CIVIL ENGINEERING

PAPER – I

1. Engineering Mechanics, Strength of Materials and Structural Analysis:

1.1 Engineering Mechanics:

Units and Dimensions, SI Units, Vectors, Concept of Force, Concept of particle and rigid body. Concurrent, Non Concurrent and parallel forces in a plane, moment of force, free body diagram, conditions of equillibrium, Principle of virtual work, equivalent force system.

First and Second Moment of area, Mass moment of Inertia.

Static Friction.

Kinematics and Kinetics:

Kinematics in Cartesian Co-ordinates, motion under uniform and nonuniform acceleration, motion under gravity. Kinetics of particle: Momentum and Energy principles, collision of elastic bodies, rotation of rigid bodies.

1.2 Strength of Materials:

Simple Stress and Strain, Elastic constants, axially loaded compression members, Shear force and bending moment, theory of simple bending, Shear Stress distribution across cross sections, Beams of uniform strength.

Deflection of beams: Macaulay's method, Mohr's Moment area method, Conjugate beam method, unit load method. Torsion of Shafts, Elastic stability of columns, Euler's Rankine's and Secant formulae.

1.3 Structural Analysis:

Castiglianio's theorems I and II, unit load method of consistent deformation applied to beams and pin jointed trusses. Slope-deflection, moment distribution,

Rolling loads and Influences lines : Influences lines for Shear Force and Bending moment at a section of beam. Criteria for maximum shear force and bending Moment in beams traversed by a system of moving loads. Influences lines for simply supported plane pin jointed trusses.

Arches : Three hinged, two hinged and fixed arches, rib shortening and temperature effects.

Matrix methods of analysis : Force method and displacement method of analysis of indeterminate beams and rigid frames.

Plastic Analysis of beams and frames : Theory of plastic bending, plastic analysis, statical method, Mechanism method.

Unsymmetrical bending : Moment of inertia, product of inertia, position of Neutral Axis and Principle axes, calculation of bending stresses.

2. Design of Structures: Steel, Concrete and Masonry Structures:

2.1 **Structural Steel Design:**

Structural Steel : Factors of safety and load factors. Riveted, bolted and welded joints and connections. Design of tension and compression member, beams of built up section, riveted and welded plate girders, gantry girders, stancheons with battens and lacings.

2.2 **Design of Concrete and Masonry Structures:**

Concept of mix design. Reinforced Concrete : Working Stress and Limit State method of design–Recommendations of I.S. codes Design of one way and two way slabs, stair-case slabs, simple and continuous beams of rectangular, T and L sections. Compression members under direct load with or without eccentricity, Cantilever and Counter fort type retaining walls.

Water tanks : Design requirements for Rectangular and circular tanks resting on ground.

Prestressed concrete : Methods and systems of prestressing, anchorages, Analysis and design of sections for flexure based on working stress, loss of prestress.

Design of brick masonry as per I.S. Codes

3. Fluid Mechanics, Open Channel Flow and Hydraulic Machines:

3.1 **Fluid Mechanics:**

Fluid properties and their role in fluid motion, fluid statics including forces acting on plane and curved surfaces.

Kinematics and Dynamics of Fluid flow : Velocity and accelerations, stream lines, equation of continuity, irrotational and rotational flow, velocity potential and stream functions.

Continuity, momentum and energy equation, Navier-Stokes equation, Euler's equation of motion, application to fluid flow problems, pipe flow, sluice gates, weirs.

3.2 **Dimensional Analysis and Similitude:**

Buckingham's Pi-theorem, dimensionless parameters.

3.3 **Laminar Flow:**

Laminar flow between parallel, stationary and moving plates, flow through tube.

3.4 **Boundary layer:**

Laminar and turbulent boundary layer on a flat plate, laminar sub layer, smooth and rough boundaries, drag and lift.

Turbulent flow through pipes : Characteristics of turbulent flow, velocity distribution and variation of pipe friction factor, hydraulic grade line and total energy line.

3.5 **Open channel flow:**

Uniform and non-uniform flows, momentum and energy correction factors, specific energy and specific force, critical depth, rapidly varied flow, hydraulic jump, gradually varied flow, classification of surface profiles, control section, step method of integration of varied flow equation.

3.6 **Hydraulic Machines and Hydropower:**

Hydraulic turbines, types classification, Choice of turbines, performance parameters, controls, characteristics, specific speed.

Principles of hydropower development.

4. Geotechnical Engineering:

Soil Type and structure – gradation and particle size distribution – consistency limits.

Water in soil – capillary and structural – effective stress and pore water pressure – permeability concept – field and laboratory determination of permeability – Seepage pressure – quick sand conditions – Shear strength determination – Mohr Coulomb concept.

Compaction of soil – Laboratory and field tests.

Compressibility and consolidation concept – consolidation theory – consolidation settlement analysis.

Earth pressure theory and analysis for retaining walls, Application for sheet piles and Braced excavation.

Bearing capacity of soil – approaches for analysis – Field tests – settlement analysis – stability of slope of earth walk.

