UNIT-I - INTRODUCTION :- Enviromental friendly and cost effective building Technologies, - Requirements for building of different climatic regions - Traditional building methods and vernacular architecture - Green building ratings - IGBC and LEED manuals - Mandatory requirements.

UNIT-II - ALTERNATIVE MASONARY UNITS :- Characteristics of building blocks for walls - stones and laterite blocks - Bricks and hollow clay bricks - concrete blocks - stabilized blocks : mud blocks - steam cured blocks Pal-G-blocks - Stone masonary block.

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UNIT-5:- STRUCTURAL MASONARY UNITS:-

Compressive length of masonary elements - factors affecting compressive strength - strength of units - prism's wallet's and walls - Effect of brick work bond on strength. Bond strength of masonary : flexure and shear - Elastic Properties of masonary materials and masonary.

UNIT-I

Environmental friendly & cost effective building Technologies:-

Eco-friendly Technology:- Eco-friendly technologies involved making use of alternative Energy source which is abundant to generate renewable Energy, reducing the amount of resource which is deleted used through the conventional like fossil-fuel.

-> The Eco-friendly building materials represents a response from the building sector intended to reduce environmental cost of making & using buildings.

-> In construction industry, selection of materials during construction is important, so there is a need to select more eco-friendly building materials used in construction.

-> To Analyze new methods of work and manufacture that are less harmful to environment

-> Some eco-friendly Indian building materials are

* fly ash lime gypsum bricks
* Bamboo mat corrugated sheets
* fly ash cellular concrete
* clay - fly ash burnt bricks.

Cost effective construction Technologies:-

following properties reduces cost of construction:

(1) Locally available materials

(2) Improved SKILLS & Technology

factors affecting construction cost:- The factors are

(1) **Building cost:-** The building construction cost can be devided into 2 parts namely;

-> Building material cost

-> Labour cost.

(2) size :- The smaller ... the more it will cost per square foot.

(3) Type :- Different types of project have different levels of complexity and detail.

These were the factors affecting the budget of making any structure but we are here to know about more construction techniques and materials which helps us in reducing the cost of structure.

construction techniques adopted :- 1) foundation
2) wall
3) Lentel
4) Roof.

(1) foundation :-

→ The foundation cost comes to about 10-15% of total building.

→ so it is recommended to adopt a foundation depth of 0.6 for gravely, red soils etc.

→ and adopt arch foundation in ordinary soil for effective reduction in construction costs up to 40%.

→ In case of black cotton soils & other soft soils, adopt under ream pile foundation which saves about 20-25% in cos

* Arch foundations requires less digging, less material, but more labour to work.

Arch found

(2) wall :-

→ wall thickness of 6-9" is recommended for adoptions in the construction wall.

→ Suggest to adopt burnt brecks which are immersed in wat for 24 hours

→ use Rat-trap bond wall & Concrete block wall.

Rat-trap bond wall :- It is a cavity wall construction and leads to reduction in the quantity of bricks required for masonary work.

→ by adopting this method it is possible to reduce in material cost of bricks by 25% and about 10-15% in masonary cost.

(3) Lintel :-

→ R.C.C. Lentels which are costly can be replaced by brick arches for small spans and save construction cost upto 30-40%.

→

(4) Roof :-

→ Normaly 5" thick R.C.C. slab is used for roofing of residential buildings.

→ by adopting filler slabs & precast elements the construction cost of roofing can be reduced by about 20-25%

* filler slabs :- They are normal R.C.C. slabs, where bottom half (tension) concrete portions are replaced by filler materials such as bricks, tiles, cellular concrete blocks etc.

Requirements for buildings of different climatic Regions :-

The requirements for buildings of diffent climatic regions are (1) Min. Temperature mean

(2) Temperature mean

(3) Max. Temperature mean

(4) Min. relative humidity

(5) Max. Relative humidity

(6) wind speed & sun hours in monthly & annually

Different climatic Regions in India :-

In India, Bansal & Minke, 1988 had carried out detailed studies and reported that India can be

devided into 6 climate zones. Namely
(i) Hot & dry (ii) warm & humid (iii) moderate (iv) cold & cloudy (v) cold & sunny (vi) composite

Buildings must be designed for future climate conditions wetter winters and sudden, heavy downpours make it more important to direct rainwater and melt water away from buildings, paved areas, roads etc.

A milder climate will reduce the durability of building materials and affect the indoor climate of buildings.

