and good communication skills.

Overview

WATER RESOURCE ENGINEERING

- Subject of tapping water either from its surface or sub surface resources
- Includes hydrology, irrigation , hydraulics, water supply and dams, sewage management
- Judicious use of water resources to meet the basic requirements of humans in included
- Preservation of water sources by different scientific techniques and principles
- Using water for power supply
- Distinct use of surface water and ground water

Role of civil engineer

- Developing guidelines regarding water supply and management to industrial contractors
- predicting all the hazards possible in the use of these resources and possible harms to environments
- Designing required techniques for the fulfillment of proposed action

Achievements

Dam

Sewage treatment

TRANSPORTATION ENGINEERING

- **Transportation engineering** or **transport engineering** is the application of technology and scientific principles to the planning, functional design, operation and management of facilities for any mode of transportation in order to provide for the safe, efficient, rapid, comfortable, convenient, economical, and environmentally compatible movement of people and goods.
- It is a sub-discipline of civil engineering and of industrial engineering. Transportation engineering is a major component of the civil engineering and mechanical engineering disciplines

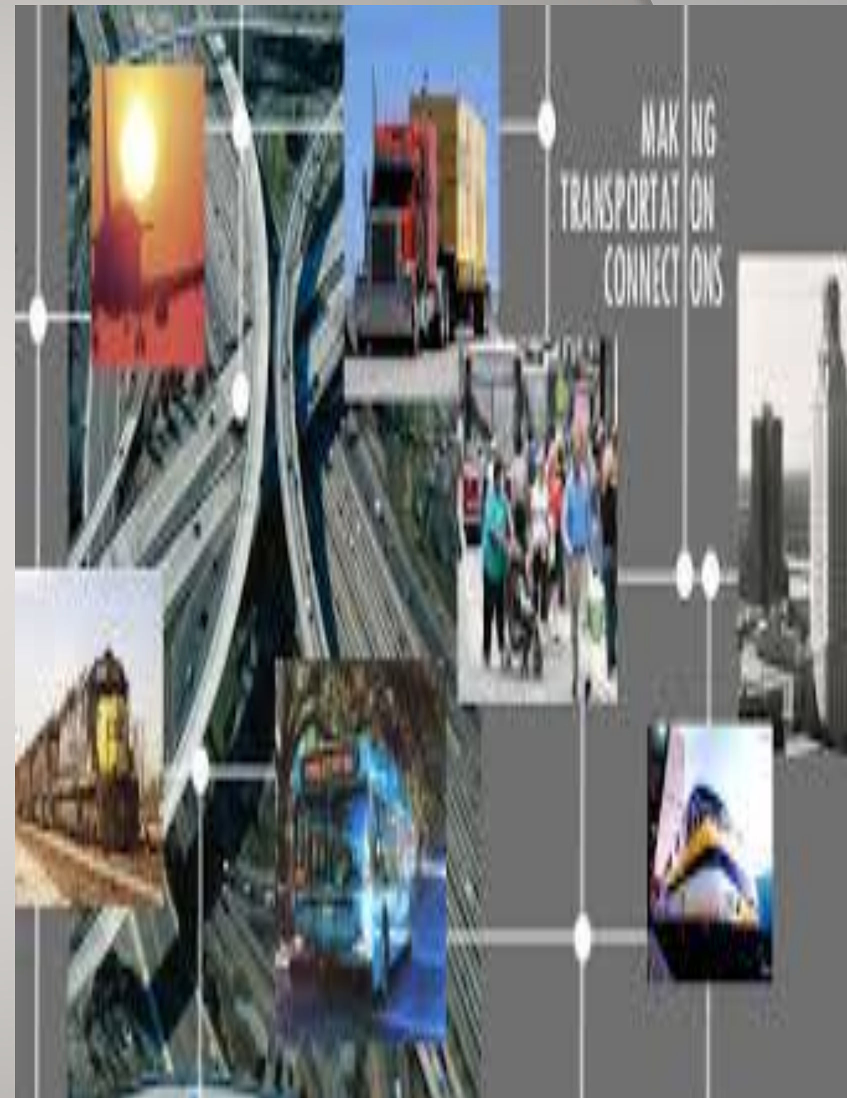
- The importance of transportation engineering within the civil and industrial engineering profession can be judged by the number of divisions in ASCE(American Society of Civil Engineers) that are directly related to transportation. There are six such divisions (Aerospace; Air Transportation; Highway; Pipeline; Waterway, Port, Coastal and Ocean; and Urban Transportation)

Role of civil engineer

- Transportation engineering, as practiced by civil engineers, primarily involves planning, design, construction, maintenance, and operation of transportation facilities. The facilities support air, highway, railroad, pipeline, water, and even space transportation.
- The planning aspects of transportation engineering relate to urban planning, and involve technical forecasting decisions and political factors.
- Technical forecasting of passenger travel usually involves an urban transportation planning model, requiring the estimation of trip generation (how many trips for what purpose), trip distribution (destination choice, where is the traveler going), mode choice (what mode is being taken), and route assignment (which streets or routes are being used)

- Before any planning occurs the Engineer must take what is known as an inventory of the area or if it is appropriate, the previous system in place. This inventory or database must include information on (1)population, (2)land use, (3)economic activity, (4)transportation facilities and services, (5)travel patterns and volumes, (6)laws and ordinances, (7)regional financial resources, (8)community values and expectations. These inventories help the engineer create business models to complete accurate forecasts of the future conditions of the systemReview .
- Operations and management involve traffic engineering , so that vehicles move smoothly on the road or track. Older techniques include signs , signals , markings , and tolling . Newer technologies involve intelligent transportation systems , including advanced traveler information systems (such as variable message signs), advanced traffic control systems (such as ramp meters), and vehicle infrastructure integration . Human factors are an aspect of transportation engineering, particularly concerning driver-vehicle interface and user interface of road signs, signals, and markings.

- The design aspects of transportation engineering include the sizing of transportation facilities (how many lanes or how much capacity the facility has), determining the materials and thickness used in pavement designing the geometry (vertical and horizontal alignment) of the roadway (or track).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PUBLIC HEALTH ENGINEERING

- the science and art of preventing disease, prolonging life and promoting health through organized efforts and informed choices of society, organizations, public and private, communities and individuals
- Promote concept of sustainable development
- Includes all the techniques requires to maintain sound public health
- water treatment, sanitation, material inspection whether it harms the public or not, impact of upcoming buildings on the surrounding public health etc

Role of civil engineer

- public health engineers tackle diverse challenges – from sustainable strategies to fire suppression systems, and from drainage in high-rise buildings to supplying ultra-pure water and piping specialist gases and fluids for healthcare, science and industry facilities.