Subsurface exploration of soils – methods

Foundation – Type and selection criteria for foundation of structures – Design criteria for foundation – Analysis of distribution of stress for footings and pile – pile group action-pile load test.

Ground improvement techniques.

PAPER - II

1. Construction Technology, Equipment, Planning and Management:

1.1 Construction Technology:

Engineering Materials :

Physical properties of construction materials with respect to their use in construction—Stones, Bricks and Tiles; Lime, Cement, different types of Mortars and Concrete.

Specific use of ferro cement, fibre reinforced C.C, High strength concrete.

Timber, properties and defects—common preservation treatments.

Use and selection of materials for specific use like Low Cost Housing, Mass Housing, High Rise Buildings.

1.2 Construction:

Masonry principles using Brick, stone, Blocks – construction detailing and strength characteristics.

Types of plastering, pointing, flooring, roofing and construction features.

Common repairs in buildings.

Principles of functional planning of building for residents and specific use—Building code provisions.

Basic principles of detailed and approximate estimating—specification writing and rate analysis – principles of valuation of real property.

Machinery for earthwork, concreting and their specific uses – Factors affecting selection of equipments – operating cost of Equipments.

1.3 Construction Planning and Management:

Construction activity – schedules- organization for construction industry – Quality assurance principles.

Use of Basic principles of network – analysis in form of CPM and PERT – their use in construction monitoring, Cost optimization and resource allocation.

Basic principles of Economic analysis and methods.

Project profitability – Basic principles of Boot approach to financial planning – simple toll fixation criterions.

2. Surveying and Transportation Engineering

2.1 Surveying:

Common methods and instruments for distance and angle measurement for CE work – their use in plane table, traverse survey, leveling work, triangulation, contouring and topographical map.

Basic principles of photogrammetry and remote sensing.

2.2 Railway Engineering:

Permanent way – components, types and their functions – Functions and Design constituents of turn and crossings – Necessity of geometric design of track – Design of station and yards.

2.3 Highway Engineering:

Principles of Highway alignments – classification and geometrical design elements and standards for Roads.

Pavement structure for flexible and rigid pavements—Design principles and methodology of pavements.

Typical construction methods and standards of materials for stabilized soil, WBM, Bituminous works and CC roads.

Surface and sub-surface drainage arrangements for roads—culvert structures.

Pavement distresses and strengthening by overlays.

Traffic surveys and their applications in traffic planning—Typical design features for channelized, intersection, rotary etc.–signal designs – standard Traffic signs and markings.

3. Hydrology, Water Resources and Engineering:

3.1 Hydrology:

Hydrological cycle, precipitation, evaporation, transpiration, infiltration, overland flow, hydrograph, flood frequency analysis, flood routing through a reservoir, channel flow routing-Muskingam method.

3.2 Ground water flow:

Specific yield, storage coefficient, coefficient of permeability, confined and unconfined equifers, aquifers, aquitards, radial flow into a well under confined and unconfined conditions.

3.3 Water Resources Engineering:

Ground and surface water resource, single and multipurpose projects, storage capacity of reservoirs, reservoir losses, reservoir sedimentation.

3.4 Irrigation Engineering:

(i) Water requirements of crops: consumptive use, duty and delta, irrigation methods and their efficiencies.

(ii) Canals: Distribution systems for canal irrigation, canal capacity, canal losses, alignment of main and distributory canals, most efficient section, lined canals, their design, regime theory, critical shear stress, bed load.

(iii) Water logging: causes and control, salinity.

(iv) Canal structures: Design of, head regulators, canal falls, aqueducts, metering flumes and canal outlets.

(v) Diversion headwork: Principles and design of weirs of permeable and impermeable foundation, Khosla's theory, energy dissipation.

(vi) Storage works: Types of dams, design, principles of rigid gravity, stability analysis.

(vii) Spillways: Spillway types, energy dissipation.

(viii) River training: Objectives of river training, methods of river training.

4. Environmental Engineering:

4.1 Water Supply:

Predicting demand for water, impurities of water and their significance, physical, chemical and bacteriological analysis, waterborne diseases, standards for potable water.

4.2 Intake of water:

Water treatment: principles of coagulation, flocculation and sedimentation; slow-; rapid-, pressure-, filters; chlorination, softening, removal of taste, odour and salinity.

4.3 Sewerage systems:

Domestic and industrial wastes, storm sewage–separate and combined systems, flow through sewers, design of sewers.

4.4 Sewage characterization:

BOD, COD, solids, dissolved oxygen, nitrogen and TOC. Standards of disposal in normal watercourse and on land.

4.5 Sewage treatment:

Working principles, units, chambers, sedimentation tanks, trickling filters, oxidation ponds, activated sludge process, septic tank, disposal of sludge, recycling of wastewater.

4.6 Solid waste:

Collection and disposal in rural and urban contexts, management of long-term ill effects.

5. Environmental pollution:

Sustainable development. Radioactive wastes and disposal. Environmental impact assessment for thermal power plants, mines, river valley projects. Air pollution. Pollution control acts.