3.6 INFRASTRUCTURE DEVELOPMENT STANDARDS & CODES

The **World Standards cooperation (WSC)**, a collaboration between; International Organization for Standardization (ISO), International Telecommunication Union (ITU), and International Electrotechnical Commission (IEC), sets the global framework for standards for many sectors including infrastructure and forms the backbone for the national standards in India. In the recent Global Quality Infrastructure Index (GQII) 2021, which ranks 184 economies in the world on the basis of the quality infrastructure (QI), **India's national accreditation system** under the Quality Council of India (QCI) has *ranked 5th in the world*, and our overall QI system ranked at the 10th position, with the standardization system (under BIS) at 9th and the metrology system (under NPL-CSIR) at 21st position in the world. The Bureau of Indian Standards (BIS), a statutory body established through legislation through The Bureau of Indian Standards Act 1986, adopts from ISO and IEC standards while the Ministry of Communication and Information Technology have ITU membership. The other standards making bodies of India, apart from BIS are; Telecom Engineering Centre (TEC), Telecommunications Standards Development Society of India (TSDSI), Automotive Research Association of India (ARAI), and Research Designs and Standards organization (RDSO).

In India, the roles and responsibilities for development of infrastructure is defined by the Constitution of India. While the centre is responsible for the critical national-level infrastructures, such as, National highways, Railways, Major ports, Airports and Telecom, the State together with the Municipality and Panchayats are responsible for regulating building construction, water management and supply, urban town planning, other roads and bridges, rural housing and rural electricity. To aid in Public-Private Partnership to see through infrastructural development, in 2007 the Centre set up the **India Infrastructure Project Development Fund (IIPDF) Scheme** aimed at creating appropriate mechanisms, guidelines, advisories, and funding support.

3.6.1 International and National Codes for Civil Engineering and Construction

There are a large number of **Indian Standard (IS) codes** that support the practice of civil engineering and architecture for safe and durable infrastructure construction. These offer guidelines, specifications, and safety prerequisites for construction materials, design parameters, testing techniques, and construction practices, and serve as a reference to guarantee consistency, safety, and excellence in civil engineering projects throughout the country.

Civil engineers refer to these codes for design and analysis of structures, as well as for specifications, methods and code of practice, for e.g., IS : 456; 10262; Sp 23 provides 'codes for designing concrete mixes', while IS : 2386 provides 'methods for tests for aggregate for concrete' and IS : 4925 provides 'specifications for concrete batching plant'. Dedicated list of standards is available for materials and elements, such as, Cement & Concrete, which in turn has codes on cement (IS 269, IS 8041, IS 650), coarse / fine Aggregate (IS 383, IS 2386), Masonry Mortar, Cement Concrete, Curing Compound, etc. Other codes cover Lime and Gypsum, and Doors, Windows and Shutters.

Nationally recognised, some of the **IS codes on civil engineering** are;

Code No.	Description
IS - 4031	Method of physical tests for hydraulic Cement
IS - 650	Specification for Standard sand for testing of Cement
IS - 383	Specification for Coarse and Fine aggregate for use in mass concrete
IS - 515	Specification for natural and manufactured aggregate for use in mass concrete.
IS - 2387	Method of test for aggregates for concrete.
IS - 516	Methods of test for strength of concrete.
IS - 1199	Methods of sampling and analysis of concrete
IS - 3025	Methods of sampling and test (physical and chemical) for water used in industry.
IS - 432	Specification for Mild steel and medium tensile bars and hard drawn steel wire.
IS - 1139	Specification for hot rolled mild steel, medium tensile steel and high yield strength steel deformed bars for concrete reinforcement.
IS – 1566	Specification for plain hard drawn steel wire fabric for concrete reinforcement
IS - 1785	Specification for plain hard drawn steel wire for prestressed concrete.
IS - 1786	Specification for cold twisted steel high strength deformed bars for concrete reinforcement.
IS - 303	Specification for Plywood for general purposes

Internationally recognised, the **ISO ICS 93 codes** are on civil engineering, and covers information on the following;