Traditional building methods & vernacular Architecture :-

The traditional construction methods are

* conventional method
* IBS
* Modular
* combination

Conventional :- Conventional construction is a method of ordinary (or) standard construction. It commonly involves the utility of traditional materials, and remains with in a particular set of parameters. The materials are concrete, steel, wood, masonry and stone etc.

most conventional structure buildings are based upon plans of moderate and simple measurements. The beauty of conventional construction is that it causes no two buildings to be the same. Materials are cuts & assembled piece by piece on site.

IBS method :- (Industrialised building system) It is a technique of construction where by components are manufactured in controlled environment. World wide, IBS is also known as pre-fabricated / pre-fab construction, modern method of construction (MMC) Ex :- used in forest city projects. completely built @ factory and transported to site.

Modular :- (a) Systems-built home :-

modular construction is a process where a building is constructed off site using controlled plant conditions before being transported and assembled at a final location. This type of construction can encorporate a range of different building types and floor plans. Terms such as "off-site construction" "pre-fabrication" & "modular construction" are used interchangeably these buildings are to be designed temporarily or permenantly parts are manufactured in a factory and put together on site

Vernacular Architecture :-

Vernacular Architecture can be defined as a type of local or regional construction, using traditional materials and resources from the areas where the building is located.

-> The alpine chalet (a) a bamboo home from South East Asia are just Examples of Vernacular Architecture.

-> Vernacular Architecture is a building done out side any academic tradition, and without professional Guidance.

-> Vernacular Architecture tends to evolve over time to reflect the environmental, cultural & historical context in which it exists.

-> The materials used for vernacular Architecture are mud-bricks, rammed earth, bamboo, stone, clay, Timber, ash burnt etc.

-> which are widely used in Rural areas of countrys.

-> These structures are built with native materials.

Greenbuilding ratings :-

A green building is a "building that, it by design construction (or) operation, reduces (or) eliminate negative impacts, on our climate and natural element". Green buildings preserve precious natural resources and improve our quality of life.

Green buildings ensure the efficient use of natural resources that reduce the harmful impact on the environment. Technologies implemented in these buildings use sensors that automatically adjust the room temperature according to people inside a room, or a smart lighting system that automatically saves electricity when it is not being used.

" How does one decide whether a building is Green "? There is a predefined set of guidelines that relate to the design, construction and operation of buildings which determine whether its performance is creating a harmful impact on the environment (or) not.

In India there are 3 rating systems which are often used that have their own set of criteria to be met. They are :

(1) LEED

(2) GRIHA

(3) IGBC

(1) LEED:- (Leadership on Energy & Environmental Design)

LEED stands for Leadership on energy & environmental design. It is recognised in India and globally as a point of reference for design, construction and operation of green buildings.

It was originally developed by US Green building council (USGBC) for promoting through the construction of buildings. The standards used by LEED are developed to suit every kind of building and including new construction.

A LEED certification can be acheived by a building if it meets all prerequisites and acheives the base min. standard according to them. Their rating system is based on points and establishes the technology & strategies for every credit. Based on the no. of points received, a project can earn one out of four level of LEED certification which are.

1. certified (40-49 points earned)
2. Silver (50-59 points earned)
3. Gold (60-79 points earned)
4. platenum (80+ point earned)

Ex:- The Rajiv Gandhi International Airport in Hyderabad is LEED 'Silver' rated.

(2) GRIHA:- [Green rating for Integrated Habitat Assesment]

GRIHA is a national rating system that was developed keeping in mind the different zones in the country. It is suitable for rating all kinds of buildings. GRIHA stands for Green rating for Integrated Habitat Assesment. The rating system takes into account the National building code of India. The GRIHA rating system evaluates the environmental performance of a building over its entire life cycle and provides

a standard for what is ... building
GRIHA's rating system has 100 points where certain requirements are mandatory to receive a min. score of 50.

points awarded	Rating
50 - 60	one star
61 - 70	Two stars.
71 - 80	Three stars
81 - 90	four stars
91 - 100	five stars

IGBC :-

IGBC stands for 'Indian Green Building Council'. This green building rating system was developed with a holistic approach towards creating environmentally - friendly buildings.

This system is designed to initiate a need to address national priorities and increase the quality of life for its occupants and it keeps pace with current standards and growing Technology. it is mainly designed for newly built structures, both Air - conditioned and non-air conditioned buildings including residential, factory buildings, schools, offices, commercial building e.t.c.

The rating system is classified into 2 types.

1) owner-occupied
2) Tenant - occupied

Based on the total level of credits earned, a building is awarded a level of certification.

Level of certification	Recognition
certified	Good practice
silver	Best practice
Gold	outstanding performance
platenum	National excellence
Super platenum	Global leadership.

Ex:- Wipro technologies in Gopanapally, Hyderabad has a 'Gold level certification'.