Well-designed water and waste systems are essential to successful, healthy and sustainable buildings

ENVIRONMENT ENGINEERING

- **Environmental Engineering** is the integration of sciences and engineering principles to improve the natural environment, to provide healthy water, air, and land for human habitation and for other organisms, and to clean up pollution sites.
- Environmental engineering can also be described as a branch of applied science and technology that addresses the issue of energy preservation, production asset and control of waste from human and animal activities
- It involves waste water management and air Pollution control, recycling, waste disposal , radiation protection, industrial hygiene, environmental sustainability, and public health issues as well as a knowledge of environmental engineering law . It also includes studies on the environmental impact of proposed construction projects.

- Environmental engineers study the effect of technological advances on the environment. To do so, they conduct studies on hazardous-waste management to evaluate the significance of such hazards, advise on treatment and containment, and develop regulations to prevent mishaps. Environmental engineers also design municipal water supply and industrial wastewater treatment systems as well as address local and worldwide environmental issues such as the effects of acid rain, global warming, ozone depletion, water pollution and air pollution from automobile exhausts and industrial sources.
- environmental engineering programs follow either the department of civil engineering at engineering faculties. Environmental "civil" engineers focus on hydrology, water resources management, bioremediation, and water treatment plant design. Environmental "chemical" engineers, on the other hand, focus on environmental chemistry, advanced air and water treatment technologies and separation processes

Role of civil engineer

AN ENVIRONMENTAL ENGINEER CONCENTRATES ON

- Solid waste management
- Environmental impact assessment
- Water supply and management
- Air pollution management
- Environmental protection


Environmental Engineering

CONSTRUCTION MATERIALS IN CIVIL ENGINEERING

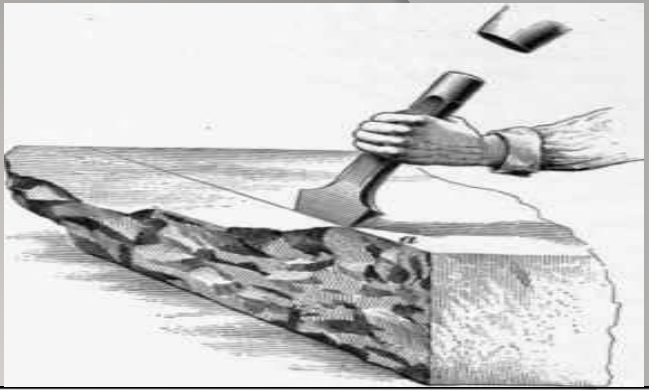
INTRODUCTION

Civil engineers are often responsible for specifying, designing and manufacturing the materials with which they build their structures. Studies in construction materials are intended to make structural, transportation and foundation engineers aware of the fundamental properties of the materials they use.

Building material is any material which is used for construction purposes. Many naturally occurring substances, such as clay, rocks, sand, and wood, even twigs and leaves, have been used to construct buildings. Traditional building materials – steel, concrete, and wood. Apart from naturally occurring materials, many man-made products are in use, some more and some less synthetic. In ideal environments, most common construction materials are very durable and can last indefinitely. However, design or construction deficiencies or lack of proper maintenance can result in less-than-ideal conditions under which construction materials will degrade. They provide the make-up of habitats and structures

VARIOUS MATERIALS USED

- STONE
- CLAY
- EARTH
- SOIL
- WOOD
- SAND
- BRICK
- LIME
- CEMENT
- METEL
- CERAMICS
- TIMBER
- SAND
- AGGREGATES
- MORTAR



Bricks	**Stones**
Manufactured from mud	Obtained from quarrying
Regular in shape with plain surfaces and edges	Usually irregular in size, shape.
Do not need dressing to make regular shape	Need dressing to make blocks of regular shape
Types depend on colour, strength, and similar qualities	Types depend on parent rock. (Igneous, sedimentary, metamorphic)
Comparatively less strength but self weight is small	High strength and also heavy weight.

Widely used for all types of building.	Used for compound walls, steps, stairs, bungalows.
Plastering and pointing for bricks is must.	Masonry can be left without plaster but good pointing is necessary.
Bricks are easily workable. Masonry construction is easy and faster. 	Masonry construction is tedious. Stones are very difficult to work 

STONES

Stones are building materials that have been used since a long time. They are strong, durable and cheap building materials, however they are not used very often nowadays as working on stones is difficult as they are heavy and good building stones are hard to procure.

CLASSIFICATION OF STONES

stones may be classified into :

- **Igneous rocks:** igneous rocks are formed from molten lava material erupted from the earths' interior. These are solid, massive and crystalline stone whiteout stratification.
- **Sedimentary rocks:** These are stratified rocks formed from the cementation of sand, clay, pebbles etc. strength of such rocks depends on the strength and degree of cementation.
- **Metamorphic Rocks:** metamorphic rocks are formed from metamorphic processes under the actions of heat, pressure, and/or their combined actions.

REQUIREMENTS OF A GOOD STONE

1. Stones should be hard, tough, compact, grained, durable with uniform texture
2. Stones should be water tight, heat resistant and should have good resistance to weathering and decomposition
3. Stones should be free from cracks, joint or other types of structural defects.
4. They should have sufficient strength o withstand the loads coming on it

5. Specific gravity should be 2.5

6. The appearance of a stone in relation to the design is of great importance from an architectural point of view. Light coloured stones are preferred over dark ones because even if they fade a little they will not show a striking difference and spoil the appearance.

AVANTAGES

1. available in nature, sometimes cheaply and readily available.
2. Water tight, hard, compact and tough with good strength and resistance to wear, tear and abrasion
3. Available in different colours and textures
4. Suitable and useful for walls, ornamental work, retaining walls especially in rural areas.

