1. **Introduction**

Codes and standards serve as the backbone of civil engineering, providing guidelines, regulations, and best practices essential for ensuring the safety, reliability, and quality of the projects. They encompass a set of technical specifications, design criteria, and regulatory requirements established by professional organizations, government agencies, and industry stakeholders to govern the planning, design, construction, operation, and maintenance of civil engineering projects. These documents codify industry knowledge, research findings, and engineering principles into actionable guidelines that engineers, architects, contractors, and regulators adhere to in their respective roles. On the other hand, they promote innovation, protect public health and safety, and drive a sustainable development across diverse sectors of the built environment.

1. **History of codes and standards**

The history of technical standards is closely related to the history of humankind. Historically, The Code of Hammurabi written about 4000 years ago can be considered as the first example of standards. Many of the laws included in this document related to crimes, marriage, and general legal obligations but it also provided basic performance standards for construction of buildings and boats.

In the Middle Ages in Europe, there was no unified standard for measuring length, currency, or weight. For example, in the Baden region of today's Germany, there were 122 methods of measurement for length alone. For weight, 80 methods of measurement were in use. In other words, a uniform standard was not well established in the European Middle Ages.

Aside from the great people of old times, safety standards were implemented to social life, industry and business after major disasters or technological developments:

Fire that burned most of London in 1666 resulted in the first examples of current building and safety codes. Steam engine explosions throughout 1800s resulted in the initial version of the modern ASME boiler code in 1914. ASME boiler code later became Boiler and Pressure Vessel Code (BPVC) with sections on various types of pressure vessels, materials, welding, and inspection. Accidents in elevators, escalators, electrical processing equipment resulted in piping codes, lifting devices standards, electrical codes, and more. These examples of standards are prescriptive unlike the Code of Hammurabi, specifying dimensions of structures, materials of construction and method of processes.

Modern standards emphasize both performance and design by taking scientific theories and making modifications to permit their application in engineering for safe designs. Engineers often rely on national and international standards for obtaining appropriate material properties and safety factors for their designs. Such standards establish factors of safety based on experience, practical limits, and understanding of material characteristics such as endurance limits, creep, and fatigue crack growth rates.

The details in these standards are based on years of practical experience and they are subject to change in the light of new information. For example, the 1971 and 1994 earthquakes in Los Angeles and the collapse of the World Trade Center in 2001 resulted in considerable changes in steel construction joint details and other design requirements in construction standards.

1. **Roles of Codes and standards**

Codes and standards have numerous objectives as shown below:

* **Ensuring safety and public health**: Codes and standards play a crucial role in mitigating risks and preventing accidents in the built environment. They dictate minimum design loads, material strengths, and construction practices to ensure structural integrity and resistance to forces such as wind, earthquakes, and gravity loads.
* **Promoting quality and reliability:** Standards for materials, construction methods, and testing procedures ensure the consistency, performance, and the durability of building materials and components.
* **Fostering innovation and best practices:** Codes and standards evolve alongside technological advancements and lessons learned from past experiences. They serve as catalysts for innovation by encouraging the adoption of new materials, construction techniques, and sustainable practices that enhance efficiency, resilience, and environmental performance in civil engineering projects.
* **Ensuring regulatory compliance:** Codes and standards provide guidelines for engineers to ensure that their designs and constructions comply with local, state, and federal regulations governing zoning, land use, environmental protection, and public safety.
* **Challenges and opportunities:** Despite their critical importance, codes and standards present challenges such as complexity, inconsistencies, and gaps in coverage that require ongoing review, revision, and harmonization efforts. Globalization, climate change, and emerging technologies introduce new challenges and opportunities for codes and standards development.

The importance of codes and standards in civil engineering cannot be overstated. They serve as essential tools for ensuring safety, promoting quality, fostering innovation. As the built environment continues to evolve, codes and standards will play a central role in upholding excellence, driving progress, and advancing the collective goals of sustainability, resilience, and societal well-being in communities worldwide.

1. **Distinguishing between codes, standards, specifications and regulations**

Codes, standards, specifications and regulations are all crucial documents for civil engineers that contain roles, methods, and guidelines establishing a minimum acceptable levels of safety, quality, and reliability. In the following table, the differences between a code, standard, specification and regulation are considered:

|  |  |
| --- | --- |
| Item | Detail |
| Codes | Includes generally accepted sets of rules “ what you need to do”. |
| Standards | Provide the way of executing codes “how to”. |
| Specifications | Unlike codes or standards, they outline the requirements of a specific case or location. |
| Regulations | Which can incorporate codes and standards, are mandated by a government and required, by law, to be complied with. |

1. **Standards types**

The civil engineering standards can be divided into four types depending on their contents:

* **Fundamental standards**: they provide the rules for terminology, acronyms, symbols, and metrology (ISO 31: quantities and units).
* **Specification standards**: they indicate the characteristics and performance thresholds of a product or service (example: EN 2076-2: Aerospace series – Ingots and castings in aluminum and magnesium alloys.)
* **Analysis and testing standards**: they indicate the methods and means for carrying out a test on a product (example: ISO 6506-1: Metallic materials – Brinell hardness test – Part 1: Test method).
* **Organizational standards**: they describe the functions and organizational relationships within an entity (example: ISO 9001: Quality management systems – Requirements).
1. **National and international standards organizations:**

A standard is a reference document developed by a national or international standardization body that include all the stakeholders. The standards organizations can be classified by their role, position, and the extent of their influence on the local, national, regional, and global standardization arena.