Mandatory Requirements :-

There is a certain mandatory criterion that is predefined which would determine whether a building is certified or not in terms of Green building. They are:

1) Selection of site and its design
2) Energy efficiency
3) Building Materials
4) Waste management
5) water efficiency
6) Quality of Indoor Air
7) Innovation and other technologies

UNIT-II

ALTERNATIVE MASONARY UNITS

Characteristics of building blocks for walls:-

The alternative masonary units which can used in place of ordinary building stones and bricks are given below

1. Terracota hollow block
2. Natural Bangalore stone
3. Interlocking mud blocks
4. soil stabilized blocks
5. concrete blocks
6. fly ash bricks
7. calcium silicate bricks.

These are the few alternative masonary units used in conventional building.

Characteristics:-

Characteristics of concrete blocks are made from a mixture of portland cement, blended cement, various types of aggregates, and water. And these also referred to as concrete masonary units (CMU).

Advantages:- -) Inexpensive
-) light weight
-) durable
-) easy to install
-) fire proof
-) low maintainance

Characteristics of blocks may uniform in colour, size & shape.
-) They should be sound and compact.
-) free from cracks and other flaws such as air bubbles etc.

It considers implementation and usage, and evolves to explort technology and standards. It may be assembled from other building blocks. It may be a subassembly of other building blocks. Ideally a building block is reusable and replaceable and well specified. Building blocks are further described as

(1) Architectural building blocks
(2) solution Building blocks.

Stones & laterite blocks :-

Laterite stones are manual (or) machine-cut block pieces from the quarries (or) mines containing laterite crusts.

Laterite is a soft rock composed of iron & aluminium as the main ingredient. Due to the weathering actions, in hot wet tropical areas, lateritic soil gradually gains strength to become a hard mass.

These hard layers of laterite are cut into blocks of required sizes & transported for the building construction works.

Advantages :-

→ They keep building cool in the summer season as they are quarried natural stones.
→ Laterite stones have good thermal insulation properties.
→ The stone provides a rustic natural look to the building.
→ The stone hardens & gains strength as time progresses.

Disadvantages :-

→ The strength of the block is not uniform.
→ Laterite stones are available in limited regions.
→ stone dressing is needed before masonary work to match the size
→ Laterite stones are avoided in multistory buildings due to their weight and chemical composition.

Bricks and hollow clay blocks :-

Hollow clay blocks. horizontally perforated clay bricks have the advantages of natural materials, and they are light weight and efficient because they are hollow from the inside.

Hollow clay bricks, made of natural clay combined with other natural additives such as coal ash, rice husk ash, and sawdust, fly ash.

They are free from any synthetic and chemical substances that emit harmful gases into the environment. from - Technical point of view, hollow bricks are light, durable, readily available and provide sufficient strength for construction. It cools the building by reducing the heat induced inside the building due to the empty space inside.

The main attractions of hollow clay bricks are :-

→ These type of bricks are used for both non-load bearing and load bearing structures.

(i) In non-loaide bearing structure inner and outer wall (up to G+3).

(ii) In non-load bearing structure infill blocks & partition wall.

weight & size of hollow clay bricks :-

16 * 4 * 8 (4 inch) = 6-7 kgs

16 * 6 * 8 (6 inch) = 8.5-9.5 kgs

16 * 8 * 8 (8 inch) = 11-11.5 kgs

→ compressive strength of hollow bricks is 35 kg/cm² = 3.5 N/mm².

→ The water absorption of these bricks is 20% by their weight.

→ density of hollow clay brick is 694 - 783 kg/m³.

Adv :-
- Reducing dead loads
- Fast construction
- Saveson construction cost

Dis Adv :-
→ maintanance cost is high
→ Hollow blocks are porous so, high chance of water seepage.

Concrete blocks :- Concrete blocks are nowadays replacing bricks in masonary construction, in many multi-storeyed buildings. They are available in three types namely solid, hollow & cellular widely used for the construction of filler walls & boundary walls in R.C. frame work.

Concrete blocks are usually made in large sizes to make blockwork faster and consume less cement in joints than the brickwork. If the percentage of voids is more than 25%, then they are hollow blocks and blocks with voids less than 25% are only perforated blocks.