DISADVANTAGES

1. Very high self weight hence it is inconvenient to handle and not suitable for upper floors in walls or floorings.
2. Chiselling and dressing needed.
3. Sizes/shapes convenient for walls/flooring are to be found or prepared by breaking/ chiselling.
4. Less fire resistance and chemical reaction possible in contact with water, acids or alkalis.
5. Labour is costly and may not be easily available.

TILES

Tiles can be defined as thin slabs or bricks, which are burnt in kilns. The tiles are thinner than bricks. Tiles are classified into two types: common tiles: which are available in different shapes and sizes and used for paving, flooring and roofing, and encaustic tiles: which are used for decorative purposes in floors, walls, ceilings and roofs.

DIFFERENT TYPES OF TILES

The different types of tiles are .

- Drain tiles
- Flooring tiles
- Roofing tiles

- **Drain tiles:**

Drain tiles are prepared in such a way that they retain their porous texture after burning. Hence, they are suitable to be laid in waterlogged areas. They allow water to pass. They are also used to convey irrigation water. These drains may be circular, semicircular or segmental.

- **Flooring tiles :**

The flooring tiles should be hard enough to resist wear and tear. They are thin tiles of thickness 12–50 mm and can also be adopted for ceilings. Colouring substances can be added to the clay during preparation to impart colour to floor tiles. Low strength floor tiles can be used for fixing on the surface of walls. They are easier to lay as they are small in size and much lighter than mosaic and marbles. They do not require polishing. They are scratch, stain and damp proof in nature. Examples are wood, cork, cement concrete, ceramic and magnesium flooring tiles.

- **Roofing tiles:**

They act as a covering to the roof. They are made from clay. For example Corrugated tiles, Mangalore tiles, Encaustic tiles and pan tiles.

CHARACTERISTICS OF A GOOD TILE

- It should possess uniform colour.
- It should give an even and compact structure when seen on its broken surface.
- It should be sound, hard and durable.
- It should be regular in shape and size.
- It should fit in properly when placed in the proper position.
- It should be free from cracks, bends and warps.

PORCELAIN GLAZED TILES

The purpose for which glazing is done are:
. To improve the appearance.
. To produce decorative effects.
. To provide smooth surfacing.
. To protect the surface from the action of atmospheric agencies.
. To make the particles durable.

Timber

Timber denotes wood which is suitable for building or carpentry and for various engineering and other purposes. The word timber is derived from an old English word ‘timbrian’ which means to build. Timber or wood as a building material possesses a number of valuable properties, such as low heat conductivity, amenability to mechanical working, low bulk density and relatively high strength. Timber has been a very important structural member from time immemorial. It has been extensively used as beams, columns and plates in construction in a variety of situations, such as foundation, flooring, stairs and roofing. Even today its use as a building material is quite popular, though it has to face tough competition from structural steel and reinforced concrete.

QUALITIES OF GOOD TIMBER

. **Appearance:** A freshly cut surface of timber should exhibit a hard and shining appearance.
. **Colour:** The colour of the timber should be preferably dark. A light colour indicates low strength.
. **Hardness:** A good timber should be hard, i.e., it should offer resistance when it is being penetrated by another body. The chemical present in heartwood and the density of wood imparts hardness to timber.
. **Durability:** A good timber should be durable. It should be capable of resisting the action of fungi, insects, chemicals, physical agencies and mechanical agencies.
. **Strength:** A good timber should be strong for working as a structural member such as joist, beams and rafter. It should be capable of taking loads slowly or suddenly.

. Structure: The structure should be uniform and the medullary rays should be hard and compact. The annual rings should be regular and should be closely located.

. Mechanical wear: A good timber should not deteriorate easily due to mechanical wear or abrasion. This property is essential for places where timber would be subjected to traffic, like wooden floors and pavements.

. Toughness: A good timber should be tough. It should be capable of offering resistance to shocks due to vibrations.

. Elasticity: This is the property by which the timber returns to the original shape when load causing deformation is removed. This property is essential when timber is used for bows, carriage shaft, etc.

. Fire resistance: Timber is a bad conductor of heat. A dense wood offers good resistance to fire and it requires sufficient heat to cause a flame.

. Shape: A good timber should be capable of retaining the shape during conversion or seasoning.

. Smell: A good timber should have a sweet smell. . Sound: A good timber should give a clear ringing sound when struck.

. Weight: A timber with heavy weight is considered to be sound and strong.

. Working condition: Timber should be easily workable. It should not clog the teeth of saw and should be capable of being easily planed or made smooth.

Wood from freshly felled trees cannot be used in construction because it contains more moisture and is undesirable in many accounts. The water is to be removed before the timber can be used for any engineering purpose. This process of drying out the timber is known as seasoning of timber and the moisture should be extracted during seasoning under controlled conditions at a uniform rate from all parts of the timber. The remaining moisture, which cannot be extracted, should be uniformly distributed throughout the mass. The major objectives of seasoning are as follows:

. To reduce the weight of the timber.

. To increase the strength, stiffness and durability of the timber.

. To make the timber easily workable.

. To reduce the tendency of timber to crack, shrink and warp.

. To allow the timber to burn readily if used as a fuel.

. To make the timber fit for receiving treatment of paints, varnishes, etc.

. To make the timber safe from the attack of fungi and insects.

seasoning can be achieved using artificial and natural methods .

BRICKS

COMPOSITION OF BRICK

- AIUMINA:A good brick earth should contain 20 to 30 percent of alumina.
- SILICA: It forms 50-60% of good brick.
- LIME:A good brick should contain lime not exceeding 5%
- OXIDES OF IRON:A small quantity of the oxide of iron to the extent of 5-6% is desirable in good brick earth.

- MAGNESIA: Presence of it in small quantity imparts a yellowish tint to bricks and decreases the shrinkage.

  But if in excess it causes the decay of bricks.

MANUFACTURE OF BRICKS

It is carried out in various stages as follows:

- SELECTION AND PREPARATION OF CLAY

As a practice suitable deposits of clay are first located and thoroughly tested for the quality of bricks making.

- SHAPING AND MOULDING OF UNITS

Here the process of making rectangular shaped brick units from properly tempered clay.

- DRYING

The drying of bricks is necessary, firstly to make them strong enough for rough handling during subsequent stages and secondly to save fuel during burning. For drying the bricks are laid longitudinally in stocks of bricks with width equal to two bricks. Drying of bricks is achieved by either natural or artificial methods.

