

## **Syllabus for Level-11 Post Code-NCB/CRT-02**

### **Introduction to Cement and cement manufacturing process in General:**

What is cement, its brief history and importance in construction, Cement manufacturing process, material and chemical composition of cement, various unit operations in cement manufacturing, present status and future of cement industry in India.

### **Types of Cement:**

Characteristics and use of OPC Clinker and various type of Cement such as, Ordinary Portland Cement, Blended Cements (PPC, PSC and PCC), Special Cements (Sulphate Resisting Cement, White Portland Cement, Low Heat Cement, Masonry Cement, Oil Well Cement, High Alumina Cement, Supersulphated Cement, Rapid hardening Cement and Hydrophobic Cement). Awareness of standard Indian (BIS) Codes for cement specifications.

### **Cement raw Materials:**

**Calcareous Raw Materials:** Various Source of Lime (Limestone, Chalk, Marl, Industrial waste) Awareness of geological distribution of limestone deposits in India. Awareness of specifications of grades of limestone. Assessment of physiochemical characteristics of limestone for Cement manufacturing using different methods/techniques.

**Argillaceous Raw Materials:** Source of silica, Alumina, Iron Oxide, Shale and effect of coal ash and additives use as corrective materials, Fly Ash, Slag, Lime sludge as cement raw materials. Assessment of materials for cement manufacturing through different methods/techniques.

**Additives:** Characteristics, types and use of various additive materials like Fly ash and slag. Relevant Indian Standards.

**Gypsum:** Types and Chemical properties of gypsum, Awareness of BIS Codes for gypsum. Influence of Raw Materials on unit operations

### **Raw mix proportioning, processing and burnability:**

Raw material selection and proportioning method (Raw Mix Design), Quality (Stoichiometric) Requirements in terms of oxides, phases, and moduli (Silica Modules, Alumina Modulus, Hydraulic Modulus, Lime Saturation Factor), Liquid Content, Impact of moduli values on cement manufacturing process and quality of clinker, potential phase calculation by Bogue equations, Coal ash absorption, Factors affecting burnability of raw meal like fineness, homogeneity, chemical and mineral characteristics, minor constituents, reactivity, Mineralizer, Role of additive in clinker formation, various mineralizer and fluxes, their role in manufacture of clinker.

Clinkerization reactions, sequence of reactions and reaction products, calculation of potential phase composition and liquid phase temperature, Bogue's calculation, formation of clinker minerals, absorption of constituents in clinker phase, phase diagram, Role of minor constituents in clinkerization, Thermo-chemistry of clinker formation.

### **Hydration of Portland cement:**

Hydration of clinker minerals, role of gypsum in cement hydration process, hydration and strength of Portland cement.

**Instrumental Methods of Analysis:**

Principles, working and applications of UV-VIS spectrophotometer, pH meter, conductivity meter, ion selective electrodes, flame photometer, Atomic Absorption Spectrophotometer, Induction Coupled Plasma (ICP) Spectrophotometer, Isothermal Conduction Calorimeter, TG/DTA, TGA, DSC, XRF, XRD and SEM. Applications of advanced instrumental techniques in cement R&D.

**Alternate Fuels and Raw Materials (AFR) Co-processing in Cement manufacturing:**

Traditional and alternate fuels and raw materials (AFR) in cement manufacturing, Types (based on source) and characteristics (hazardous and non-hazardous) of AFR, Assessment of AFR characteristics and effect on clinkerization CO<sub>2</sub>-processing of wastes as AFR materials in cement manufacturing, CPCB guidelines for co-processing.

**Clinker Grinding:**

Clinker Grindability, factors affecting clinker grindability.

**Quality Management and Quality Control Systems:**

Awareness about Quality Control and Quality Assurance, Product Quality management, ISO 9001:2015 and ISO/IEC 17025:2017.