The cellular concrete blocks are generally referred to as light weight concrete blocks. All these blocks are used for Compound walls and Non-load bearing walls.

classification of concrete blocks :-

1) Hollow concrete blocks :- open & closed cavity-type hollow concrete blocks are classified into 3 grades.
   - Grade-A :- They possess a min. density 1500kg/m3 and are used for load-bearing walls.
   - Grade-B :- They have a density below 1500kg/m3 and used for load bearing walls.
   - Grade-C :- These blocks are used for non-load bearing walls and have density more than 1000kg/m3.
2) Solid concrete blocks :- They should be manufacture for specific concrete strength of 4.0 and 5.0 N/mm^2 in 28 days. These blocks are used as load-bearing walls
3) Paver blocks :- These blocks are solid concrete blocks of different shapes specially made for exterior ground paving on side walks, Petrol pumps etc.

Stabilized blocks :- Mud blocks :-

Stabilized mud blocks (SMBs) are manufactured by compacting a wetted mixture of soil, sand and stabilizer in a machine into a high-density block. Such blocks are used for the construction of load-bearing masonary. cement soil mortar is commonly used for SMB masonary.

Stabilized mud block (SMB) or pressed earth block is a building material made primarily from damp soil compressed at high pressure to form blocks. If the blocks are stabilized with a chemical binder such as portland cement they are called Compressed stabilized earth block (CSEB) or stabilized earth block (SEB). Stabilized mud blocks uses a mechanical press to form block out of an appropriate mix of fairly dry inorganic sub-soil, non-expansive clay, aggregate and sometimes a small amount of cement.

Advantages :-

→ Low cost
→ good resistant to fire
→ good temperature insulation
→ good Sound proofing
→ being a natural resource that is readily available from earth.

Disadvantages :-

→ They can be easily destroyed by wind, rain & flooding
→ it may have a musty smell when first finished construction
→ affected by dampness or dry weather.

Steam-cured blocks :

A comparision of energy content of steam-cured soil blocks and burnt bricks is presented. It has been shown that energy-efficient steam cured soil blocks (consuming 35% less thermal energy compared to burnt clay bricks) having high compressive strength can be easily produced in a decentralised manner.

steam curing blocks are coreng in water vapour at atmospheric (or) Higher pressures. when cured at atmospheric pressure, the enclosure temperatures are usually between 40 & 70°c. (100-160°F). steam curing is used where early strength gain is needed and where heat is requered for hydration, such as in cold weather.

Generaly pre-cast structures, columns, beams, walls are adopted these type of steam-cured blocks.

dis Advantages :-

-> The method does not work efficiently for large surface.
-) The process must be carried out only be skilled labours.
-) The initial cost of steam curing process is very high

Advantages of Steam Curing :-

-) High early strength can be acheived.
-) construction speed is increased
-) steam curing is fast compared to other curing methods.

Fal-G-blocks :-

Fal-G bricks & blocks are alternative building materials to the traditional burnt clay bricks and are substitutes to the traditional burnt bricks used for construction.

Gypsum used in fly-ash bricks because gypsum not only improves the reduction in the loss of strength due to soaking even at low curing periods but also improves the durability of stabilized fly ashes due to repeated cycles of wetting & drying.

Advantages of Fal-G-blocks :-

1) Appearance :- The appearance of fal-G bricks are very attractive due to their pleasing colour like cement, uniform size, and smooth finish.
2) Strength :- The compressive strength is very high (9-10N/mm²)
3) Thermal properties :- Thermal conductivity of Fal-G-brick is 0.90-1.05 W/m². They absorb less heat.
4) Durability :- These bricks are highly durable & less permeable.
5) Sound insulation.
6) Fire resistance

Dis Advantages :-

→ Not all ~~fal-G~~-fly-ash is suitable for construction, those are produced in power plants usually compatible with concrete.
→ If not made properly, it has no strength.
→ Bonding with concrete is lower due to the smooth finish.
→ Limitation in size., only modular size bricks can be produced, the larger size will have more breakages.

UNIT-III

FIBRE REINFORCED CONCRETE

Fibre-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers each of which varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation and densities.

Properties & Applications of fibre reinforced concrete :-

the use of fibers eliminate the sudden failure of characteristic of plain concrete beams. it increases the stiffness, torsional strength, ductility, rotational capacity, and the number of cracks with less crack width. Some mechanical properties of FRC (fiber reinforced concrete) are :

1) Compressive Strength :- The presence of fibers may alter the failure mode of cylinders, but the fiber effect will be minor on the improvement of compressive strength values (0-15%)

2) Modulus of elasticity :- modulus of FRC increases slightly with an increase in the fibers content. If 1% of increase in fibre content by volume there is an increase of 3% in the modulus of elasticity.

3) flexure :- The flexural strength was reported to be increased by 2.5 times using 4% fibers.

4) Toughness :- For FRC, toughness is about 10-40 times that of plain concrete.

5) splitting tensile strength :- The presence of 3% fibre by volume was reported to increase the splitting tensile strength of mortar about 2.5 times that of the unreinforced one.