- BURNING

Burning of dried bricks is essential to develop the desired engineering properties, like hardness, durability and resistance to decay. Three chemical changes are known to take place in the brick earth during burning, namely dehydration, oxidation and verification.

PLAIN CEMENT CONCRETE

PCC

COMPOSITION OF PCC

- CHEMICAL COMPOSITION

  1)Lime 2)silica

  3)Alumina 4)iron oxide

  5)Sulphate

- COMPOUND COMPOSITION

  1)Alite 2)Belite

  3)Chalk or gypsum 4)aluminate

  5)ferrite

  By manipulating the fineness and the relative of these chemical compounds in Portland cement,

  A cement with different characteristics can be obtained.

MANUFACTURE OF PCC

- Make mixture of rocks and soils rich in clay minerals and rich in calcium(lime stone and chalk).

- The rocks and soils are first ground up into particles finer size than 75 micrometer.

- It is now slowly heated in a rotating kiln to T=1500 degree Celsius.

- That material is now allowed to cool.

- 5% gypsum or chalk in the form of calcium sulphate hydrate is added to the klinkers particles.

- The mixture is then ground down to particles sizes in range of
- 2-80 micrometre resulting In PCC.

INTRODUCTION

- **Concrete** is a composite material composed mainly of water, aggregate, and cement. Often, additives and reinforcements (such as rebar) are included in the mixture to achieve the desired physical properties of the finished material. When these ingredients are mixed together, they form a fluid mass that is easily molded into shape. Over time, the cement forms a hard matrix which binds the rest of the ingredients together into a durable stone-like material with many uses.

- Famous concrete structures include the Hoover Dam, the Panama Canal and the Roman Pantheon. The earliest large-scale users of concrete technology were the ancient Romans, and concrete was widely used in the Roman Empire. The Colosseum in Rome was built largely of concrete, and the concrete dome of the Pantheon is the world's largest unreinforced concrete dome.[3]
- After the Roman Empire collapsed, use of concrete became rare until the technology was re-pioneered in the mid-18th century. Today, concrete is the most widely used man-made material (measured by tonnage).

Outer view of the Roman Pantheon, still the largest unreinforced solid concrete dome.

Impact of modern concrete use

- Concrete is widely used for making architectural structures, foundations, brick/block walls, pavements, bridges/overpasses, highways, runways, parking structures, dams, pools/reservoirs, pipes, footings for gates, fences and poles and even boats. Concrete is used in large quantities almost everywhere mankind has a need for infrastructure.
- The amount of concrete used worldwide, ton for ton, is twice that of steel, wood, plastics, and aluminum combined. Concrete's use in the modern world is exceeded only by that of naturally occurring water.
- Concrete is also the basis of a large commercial industry. Globally, the ready-mix concrete industry, the largest segment of the concrete market, is projected to exceed $100 billion in revenue by 2015.

Concrete recycling

- Concrete recycling is an increasingly common method of disposing of concrete structures. Concrete debris was once routinely shipped to landfills for disposal, but recycling is increasing due to improved environmental awareness, governmental laws and economic benefits.
- Concrete, which must be free of trash, wood, paper and other such materials, is collected from demolition sites and put through a crushing machine, often along with asphalt, bricks and rocks.
- Reinforced concrete contains rebar and other metallic reinforcements, which are removed with magnets and recycled elsewhere. The remaining aggregate chunks are sorted by size. Larger chunks may go through the crusher again.

Composition of concrete

- "Aggregate" consists of large chunks of material in a concrete mix, generally a coarse gravel or crushed rocks such as limestone, or granite, along with finer materials such as sand.
- "Cement", most commonly Portland cement is associated with the general term "concrete." A range of materials can be used as the cement in concrete. One of the most familiar of these alternative cements is asphalt. Other cementitious materials such as fly ash and slag cement, are sometimes added to Portland cement and become a part of the binder for the aggregate.

- Water is then mixed with this dry composite, which produces a semi-liquid that workers can shape (typically by pouring it into a form). The concrete solidifies and hardens through a chemical process called hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone-like material.
- "Chemical admixtures" are added to achieve varied properties. These ingredients may speed or slow down the rate at which the concrete hardens, and impart many other useful properties including increased tensile strength and water resistance.

- "Reinforcements" are often added to concrete. Concrete can be formulated with high compressive strength, but always has lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension (often steel).
- "Mineral admixtures" are becoming more popular in recent decades. The use of recycled materials as concrete ingredients has been gaining popularity because of increasingly stringent environmental legislation, and the discovery that such materials often have complementary and valuable properties. The most conspicuous of these are fly ash, a by-product of coal-fired power plants, and silica fume, a byproduct of industrial electric arc furnaces.
- The *mix design* depends on the type of structure being built, how the concrete is mixed and delivered, and how it is placed to form the structure.

workability

- *Workability* is the ability of a fresh (plastic) concrete mix to fill the form/mold properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, aggregate (shape and size distribution), cementitious content and age (level of hydration) and can be modified by adding chemical admixtures, like superplasticizer. Raising the water content or adding chemical admixtures increases concrete workability. Excessive water leads to increased bleeding (surface water) and/or segregation of aggregates (when the cement and aggregates start to separate), with the resulting concrete having reduced quality.

curing

- In all but the least critical applications, care must be taken to properly *cure* concrete, to achieve best strength and hardness. This happens after the concrete has been placed. Cement requires a moist, controlled environment to gain strength and harden fully. The cement paste hardens over time, initially setting and becoming rigid though very weak and gaining in strength in the weeks following. In around 4 weeks, typically over 90% of the final strength is reached, though strengthening may continue for decades. The conversion of calcium hydroxide in the concrete into calcium carbonate from absorption of CO_2 over several decades further strengthens the concrete and makes it more resistant to damage. However, this reaction, called carbonation, lowers the pH of the cement pore solution and can cause the reinforcement bars to corrode.

properties

- Concrete has relatively high compressive strength, but much lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension (often steel). The elasticity of concrete is relatively constant at low stress levels but starts decreasing at higher stress levels as matrix cracking develops. Concrete has a very low coefficient of thermal expansion and shrinks as it matures. All concrete structures crack to some extent, due to shrinkage and tension. Concrete that is subjected to long-duration forces is prone to creep.
- Tests can be performed to ensure that the properties of concrete correspond to specifications for the application.
- Compression testing of a concrete cylinder

Reinforced Cement Concrete

MANUFACTURE OF RCC

Concrete is a good resisting compression but weak in resisting tension. Hence reinforcement is provided. Best reinforce is steel.