ISO Code No.	Description
93.010	Civil engineering in general Construction drawings, see 01.100.30
93.020	Earthworks. Excavations. Foundation construction. Underground works Including geotechnics. Earth-moving machinery, see 53.100
93.025	External water conveyance systems Including buried and above ground installations Pipelines and its parts for external water conveyance systems, see 23.040.03 Internal water supply systems, see 91.140.60
93.030	External sewage systems Sewage water disposal and treatment, see 13.060.30 Pipelines and its parts for external sewage systems, see 23.040.05 Internal drainage systems, see 91.140.80
93.040	Bridge construction
93.060	Tunnel construction
93.080	Road engineering
93.100	Construction of railways Including the construction of tramways, funicular railways, cableways, rail traffic control equipment and installations, etc. Rails and railway components, including track, see 45.080 Equipment for railway/cableway construction and maintenance, see 45.120
93.110	Construction of ropeways Ropeway equipment, see 45.100 Equipment for ropeway construction and maintenance, see 45.120
93.120	Construction of airports Including air transport control equipment and installations
93.140	Construction of waterways, ports and dykes Including river embankments, water transport control equipment and installations, etc.
93.160	Hydraulic construction Hydraulic energy equipment, see 27.140

In addition, the **National Building Code (NBC),** discussed in detail in Unit 5**,** a model code for adoption of across the nation and contains administrative regulations, development control rules and general building requirements; fire safety requirements; stipulations regarding materials, structural design and construction (including safety); construction management practices and safety, building and plumbing services; approach to sustainability; and asset and facility management is referred to during design and detailing construction working drawings .

Eventually the quality of design and execution is the onus of the Civil engineer and Architect. Thus, to aid in other complimentary areas, Niti Ayog has compiled the '**Indian Infrastructure Body of Knowledge –** A technical Baseline to the Practice of Program and Project Management in India**'** under the National Program and Project Management Policy Framework with the intention of "*laying down a plan of action and advocating short-term and long-term strategies for improving Program and Project Management practices in India, as well as align with the global best practices*" (CEO, Niti Ayog)

3.7 INNOVATIONS AND METHODOLOGIES FOR SUSTAINABILITY

Sustainable Infrastructure, be it built, natural or hybrid, are systems that are "*planned, designed, constructed, operated and decommissioned in a manner that ensures economic and financial, social, environmental, including climate resilience, and institutional sustainability over the entire infrastructure life cycle*" (UNEP). The Organisation for Economic Co-operation and Development (OECD) estimates that an annual investment of USD 6.9 trillion is needed for infrastructure to meet development goals and create a low carbon, climate resilient future by 2050. OECD's ***Strategic Policies for Sustainable Infrastructure*** identifies various themes that require attention, such as, Low-carbon transition, Technology and Innovation, Inclusiveness and Accessibility, etc.

Presently the OECD is developing a toolkit on quality infrastructure investment for policymakers and practitioners, based on the ***G20 Principles for Quality Infrastructure Investment (QII)***, developed under the Japanese G20 Presidency, that stated, "*quality infrastructure investment contributes to maximizing the positive impact of infrastructure to achieve sustainable growth and development, raising economic efficiency in view of life cycle costs, integrating environmental and social considerations in infrastructure, building resilience against natural disasters, and strengthening infrastructure governance*."

The UN Environment Assembly (UNEA) Members States in March 2023 adopted a resolution on '***Sustainable and Resilient Infrastructure'*** encouraging them to;

- provide opportunities for engaging relevant stakeholders,
- promote investment in sustainable and resilient infrastructure, natural infrastructure and nature-based solutions,
- cooperate internationally to strengthen frameworks, including for financing, and