5) Impact Resistance :- The impact strength of fibrous concrete is generally 5-10 times that of plain concrete depending on the volume of fiber used.

Application of FRC :- The main areas of FRC applications are :

-> Runway, Aircraft parking and pavements :-

For the same wheel loads, FRC slabs could be about one half the thickness of plain concrete slab. Compared to a 375 mm thickness of conventionally reinforced concrete slab, a 150 mm thick crimped-end FRC slab was used to overlay an existing asphalt-paved aircraft parking area. FRC pavements are now in Ser severe and mild environments.

-> Tunnel lining and slope stabilization :-

Steel-fibre reinforced shotcrete (SFRS) are being used to line underground openings and rock slope stabilization. It eliminates the need for mesh reinforcement and scaffolding.

-> Blast Resistant structures :-

When plain concrete slabs are reinforced conventionally tests shows that there is no reduction of fragment velocities no. of fragments under blast and schock waves. Similarly, reinforced slabs of fibrous concrete, however, showed 20% reduction in and over 80-90 fragmentations.

-> Dams and Hydraulic structures :-

FRC is being used for the construction and repair of dams and other hydraulic structures to provide resistance to cavitation and severe erosion caused by the impact of large underborn debris

-> other Applications :- These include machine tool frames, light poles, water and oil tanks and concrete repairs.

-> Thin shells, walls, pipes and manholes.

Fibre-Reinforced plastics :-

Fibre-reinforced plastic is a composite material made of a polymer matrix reinforced with fibres. The fibers are usually glass, carbon, basalt. Rarely other fibres such as paper, wood, or asbestos have been used. Fibre-reinforced plastics are also called "fibre-reinforced polymer". The polymer is usually an Epoxy, vinyl ester, or polyster thermosetting plastic, Though phenol formaldehyde resins are still in use.

Fibre Reinforced plastics (FRPs) are commonly used in the aerospace, automative, marine and construction Industries They are commonly found in cylinders for self-contained breathing apparatuses.

Properties :-

fibre-reinforced polymer composite offers not only high strength to weight ratio, but also reveals exceptional properties such as ⇒ High durability

⇒ Stiffness

⇒ Damping property

⇒ flexural strength

⇒ Resistance to corrosion

⇒ wear impact & fire.

→ Different types of FRP's are

1) Glass fibre Reinforced polymer (GFRP) :-
These are basically made by mixing silica sand, limestone, folic acid and other minor ingredients.

2) carbon fibre Reinforced polymer (CFRP)

3) Aramid fibre reinforced polymer (AFRP) :-
Aramid is the short form of aromatic polyamide.

Uses :-

FRP are composites used in almost every type of advanced engineering structure, with their usage ranging from Aircraft, helicopters and space craft Through to boats, ships and offshore platforms and to Automobiles, Sports goods, Chemical processing equipment and civil Infrastructure such as bridges & buildings.

Matrix materials :-

The matrix is basically a homogeneous and monolithic material in which a fibre system of a composite is embedded. It is completely continuous. The matrix provides a medium for binding and holding reinforcements together in to a solid. It offers protection to the reinforcements from environmental damage, serves to transfer load, and provides finish, texture, color, durability and functionality.

Types of Matrix materials :- there are main 3 main types of composite matrix materials.

1) ceramic Matrix
2) Metal Matrix
3) polymer matrix

(1) ceramic matrix composites are a subgroup of composite materials. They consist of ceramic fibers embedded in a ceramic matrix, thus forming a ceramic fiber reinforced ceramic material (CFRC). CMC materials were designed to to overcome the major disadvantages such as low fracture toughness, brittleness, and limited thermal shock resistance faced by the traditional technical ceramics.

2) Metal matrix composites are composite materials that contain at least two constituent parts - a metal and another material (or) a different metal. The metal matrix is reinforced with the other material to improve strength and wear.

3) polymer matrix composites can be devided into 3-sub types, namely thermoset, thermoplastic and rubber. PMC's are less dense than metals(or) ceramics, can resist atmospheric and other forms of corrosion, and exhibit superior resistance to the conduction of electrical current.

Applications:- The following are common application areas of composite matrix materials:

→ Electrical moldings
→ decorative laminates
→ High performance Cookware
→ components for burners, flame holders etc.

