CIVIL ENGINEERING MATERIALS

ENCE 103

Lecture : 2 **Year : I**
Tutorial : 0 **Part : I**
Practical : 1

Course Objectives:
To provide students an introductory knowledge about the wide range of materials used in the construction of engineering projects. This course emphasizes on the property, defects, productions, preservation, alternatives and utilities of various civil engineering materials which would help in selection of the suitable materials for construction projects. This helps to build a base for the selection, adequate consideration and precautions in aspect of materials during design and construction.

1 Basics of Civil Engineering Materials (2 hours)

1.1 Materials used in engineering constructions: Buildings; Road and bridges; Irrigation and hydropower; Water, gas and petroleum supply
1.2 Classification of materials on various basis: Existence in nature, functions or usage; Metallurgy; Composition of materials
1.3 Properties: Physical; Chemical; Mechanical; Thermal; Optical; Electrical; Magnetic
1.4 Failure of materials: Ductile and brittle failure
1.5 Factors affecting selection of materials: Properties and performance; Attributes and suitability; Durability, safety and requirements; Availability, reliability and disposability; and Economy and environment
1.6 Material and environment interactions: Corrosion; Weathering; Erosion; Thermal strain; Exposure to moisture, sunlight, and chemicals

2 Stones (3 hours)

2.1 Classification of rocks and aggregates: Geological, physical and chemical classifications of rocks; Introduction to coarse and fine aggregates
2.2 Properties of stones: Physical, chemical and mechanical properties
2.3 Characteristics of good stones: Appearance; Structure; Strength; Porosity and absorption; Weathering; Fire resistance; Hardness and toughness; Specific gravity; Thermal properties
2.4 Selection and use of stones: Selection criteria; Various uses of stones in engineering constructions
2.5 Deterioration and preservation of stones: Deterioration and its retardation; Preservation and preservatives used in stones
2.6 Production, storage and handling of stones: Natural bed of stones; Selection of quarry site; Methods of quarrying; Dressing of stones

3 Clay and Clay Products (3 hours)

3.1 Clay: Use of clay in constructions; Classification/types of clays; Properties of clays

3.2 Brick earth: Constituents; Properties; Testing (Consistency test; Molding property test; Deformation and shrinkage test on burning; Strength and quality of brick test)

3.3 Bricks: Use of bricks; Manufacturing of local bricks; Classification and properties (Including mechanical properties) of bricks (Unburnt and burnt bricks); Characteristics of good bricks; Standard tests for bricks (Shape and size test; Colour test; Structure test; Soundness test; Hardness test; Water adsorption test; Efflorescence test; Compressive strength test)

3.4 Tiles: Use of tiles; Manufacturing process of tiles; Types and properties of tiles (Roof tiles, wall tiles, floor tiles, drain tiles); Characteristics of good tiles

3.5 Terracotta, earthenware and glazing: Properties; Use; Composition; Production

3.6 Storage and handling of clay and clay products

4 Lime (2 hours)

4.1 Sources and constituent of limestones: Limestones and stone lime; Kankar lime; Shell lime; Magnesian lime; Impurities in limestones

4.2 Classification/types of limes: Quick lime; Flat lime, hydraulic lime, poor lime; Hydrated lime; Milk lime; Lump lime

4.3 Characteristics of lime, hydration of lime, slaking nature of lime, solidification of lime

4.4 Manufacture/production of lime: Flow diagram of lime production from limestone and kankar

4.5 Storage, handling and use of different types of lime

4.6 Types of pozzolanic materials and use with lime: Volcanic ash; Calcinated clay products; Clay/kaolin pozzolana; Mineral slag; Ashes of organic origin

5 Cement (4 hours)

5.1 Fundamentals of cement: Ingredients of cement; Type and properties of cement; Storage, handling and use of cement; Characteristics of good cement

5.2 Classification of cements: Natural and artificial; Different types of cements, their composition, properties and applications (Ordinary Portland cement (OPC), rapid hardening cement, slow setting cement, Portland pozzolana cement (PPC), white cement, colored cement)

5.3 Manufacture of ordinary cement: Dry manufacturing process; Wet manufacturing process

5.4 Tests of cement: Field test; Laboratory tests (Fineness test, consistency test, initial and final setting time test, soundness test, compressive and tensile strength test)
5.5 Cement clinkers: Compounds of cement clinkers and their functions in cement
5.6 Hydration of cement and admixtures: Function and examples of admixture like water proofers, accelerators, retarders, plasticizers, air entraining agents