- implement the '*International Good Practice Principles for Sustainable Infrastructure'*, which in turn has the following guiding principles ;
    1. Strategic Planning
    2. Responsive, Resilient, And Flexible Service Provision
    3. Comprehensive Life Cycle Assessment of Sustainability
    4. Avoiding Environmental Impacts and Investing In Nature
    5. Resource Efficiency and Circularity
    6. Equity, Inclusiveness, And Empowerment
    7. Enhancing Economic Benefits
    8. Fiscal Sustainability and Innovative Financing
    9. Transparent, Inclusive, And Participatory Decision-Making
    10. Evidence-Based Decision-Making

There are several **innovations and methodologies** that can be employed to ensure the sustainability of infrastructure development, such as :

1. ***Green infrastructure*** is a concept of incorporating the importance of Environment and considering the impact of decisions on it while developing infrastructure strategies. It involves the use of natural systems and materials to provide sustainable solutions, for e.g., green roofs, permeable pavements, and rain gardens, which can help to reduce stormwater runoff and mitigate the urban heat island effect.
2. ***Integrated Water Resources Management (IWRM)*** is a process that promotes the "*coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*" (UNEP).
3. ***Circular Economy*** or circularity is an economic model of production and consumption that seeks to eliminate waste and promote the sustainable use of resources. In the context of infrastructure development, it can be used to design infrastructure projects that prioritize the use of renewable materials, reduce waste, and promote the reuse and recycling of materials.
4. ***Tool and methods for reducing Environmental Impact***, such as, Environmental Impact Assessment (EIA) is a methodology used "*to identify the environmental, social and economic impacts of a project prior to decision-making*, Life-Cycle Assessment (LCA**)** is a tool used to "*evaluate the environmental impact of infrastructure projects throughout their entire life cycle, from raw material extraction to disposal*", and Building Information Modelling (BIM) is a digital modelling technology that enables the creation of detailed 3D models of infrastructure projects, to help improve project efficiency, reduce waste, and optimize the use of materials and resources.

Infrastructure design and development is crucial for a Nation's growth and civil engineers play the most pivotal role in ensuring quality, safety, innovation, and sustainability of the same, bearing great societal and global impact.

UNIT SUMMARY

This unit focusses on present and future projection of various facets of Infrastructure development by discussing concepts such as 'Smart City' and further delves into understanding critical infrastructure, such as, Transportation, Energy, Water resources management and Telecommunication. It also offers an overview on the Standards and Codes relevant for infrastructure and construction industry, and culminates with a discussion on present day initiatives, innovations and methodologies employed in this sector to ensure sustainability.

EXERCISES

I. Multiple Choice Questions

Q. 3.1 Which of the following are 'critical infrastructure' as per India ?
(a) Disaster Management
(b) Aviation
(c) Cyber security
(d) all of the above

Q. 3.2 What is the population of a 'Megacity' ?
(a) 1 to 5 million
(b) over 10 million
(c) less than 10 million
(d) 1 million

Q. 3.3 Which ancient Indian University town, now in present day Afghanistan, was connected to Prayagraj by the Great Road built by Mauryan Empire?
(a) Bhagalpur
(b) Gandhar
(c) Takshashila
(d) Benaras

Q. 3.4 What is the world's longest road tunnel?
(a) the Lærdalstunnelen
(b) Channel Tunnel
(c) Yamate Tunnel
(d) Gotthard Base Tunnel

Q. 3.5 Which of the following renewable energy source may be argued to not be a 'clean energy' source?
(a) Solar
(b) Biomass
(c) Geothermal
(d) Wind

Answers of Multiple Choice Questions: 3.1 (d) , 3.2 (b) , 3.3 (c), 3.4 (a), 3.5 (b

II. Short and Long Answer Type Questions

Q. 3.6 What is a 'Smart City'? Briefly explains the characteristics of a Smart City.

Q. 3.7 What are some of the potential new sources of energy? What are the associated challenges and impacts?

Q. 3.8 Define WASH? What are the various initiatives by Govt. of India to promote WASH?

Q. 3.9 What are the various types of physical facilities and equipment required as part of Telecommunication infrastructure? Discuss the challenges that impact Telecommunication infrastructure?

Q. 3.10 What is the importance of Infrastructure development standards and codes? Illustrate with examples how this supports the profession of civil engineering.