Fibers:- → organic fibers
→ Synthetic fibers

organic fiber:- organic fiber includes cotton, wool, hemp, flax (linen), and other. Natural fibers grown according to natural organic standards without the use of toxic and persistent pesticides, synthetic fertilizers (or) genetic engineering.

organic fibers commonly encountered in textile applications can be employed as reinforcing elements of advanced composites. Naturally, only high performance fibers, i.e. fibers possessing high stiffness & strength can be used for this purpose. The most widely used organic fibers that satisfy these requirements are known as aramid (aromatic polyamide) fibers. and the aramid fibers are characterized by low density providing

high specific strength and stiffness, low thermal conductivity resulting in high heat insulation.

Properties :- The main characteristics of natural fibers are

→ Low Energy consumption
→ Low density
→ Non-abrasive nature
→ Low cost
→ renewability
→ Bio-degradability
→ Easy availability & world wide abundance.

Applications :- organic fibers are used in various application such as → Building materials
→ Human feed & Animal feed cosmetics
→ medicine and for other biopolymers and fine chemica

Synthetic fibers :- Synthetic fibers are man-made fibers, mo of them are prepared from raw material petroleum called as - petrochemicals. All fabrics are obtained from fibers, while fibers are obtained from artificial (or) man-made sources. The consists of a small unit or a polymer which is made from many repeating units known as monomers. They include nylon, acryl polypropylyne etc.

Ex:- Rayon, Nylon, Polyster, etc.

This fibre finds its applications in

→ Household articles like ropes, buckes, furnitu etc

Properties (or) Advantages :-

→ Synthetic fibers are very durable and do not wrinkle easily.
→ They are elastic and can be easily stretched out.
→ They are strong and can sustain heavy load.
→ They are soft and hence used in clothing material.
→ They are cheaper compared to natural (or) organic fibers.

Synthetic febers are added to concrete before (or) during the mixing operation. The use of synthetic febers at typical addition rates does not require any mix design changes.

Synthetic fibres benifit the concrete in both the plastic and hardened state. Some of the benifits are

→ reduce plastic settlement cracks
→ reduce plastic shrinkage cracks
→ lower permeabelity
→ increased impact and abrasion resistance

Some synthetic febers may be used as secondary reinforcement.

Building material from AGRO & INDUSTRIAL WASTES :-

Construction wastes are obtained during the building process (or) after demolition. different types of materials such as bricks, concrete, mortar, wood, steel, rebar, insulation material, electrical wiring, plastic materials, glass, iron plate, tile, sanitary pieces e.t.c.

AGRO wastes :- Agro waste as building materials

→ Rice husk ash (RHA)
→ Sugarcane Bagasse Ash (SCBA)
→ Bamboo leaves Ash (BLA)
→ Groundnut shell (GNS)
→ Saw Dust
→ oil palm shell
→ cork waste ash
→ coconut shell.

Agro waste is a term used to describe the waste material produced during farming practices that can be any chemical, pesticide (or) fertilizer.

→ Agricultural wastes are utilized to minimize the environmental pollution.

→ The utilization of Agro-residues in concrete has attracted interest from both science and construction industries, because of the sustainable benefits offered by such residues, in addition to their cost effective and environment-friendly nature compared with portland cement.

Types of Agro wastes :- Agricultural wastes include

crop (or) field residues & process residues

Types from field residues :-

- → stems
- → stalks
- → leaves
- → seed pods

Types from process residues

- → Husks
- → Seeds
- → Roots
- → molasses etc.

Types of Industrial wastes :- Now a days, natural resources are depleting world wide, while at the same time the generated wastes from the industries are increasing substantially. According to their fineness and specific gravity the wastes are partially (or) fully replaced with the construction materials. The industrial waste materials increases the strength of materials.

Types of industrial waste include

- → dirt & gravel
- → Masonary & concrete
- → Scrap metal
- → oil
- → solvents
- → Chemicals
- → even vegetable matter from Restaurants.

Industrial waste may be solid, semi-solid (or) liquid in form. It may be hazardous waste (or) non-hazardous waste.

ex: fly ash:- It is an industrial waste generated from thermal power plants. it is commonly used in the construction industry. the fly ash has a wider application in the production of cement.

types :- 1) Chemical
2) Solid waste
3) Toxic & Hazardous waste.

→ generally generated by factories, processing centres, warehouses and plants. This waste may include harmful or dangerous.

→ In industrial services, solid wastes include a variety of different materials, including paper, cardboard, plastics, packaging materials, wood and scrap metal. Some of these materials can be reused and recycled by a recycling center.

→ Toxic & Hazardous waste is composed of materials that can cause serious health & safety problems if waste disposal is not handled correctly. This type of waste typically includes dangerous by products materials generated by factories, farms, construction site, laboratories, garages, Hospitals and certain production and manufacturing plants.

properties & Applications :-

1) partical size distribution
2) coefficient of uniformity
3) permeability in saturation conditions
4) Saturation water content
5) field capacity & effective porosity.