6 Mortar (2 hours)

6.1 Function and use of mortar
6.2 Properties of mortar: Workability, inertness, setting and hardening, adhesion
6.3 Types of mortars: Classification (On the basis of binding materials, bulk density, nature of applications; Special mortars); Properties and use of different types of mortar
6.4 Preparation, storage and handling of mortar: Hand mixing, machine mixing; Storage and handling of mortar
6.5 Selection of mortar for different construction works: Selection criteria; Characteristics of a good mortar
6.6 Testing of mortars: Crushing strength test, tensile strength test, adhesiveness test on building unit

7 Timber (3 hours)

7.1 Tree and timber: Growth and structure of tree; Properties (Including mechanical) and use of timber; Defects in timber (During growth of trees, after felling of trees); Characteristics of good timber
7.2 Classification of tree and properties of wood: Hard wood, soft wood
7.3 Seasoning of timber: Definition and importance of seasoning; Types of seasoning (Natural and artificial seasoning)
7.4 Deterioration and preservation of timber: Deterioration (Physical, chemical, biological); Types of preservatives; Methods of preservation
7.5 Commercial product of timber: Veneers and ply wood; Boards (Laminated boards, fiber boards, block boards, and batten boards); Impreg and compreg timbers
7.6 Bamboo: Properties (Including mechanical) of bamboo; Structural use of bamboo

8 Metals and Alloys (4 hours)

8.1 Metals: Classification (Ferrous and nonferrous metals); Properties (Physical, chemical, mechanical, electrical, thermal, magnetic)
8.2 Sources, composition, properties and uses of ferrous metals: Pig iron, cast iron, wrought iron, steel, alloys of steel

8.3 Sources, properties and uses of nonferrous metals: Aluminum, copper, lead, tin, zinc, magnesium, nickel

8.4 Heat treatment process and its importance in metals: Annealing, normalizing, quenching or hardening, tempering, surface hardening (Case hardening, nitriding, cyaniding, flame/ induction/laser hardening), defects in heat treatments

8.5 Commercial forms of metals and their uses: Sheets, channel sections (I, C, angle, tubular), bars

8.6 Corrosion and its prevention in steel: Theory of corrosion and its prevention with enameling; Applying metal coatings–Galvanizing, tin plating, electroplating; applying coatings – Painting and tarring

9 Paints and Varnishes (3 hours)

9.1 Paints: Function and ingredients of paints; Characteristics of good paint

9.2 Type, composition, properties and uses of paints: Oil paints; Aluminum paints; Asbestos paints; Bituminous paints; Cellulose paints; Cement paints; Colloidal paints; Emulsion paints; Enamel paints; Graphite paints; Silicate paints; Anticorrosion paints; Plastic paints; Synthetic rubber paints; Distempers

9.3 Varnishes: Function and ingredients of varnishes; Characteristics of good varnishes

9.4 Type, composition, properties and uses of varnishes: Oil varnish; Turpentine varnish; Spirit varnish; Water varnish; Asphalt varnish; Spar varnish; Flat varnish

9.5 Process of application of different paints and varnishes: Application in new surfaces; Application in old surfaces

9.6 Defects in paints and varnishes: Effects of background (Dampness, cleanness, movement, reactions); Effects of weather (Blistering, peeling, checking, cracking, flaking, chalking, alligatoring, wrinkling, running and sagging, mildew, bloom, flashing, grining)

10 Miscellaneous Materials (4 hours)

10.1 Asphalt: Origin, composition, properties, types and uses

10.2 Bitumen: Origin, composition, properties, types and uses

10.3 Tar: Origin, composition, properties, types and uses

10.4 Other materials: Composition, properties, types and uses of – Glass, plastic materials, rubber materials, insulating materials, gypsum products, adhesive and sealant materials, anti-termite treatment, water proofers, geosynthetics, carbon fiber

10.5 Composite materials: Composition, properties, types and uses of – Cement steel reinforced concrete, fiber reinforced plastics, glass fiber reinforced cement concrete or plastics, metal matrix composite

10.6 Emerging materials: Calcium silicate bricks; Concrete blocks; Aerated autoclave concrete blocks (AAC blocks); Interlocking compressed stabilized earth blocks (Interlocking CSEB), panels and boards

Assignments

1. Various ways to join timbers and metals
2. Commercially available other new materials used in constructions

Practical **(15 hours)**

1. Water absorption test and bulk density, specific gravity test on brick sample
2. Compressive strength test of brick and stones
3. Consistency test of cement
4. Fineness and soundness test of cement
5. Setting time test of cement
6. Compressive strength of cement
7. Toughness test on steel and timber

Reference

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