Hair cracks in concrete are unavoidable.Reinfor-

Cements are usually in the form of mild steel.

A cage of reinforcements is prepared as per the design requirements, kept in the form of work and then green concrete is powdered.

After the concrete hardness, the form work is removed. The composite material of steel and

concrete now is called RCC.

KEY CHARACTERISTICS

- Three physical characteristics give reinforced concrete its special properties:
- The coefficient of thermal expansion of concrete is similar to that of steel, eliminating large internal stresses due to differences in thermal expansion or contraction.
- When the cement paste within the concrete hardens, this conforms to the surface details of the steel, permitting any stress to be transmitted efficiently between the different materials. Usually steel bars are roughened or corrugated to further improve the bond or cohesion between the concrete and steel.

- The alkaline chemical environment provided by the alkali reserve (KOH, NaOH) and the portlandite (calcium hydroxide) contained in the hardened cement paste causes a passivating film to form on the surface of the steel, making it much more resistant to corrosion than it would be in neutral or acidic conditions. When the cement paste is exposed to the air and meteoric water reacts with the atmospheric CO_2, portlandite and the Calcium Silicate Hydrate (CSH) of the hardened cement paste become progressively carbonated and the high pH gradually decreases from 13.5 – 12.5 to 8.5, the pH of water in equilibrium with calcite (calcium carbonate) and the steel is no longer passivated.

- A heavy reinforced concrete column, seen before and after the concrete has been cast in place around the rebar cage.

BEHAVIOR OF RCC

- Concrete is a mixture of coarse (stone or brick chips) and fine (generally sand or crushed stone) aggregates with a paste of binder material (usually Portland cement) and water. When cement is mixed with a small amount of water, it hydrates to form microscopic opaque crystal lattices encapsulating and locking the aggregate into a rigid structure.
- If a material with high strength in tension, such as steel, is placed in concrete, then the composite material, reinforced concrete, resists not only compression but also bending and other direct tensile actions. A reinforced concrete section where the concrete resists the compression and steel resists the tension can be made into almost any shape and size for the construction industry.

ANCHORAGE

- Because the actual bond stress varies along the length of a bar anchored in a zone of tension, current international codes of specifications use the concept of development length rather than bond stress. The main requirement for safety against bond failure is to provide a sufficient extension of the length of the bar beyond the point where the steel is required to develop its yield stress and this length must be at least equal to its development length.

ANTI CORROSION MEASURES

- In wet and cold climates, reinforced concrete for roads, bridges, parking structures and other structures that may be exposed to deicing salt may benefit from use of corrosion-resistant reinforcement such as uncoated, low carbon/chromium (micro composite), epoxy-coated, hot dip galvanised or stainless steel rebar. Good design and a well-chosen concrete mix will provide additional protection for many applications. Uncoated, low carbon/chromium rebar looks similar to standard carbon steel rebar due to its lack of a coating; its highly corrosion-resistant features are inherent in the steel microstructure. It can be identified by the unique

PHYSICAL PROPERTIES

1.Density:

Density is the dry mass per unit volume of a substance under absolute compact conditions

$$\rho = v/m$$

In the measurement of density of a material the material is first ground into powder the powder is dried to a fixed mass solid volume is measured and finally the density is calculated by the formula

2.Solidity:

Solidity refer to the degree as to how the volume of a material is packed with solid substances . It is defined as the ratio of solid volume to total volume

$$D = V/V_o * 100\%$$

3. Porosity:

Porosity is the percentage of pores volume to the total volume with the volume of the substance.

P=Vo-V/Vo*100%

the relationship between solidity and porosity :

D+P=1

4.Water absorption:

.Specific absorption of quality:

Percentage of absorbed water to the dry mass

.Specific absorption of volume :

Percentage of absorbed volume of water to the material`s natural volume.

For normal materials higher the porosity stronger is the water absorption

EX: WAQ for granite 0.2%-0.7%, concrete 2%-3%, brick 8%-20%

5. impermeability:

Ability of the material to resist the water pressure or infiltration of any other liquids.

Smaller the porosity stronger is the impermeability .

6.Thermal conductivity:

Property of materials that indicates its ability to conduct heat .

The thermal conductivity is bigger for metallic materials than non-metallic materials.

Tiny and closed pores indicates that thermal conductivity is low ,big and open pores indicates that thermal conductivity is high.

CHEMICAL PROPERTIES

1.Chemical composition:

The chemical composition refers to the chemical constituents .

Various chemical compositions result in different properties. For example : with the increase of carbon content the strength, hardness and toughness of carbon steel will change.

2.Mineral composition:

Minerals are monomers and compounds with certain chemical components and structures. The mineral compositions are the key factors for the properties of some building materials(such as natural stone). For example: cement reveals different characteristics because of high levels of clinker mineral.

3.CORROSION RESISTANCE:

Corrosion is the gradual degradation of a metal by a chemical, often electrochemical, reaction with the surrounding environment.

The corrosion resistance of stainless steel is attributed to the thin passive film that forms spontaneously on its surface in oxidizing environments if the steel has a minimum chromium content of approximately 10.5%.

It is well known that increasing the chromium content and adding molybdenum and nitrogen as alloying elements increases stainless steels' resistance to corrosion.

There are a number of measures that can be taken in order to avoid pitting and crevice corrosion. These include:

- Selecting a highly alloyed stainless steel grade
- Lowering the chloride content of the corrosive environment
- Increasing the pH
- Decrease the content of oxygen and other oxidizing species from the environment, or eliminate them altogether
- Use a design that avoids the need for tight crevices and which discourages stagnant conditions and the formation of deposits
- Employ good fabrication practices that produce smooth and clean surfaces, and ensure that weld oxides are removed

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MECHANICAL PROPERTIES

1.Strength of materials:

Strength is the greatest stress that a substance can bare under external forces without destruction. According to different forms of external forces, the strength includes tensile strength, compressive strength, bend strength, shear strength and others. These kinds of strength are all determined by static test, known as the static strength

2.Elasticity:

The elasticity is the property of a substance to deform with external forces and return to its original shape when the stress is removed. The deformation fully

capable of restoration is called elastic deformation. The elastic modulus of low-carbon steel

is E=2.1x1O5

3. Plasticity:

The plasticity describes the deformation of a material undergoing non-reversible changes of shape in response to external forces. This non-reversible deformation is called plastic deformation. Under external forces, some materials will have elastic deformation and plastic deformation at the same time, but elastic deformation will disappear and plastic deformation still maintains when the stress is removed, such as concrete

4. Brittleness:

Brittleness describes the property of a material that fractures when subjected to stress but has a little tendency to deform before rupture . Most of inorganic non-metallic materials are brittle materials.