Applications :-

1) manufacturing of bio-fuels
2) Enzymes
3) vitamins
4) Antioxidants
5) Animal feed
6) Antibiotics
7) and other chemicals through process of fermentation.

Types of Mine wastes :-

There are 3 broad classes of mine waste they are

(1) waste rock
(2) coarse tailings.
(3) fine tailings
(4) Muddy tailings.

(1) waste rock is one of the maximum solid wastes occured in the mining industry. In order to extract ore, large amount of rock is stripped (or) excavated and transported to the waste-rock dump.

-) Tailings are major solid wastes produced in the process of mineral beneficiation. In order to extract usable minerals, ore was crushed and milled to appropriate size, then the usable minerals were seperate from unusable minerals via different methods.

Applications :-

→ A very good material for construction of roads & dams
→ it could be used for construction bricks
→ used for making wall bricks & floor tiles for construction
→ used for filling depressions, the mined out area (or) subsidence area.

properties :-

→ density
→ dry density
→ sp. gravity
→ water absorption
→ porosity etc.
→ compressibility
→ shear strength
→ permeability

field quality control test methods :-

UNIT-IV

FERROCEMENT AND FERROCONCRETE

Ferro cement is a construction material consisting of wire meshes and cement mortar. Applications of ferrocement in construction is vast due to the low self weight, lack of skilled workers, no need of framework etc.

It was developed by P.L. Nervi, an Italian architect in 1940. Quality of ferrocement works are assured because the components are manufactured on machinery set up and execution time at work site is less. This material has come in to widespread use only in construction in the last two decades.

Ferro-concrete is the original name of reinforced concrete (armored concrete) known at least since the 1890's and in 1903 it was well described in London's Society of Engineer's Journal but is now widely confused with ferro cement.

Properties :-

1) Highly versatile form of reinforced concrete.
2) It's a type of thin reinforced concrete construction, in which large amount of small diameter wire meshes uniformly throughout the cross-section.
3) Mesh may be metal or suitable material.
4) Instead of concrete portland cement mortar is used
5) strength depends on 2 factors quality of Sand / cement mortar mix and quantity of reinforcing materials used.
6) Low w/c ratio and produces impermeable structure.
7) they have better impact and punching shear resistance.
8) High tensile strength, stiffness, rigidity.
9) It has less shrinkage & weight.

1) cement
2) fine Aggregate
3) water
4) Admixture
5) Mortar Mix
6) Reinforcing Mesh → Skeleton steel
   → Rod steel mesh
7) steel
8) coating

Specifications:- The basic constituent materials required for ferrocement concrete are cement, sand, water, and wire meshes the cement should normally be of ordinary Portland type. The cement - sand ratio for the mortar varies from 1:1.5 to 1:2.5 and water-cement ratio, from 0.35 to 0.50 by weight. wire meshes are different types, such as hexagonal, woven, welded have been used. The wire meshes are generally made up of 0.5 to 1.5mm dia wires and spaced 5 to 25 mm apart.

Properties of building materials:-

→ It is very durable
→ low cost & cheap
→ large deformations before cracking (or) high deflections
→ Less shrinkage
→ strength
→ Brittleness
→ Elasticity
→ Abrasion resistance
→ Impact resistance

Advantages :-

1) Basic raw material are available in almost every country.
2) ferrocement is fabricated into any shape.
3) less labour skills are required for placing @ site.
4) It is easily constructed, low weighted & long life time.
5) Due to less weight of ferro cement the structure weight is less & this reduces the foundation cost.
6) ferrocement is mostly suitable for precast components.
7) low construction material cost
8) Resistant against earthquake forces.

Disadvantages :-

→ prone to corrosion of MS rods and GI mesh due to incomplete coverage of materials by mortar.
→ Ferro cement is labour intensive. so it might not be economical
→ It is difficult to fasten to ferrocement with bolts, screws, welding & nail etc.
→ Tying rods & mesh is time consuming.

Construction Methods for ferrocement :-

The construction process of ferrocement depends on factors such as the nature of application of ferrocement, availability of machinery for mixing, handling & placing, skill and overall cost of labor. It can also be prepared using molds.

The Construction methods for ferrocement are as follows:

1. Skeletal Armature method
2. closed Mold Method
3. Integral Mold Method
4. Open mold method.

1) Skeletal Armature Method:- In the skeletal armature method, several layers of wire mesh are tied on either side of the reinforcing bars. The mortar is applied from one side by forcing it to penetrate through the mesh layers until the excess mortar appears on other side. This excess quantity is then pressed back, and the remaining mortar is stuck off to give a good finish.