By geographic designation, there are international, regional, and national standards bodies. By technology or industry designation, there are standards developing organizations (SDOs) and also standards setting organizations (SSOs). Standards organizations may be governmental, quasi-governmental or non-governmental entities. Quasi- and non-governmental standards organizations are often non-profit organizations.

1. **International standards** **organizations**

ISO (International Organization for Standardization) is an independent, non-governmental membership organization and the world's largest developer of voluntary International Standards. It is made up of 162 member countries, which are the national standards bodies around the world, with a Central Secretariat that is based in Geneva, Switzerland.

ISO is developing standards which deal with different issues covering almost every industry, from technology, to food safety, to healthcare, and ranging from product specification to quality management, sustainable development management, etc. They help to harmonize technical standards among countries through a consensus process within technical committees by groups of experts from all over the world. In the list below, some of the most popular ISO standards are reported:

* [ISO 13485:2016 - Medical Device Quality Management System](https://stendard.com/en-sg/iso-standards-list/#elementor-toc__heading-anchor-0)
* [ISO 14001:2015 - Environmental Management System](https://stendard.com/en-sg/iso-standards-list/#elementor-toc__heading-anchor-1)
* [ISO 22000:2018 - Food Safety Management System (FSMS)](https://stendard.com/en-sg/iso-standards-list/#elementor-toc__heading-anchor-2)
* [ISO 27001:2013 - Information Security Management System (ISMS)](https://stendard.com/en-sg/iso-standards-list/#elementor-toc__heading-anchor-3)
* [ISO 22301:2019 - Business Continuity Management Systems](https://stendard.com/en-sg/iso-standards-list/#elementor-toc__heading-anchor-4)
* ISO 3166 — Country Codes
* ISO/IEC 17025 — Testing and calibration laboratories
* ISO 8601 — Date and time format
* ISO/TC 98 Base for design structures.
* ISO/TC 98 Foundation of structural design.
* ISO/IEC 80000, Quantities and units

ISO is not the only international standards organization; there are other organizations, for instance:

* **ASME** Founded in 1880 as the American Society of Mechanical Engineers.
* **IEC** Founded in 1906, as the International Electrotechnical Commission.
* **ASTM** Founded in 1898 as American Society for Testing and Materials.
* **ASHRAE** Founded in 1894 as American Society of Heating, Refrigerating and Air-Conditioning Engineers.
1. **Regional standards organizations**

Regional standards bodies also exist, such as the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC), the European Telecommunications Standards Institute (ETSI), and the Institute for Reference Materials and Measurements (IRMM) in Europe and others.

Sub-regional standards organizations also exist such as the MERCOSUR Standardization Association (AMN), the CARICOM Regional Organization for Standards and Quality (CROSQ), and the ASEAN Consultative Committee for Standards and Quality (ACCSQ), EAC East Africa Standards Committee, and the GCC Standardization Organization (GSO) for Arab States of the Persian Gulf.

1. **National standards organizations**

In general, each country or economy has a single recognized national standards body (NSB). A national standards body is likely the sole member from that economy in ISO. National standards bodies usually do not prepare the technical content of standards, which instead is developed by national technical societies.

* IANOR, or Algerian Institute of Standardization, is an industrial and commercial public institution (EPIC) founded on February 21, 1998, following Executive Decree 98-69. This creation is part of a broader restructuring including INAPI (Algerian Institute of Standardization and Industrial Property). Under the supervision of the Ministry of Industry and Mines, IANOR represents Algeria within the International Organization for Standardization (ISO).
* Operating under the authority of the Ministry of Industry, the Algerian Accreditation Body, ALGERAC, was established by Executive Decree No 05-466 of 6 December 2005, and is acknowledged by its peers as the only national organization to have the power to deliver accreditations- following an evaluation based on international standards- in favor of conformity assessing bodies testifying their technical and organizational competence to provide services relating to testing, analyzing, calibration, inspection, or certification.
* INAPI, the Algerian National Institute of Industrial Property, was established by Executive Decree 98-68 of February 21, 1998. The institute 's mission is to protect industrial property rights by providing public services, which consist of registering applications for the protection of patents for inventions, trademarks, designs, models and designations of origin.
* The National Office of Legal Metrology (ONML), initially regulated by a decree in September 1986, is an authority in charge of a number of tasks covering areas such as health, public safety, and environmental protection, in addition to commercial aspects. This authority is responsible for verifying the conformity of measuring instruments with legal standards, monitoring their use, and enforcing metrology regulations.