5. Texture:

Texture is a comprehensive impression given by the appearance of a material, such **as roughness, unevenness, grain, patterns, and colour differences. For** example, the rugged surface of concrete or brick appears relatively massy and rough; and the surface of glass or aluminium alloy is smooth and delicate .Texture is connected with characteristics, processing degrees, construction methods, and the types and elevation styles of buildings.

Building Material Testing

In today's global markets and increasing emphasis on quality, need for laboratory data has increased many fold and top of that accuracy and reliability of data is an another concern.

1.Rebound Hammer Test:

Rebound Hammer Test is done to find out the compressive strength of concrete by using Rebound Hammer

The rebound of an elastic mass depends on the hardness of the surface against which its mass strikes. When the plunger of the rebound hammer is pressed against the surface of the concrete, the pring-controlled mass rebounds and the extent of such a rebound depends upon the surface hardness of the concrete. The surface hardness and therefore the rebound is taken to be related to the compressive strength of the concrete. The rebound value is read from a graduated scale and is designated as the rebound number or rebound index.

2.Cement Testing:

Chemical Analysis

Chemical analysis of hardened concrete can provide a wealth of information about the mix constituents and possible causes of deterioration. Standard methods can be used to find the cement content and original water/cement ratio, but many other properties can also be established; Cement Content and Aggregate Cement Ratio, Cement Content and Pulverized fuel ash/fly ash (pfa) content, Cement Content and Slag content, Water/Cement Ratio, Aggregate Grading, Determination of the presence of High-Alumina Cement (HAC)

Compressive Strength

The most common strength test, compressive strength, is carried out on a 50 mm (2-inch) cement mortar test specimen. The test specimen is subjected to a compressive load (usually from a hydraulic machine) until failure.

Fineness

The fineness of cement has an important bearing on the rate of hydration and hence on the rate of gain of strength and also on the rate of evolution of heat. Greater fineness increases the surface available for hydration, causing greater early strength and more rapid generation of heat. Cement fineness play a major role in controlling concrete properties. Fineness of cement affects the place ability, workability, and water content of a concrete mixture much like the amount of cement used in concrete does.

Heat of Hydration

When cement is mixed with water, heat is liberated. This heat is called the heat of hydration, the result of the exothermic chemical reaction between cement and water. The heat generated by the cement’s hydration raises the temperature of concrete.

Setting Time

Initial setting time is the time that elapsed from the instance of adding water until the paste ceases to behave as fluid or plastic. Whereas final setting time referred to the required for the cement paste to reach certain state of hardness to sustain some load.

3. Aggregate Testing:

Aggregate Testing solutions offered are achieved through a wide range of test options. These include 10% Fine Value which is similar to one used in determining aggregate crushing value. Here, the possible variation is that instead of using standard force comprising 400kn, the force from which 10% of fines is produced is noted as Ten Percent Fines Value. For arriving at this figure, a number of tests need to be done and graph interface used for establishing exact figure.

Chloride Content –

The process of measuring total chloride content in aggregate is done for assessing if aggregate's contribution in total chloride content present in concrete mix is low enough for preventing early onset of corrosion in any of the steel reinforcement embedded

Clay Lumps and friable Particles –

This test is undertaken for determining percentage of clay lumps as well as presence of friable particles in aggregate

The definition of clay lumps in aggregate is as any particles/aggregation of particles that
- In event of being thoroughly wet can be distorted in event of squeezing between thumb as well as forefinger
- Will disintegrate in form of individual grain sizes in case of being immersed in water for short time period

Friable particles are defined as –
- Particles that vary from basic aggregate particles where these may either readily disintegrate under normal handling as well as mixing pressures which are put on them in involved construction procedures
- Particles that break down after being used into work

Los Angle Abrasion –

This abrasion test is used as a common test for indicating aggregate toughness as well as abrasion characteristics The aggregate abrasion characteristics play an important past as constituent aggregate in HMA should produce a high quality HMA by –

Resist crushing

Degradation

Disintegration

Brick Testing

Brick Testing solutions offered can be done through wide range of testing procedures.

Permanent Linear Change –

The test supports determination of permanent linear change of refractory brick in event of getting heated under prescribed conditions

This helps in measuring potential shrinking when used in load bearing walls

Abrasion Resistance –

This test done through controlling whole series of factors and need to be complemented through proper construction practices like –

- Placing
- Compaction
- Finishing
- Curing

For this test, other things that are required include –

- High abrasion resistance
- Special aggregates/dry shake

These can be added to surface or as topping

Creep Test –

This test is used for measuring creep through –
- Subjecting material to constant stress
- Deforming it at constant rate

Creep in compression (CIC) denotes percent of shrinkage present in refractory test piece under constant load as well as exposure to constant high temperatures over long time periods

Cold Crushing Strength –

Cold Crushing Strength test supports determination of strength of brick

The test allows in understanding how much load refractory can bear in cold conditions

With the concept coming from testing CCS of refractory material coming from metallurgy, it is so because any refractory brick would fail because of load put on it in cold condition

PRE STRESSED CONCRETE

Prestressed concrete is a method for overcoming concrete's natural weakness in tension. It can be used to produce beams, floors or bridges with a longer span than is practical with ordinary reinforced concrete

Prestressing tendons are used to provide a clamping load which produces a compressive stress that balances the tensile stress that the concrete compression member would otherwise experience due to a bending load. Traditional reinforced concrete is based on the use of steel reinforcement bars, rebar's, inside poured concrete. Prestressing can be accomplished in three ways: pre-tensioned concrete, and bonded or unbounded post-tensioned concrete.