The skeletal steel is placed at the centre of the section in both directions. It simply acts as spaced rods and does not contribute to the strength but adds to dead weight of the structure.

2) Closed Mold Method :- In the closed mold method, the layers of wire mesh are either tied (or) stapled together and held up in position against the closed mold's surface. The mortar is applied from one side. Though it isn't mandatory to seperate the mold from the ferrocement structure, but if needed can be removed. The closed mold method permits the use of mesh reinforcement, eliminating the use of bars (or) rods, and requires plastering only from one side.

3) Integral Mold method:- As the name suggests, the mold acts as an integral part of the structure to be made. The integral mold, also known as the core, consists of a semi-rigid framework having few layers of mesh. The mortar can be applied from one or both sides. After it sets the quality of ferrocement can be enhanced by adding more layers of mesh with the application of mortar on both sides.

(4) open mold method :-

The open mold method is partially similar to the closed mold method. Initially the mortar is applied through one side of the mesh layers and rods to the open mold. The mold is enterely cover with a polyethene sheet, thus as close but non-rigid and transparent mold would be formed. This facilitates the easy removal of mold and allows the observation and repair of any during the process of mortar application

Applications :-

Ferrocement have applications in all fields of civil construction, including water & soil retaining structures of building components, bridges, dams, dams, boats, treatment plants for water & sewage.

1) Housing and other Industrial & Commercial :-
   - -> low cost dwelling house
   - -> strengthening Reinforced concrete element
   - -> strengthening Masonary element.
2) Marine :- marine structure such as boat, trawler, barges, floating docks can be constructed.
3) Agricultural :-
   - -> Construction canal
   - -> Gates over dam
   - -> Cross-drainage work
4) Floor & roof :- we can construct floor & roof various type of buildings. ex:- residence, factories, office etc.
5) water proofing :- By using ferro cement Technique we can construct water proofing.

(6) Manhole cover:- Heavy duty & light duty manhole cover be constructed and are superior and durable than conventional once.

(7) wall cupboards:- It consists of no. of small holes in rectangular form with or without shutter used to store office record, factory material etc.

(8) Fire Resistant structure

It can resist fire upon 750° for a period of 48 hours.

(9) Pipes

(10) Sewer line

(11) Bridge

(12) Pre-cast ferrocement structure

(13) Soil-stabilization

(14) Rural Application

(15) Chemical Resistant Treatment etc.

UNIT-V

STRUCTURAL MASONARY UNITS

Compressive strength of masonary elements:-

The compressive strength of masonary depends on several factors such as;

- → Mortar strength
- → unit strength
- → Relative ratio blw the mortar & unit strength
- → Relationship blw the height of the unit and, smaller horizontal dimension of the unit
- → orientation of the unit

Compressive strength of masonary can be determined by conducting various laboratory tests

- → unit strength method of Testing compressive strength of masonary.
- → prism method of Testing compressive strength of masonary.

These two testing methods are provided by ACI 530.1-11.

Due to costs related to the making prisms and laboratory tests, the prism testing method is more costly compare with the unit strength method. The results of unit strength method are more conservative than prism strength method.

① unit strength method of Testing compressive strength of masonary:-

In unit strength method, masonary units are needed to be tested before & during construction to guarantee their sufficient strength. The value of specified compressive strength of masonary depends on not only the compressive strength of masonary units but also on the mortar.

② Prism method of Testing compressive strength of masonary :-

Test of prisms are carried out after 28 days (or any other specified period but the prism must have taken out of the air tight backs two days before the test is began.

The compressive strength of masonary is computed in by 3 steps from prism tests.

→ firstly, masonary prism strength which is equal to sustain compressive load of prisms by net c/s area of that prism.

→ secondly, calculate masonary compressive strength depend on the aspect ratio (the ht. of smallest lateral dimension of the prisms) of masonary prism tests.

→ Thirdly, the compressive strength of masonary is considered to be equal to that of masonary prism provided that the masonary prisms have aspect ratio of 2.

Factors affecting Compressive strength :-

Important factors affecting the compressive strength of concrete are

→ water cement Ratio
→ Quality of cement and chemical constituents
→ storage of cement
→ Aggregate
→ water
→ Moisture in Aggregate
→ slump
→ Degree of Compaction
→ Temp at the time of moulding cubes
→ Curing efficiency
→ Curing Temperature

- Moisture content at the time of cube tests
- Direction of loading
- Duration of loading
- Degree of lateral restraint
- Compression machine and operation factors

Strength of units :-

Prism's / wallets and walls :-