Pre-tensioned concrete

Pre-tensioned concrete is cast around steel tendons, cables or bars while they are under tension. The concrete bonds to the tendons as it cures, and when the tension is released it is transferred to the concrete as compression by static friction. Tension subsequently imposed on the concrete is transferred directly to the tendons.

Pre-tensioning requires strong, stable anchoring points between which the tendons are to be stretched. Thus, most pre-tensioned concrete elements are prefabricated and transported to the construction site, which may limit their size. Pre-tensioned elements may be incorporated into beams, balconies, lintels, floor slabs or piles. An innovative bridge design pre-stressing is the stressed ribbon bridge.

Applications:

Prestressed concrete is the main material for floors in high-rise_buildings_and the entire containment vessels of nuclear reactors.

Unbounded post-tensioning tendons are commonly used in parking garages as barrier cable Also, due to its ability to be stressed and then de-stressed, it can be used to temporarily repair a damaged building by holding up a damaged wall or floor until permanent repairs can be made.

Advantages:

- crack control and lower construction costs;
- thinner slabs especially important in high rise buildings in which floor thickness savings can translate into additional floors for the same (or lower) cost and fewer joints, since the distance that can be spanned by post-tensioned slabs exceeds that of reinforced constructions with the same thickness.
- Increasing span lengths increases the usable unencumbered floor space in buildings;
- diminishing the number of joints leads to lower maintenance costs over the design life of a building, since joints are the major focus of weakness in concrete buildings.

COMPOSITE MATERIALS-Modern Materials of Construction

Composite materials (also called **composition materials** or shortened to **composites**) are materials made from two or more constituent materials with significantly different physical or chemical properties that when combined, produce a material with characteristics different from the individual components. The individual components remain separate and distinct within the finished structure. The new material may be preferred for many reasons: common examples include materials which are stronger, lighter or less expensive when compared to traditional materials.

Typical engineered composite materials include:

- Composite building materials such as cements concrete
- Reinforced plastics such as fiber-reinforced polymer
- Metal Composites
- Ceramic Composites (composite ceramic and metal matrices)

Composite materials are generally used for buildings bridges and structures such as boat hulls, swimming pool panels, race car bodies, shower stalls, bathtubs storage tanks, imitation granite and cultured marble sinks and counter tops. The most advanced examples perform routinely on spacecraft and aircraft in demanding environments.

SMART MATERIALS-Modern Materials of Construction

Smart materials are designed materials that have one or more properties that can be significantly changed in a controlled fashion by external stimuli, such as stress, temperature moisture, pH, electric or magnetic fields.

Types

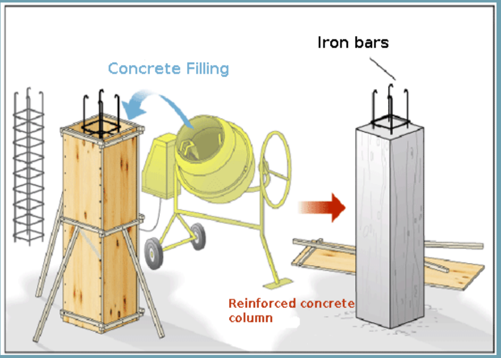
There are a number of types of smart material, some of which are already common. Some examples are as following:

- Piezoelectric materials: are materials that produce a voltage when stress is applied. Since this effect also applies in the reverse manner, a voltage across the sample will produce stress within the sample. Suitably designed structures made from these materials can therefore be made that bend, expand or contract when a voltage is applied.
- Shape-memory alloys and shape-memory polymers: are materials in which large deformation can be induced and recovered through temperature changes or stress changes (pseudo elasticity). The shape memory effect results due to respectively martens tic phase change and induced elasticity at higher temperatures.

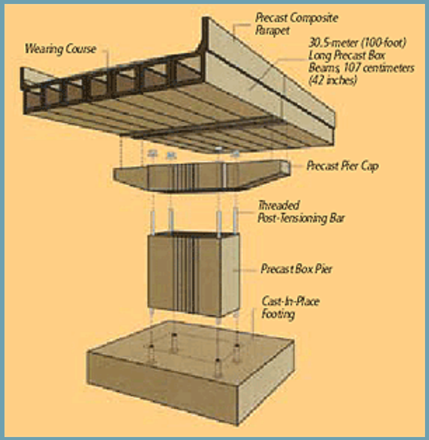
- Magnetostrictive materials: exhibit change in shape under the influence of magnetic field and also exhibit change in their magnetization under the influence of mechanical stress.
- Magnetic shape memory alloys: are materials that change their shape in response to a significant change in the magnetic field.
- pH-sensitive polymers: are materials that change in volume when the pH of the surrounding medium changes.
- Temperature-responsive polymers: are materials which undergo changes upon temperature.
- Halo chromic materials: are commonly used materials that change their color as a result of changing acidity. One suggested application is for paints that can change color to indicate corrosion in the metal underneath them.
- Chromogenic systems :change color in response to electrical, optical or thermal changes. These include electro chromic materials, which change their color or opacity on the application of a voltage (e.g., liquid crystal displays), thermo chromic materials change in color depending on their temperature, and photo chromic materials, which change color in response to light—for example, light sensitive sunglasses that darken when exposed to bright sunlight.

Smart materials have properties that react to changes in their environment. This means that one of their properties can be changed by an external condition, such as temperature, light, pressure or electricity. This change is reversible and can be repeated many times. There are a wide range of different smart materials. Each offer different properties that can be changed. Some materials are very good indeed and cover a huge range of the scales.

P.C.C.	R.C.C.
High compressive strength but less tensile strength.	High compressive as well as tensile strength.
Consists of cementing material, fine and coarse aggregates only.	Consists of binding material, fine and coarse aggregates and also reinforcement in the form of wires/bars.
Used for small footings, garden pavements where tension is not developed.	Used for building retaining walls, dams, roads, machine foundations, building foundations, staircases, beams, etc
Usually it is cast-in-situ only.	Can be cast-in-situ or prefabricated.


Iron bars
Concrete Filling
Reinforced concrete column

Precast concrete	Pre-stressed concrete
Concrete of desired proportion is mixed, cast and cured at any convenient place like workshop shed.	Pre-tensioning or post-tensioning of wires before or after setting of concrete.
It may be plain or reinforced bars for plain structural steel.	It has to be only reinforced with specially manufactured high tensile strength steel wires.
Used as blocks, slabs or any other member for small structures.	Used for heavily loaded members of bridges, large span beams.


Precast Composite Parapet
Wearing Course
30.5-meter (100-foot) Long Precast Box Beams, 107 centimeters (42 inches)
Precast Pier Cap
Threaded Post-Tensioning Bar
Precast Box Pier
Cast-In-Place Footing

Fine Aggregates	Coarse Aggregates
Has grain size less than 5mm.	Grain size is greater than 5mm may be up to 15cm.
Natural sand from river is best fine aggregates.	Manufactured by crushing stones in quarry.
Mainly acts as filler to fill up spaces and voids.	It is necessary for giving strength to concrete.
Moisture content is bulking are very important factors.	Crushing & impact strength are important parameters.

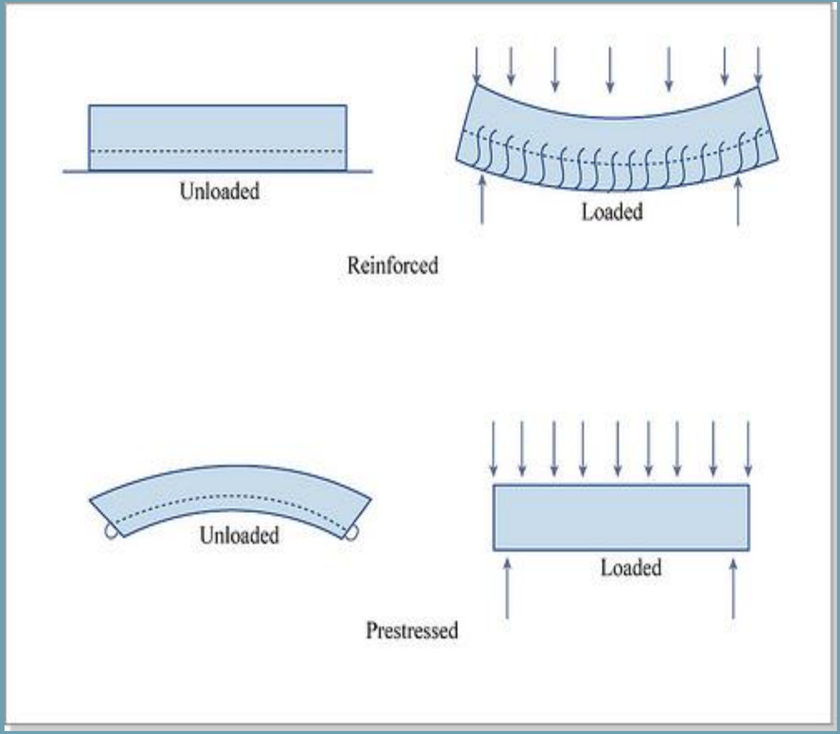
Light weight concretes	Heavy weight concretes
Self weight is small as density is low i.e. 9 to 21 kN/m3	Heavy self weight due to higher density i.e. 32 to 44 kN/m3
Coarse aggregate not used.	Even coarse aggregates are used.
Usually these are precast low density hence suitable for mass construction to be done quickly.	Usually cast-in-situ hence takes lot of time for construction.

These are latest types used for multi-storayed framed or load bearing structures. 	Conventional concrete used for making roads, dams, buildings. 

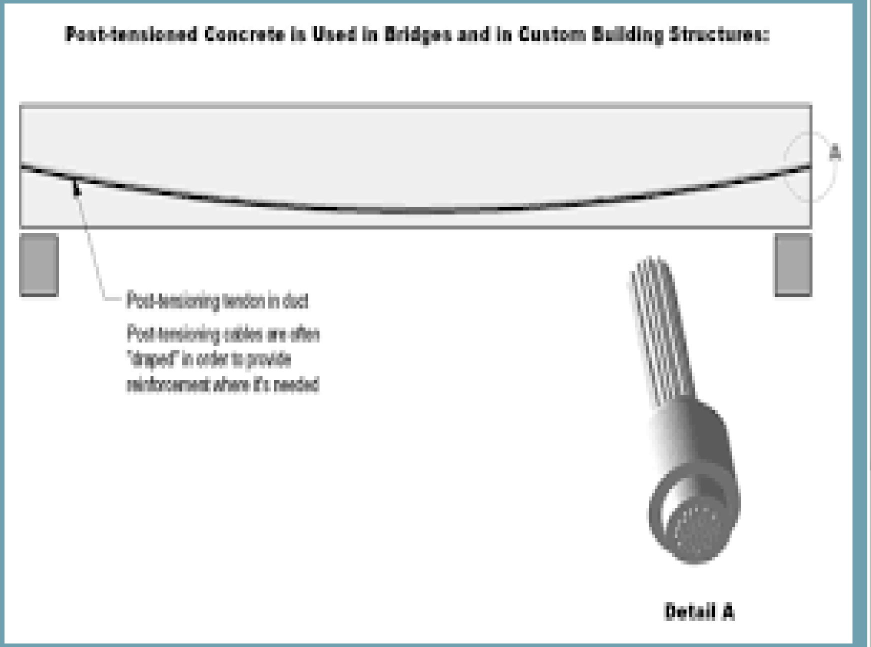
Pre-cast concrete	Cast-in-situ concrete
Concrete is placed at convenient site like sheds or factory and cured.	Concrete is mixed, poured, compacted at work site only.
Modular construction becomes very easy and quick.	No modules are possible.
Better control on strengths due to controlled operations.	Such control on site is very difficult due to poor workmanship.
Useful for huge structures within short time.	Useful for comparatively smaller buildings.

Pre- tensioned concrete	Post-tensioned concrete
Tension is applied on the cable before concrete hardens	Pull is applied on the cable after the concrete hardens.
Cable is embedded directly in the concrete.	Metal sheath or pipe forms intermediate between bars and concrete.
Reinforcement with per-stress set up by pulling retains the stress when concrete hardens.	Proper anchoring from both ends is required to maintain the pre-strength.
Concrete gets compressive stress during hardening.	Concrete has compressive stress after setting up the pre-stress in the reinforcement.

Pre-tensioned concrete



Post-tensioned concrete



References

- Courtesy Online Open Source material related to the topic concerned.