

UNIT-1

Basics of Civil Engineering

Engineering is a broad and multidisciplinary field that involves the application of scientific and mathematical principles to design, build, maintain, and improve systems, structures, devices, and processes. Engineers are responsible for solving complex problems and creating practical solutions that benefit society. Engineering plays a crucial role in various industries and sectors, from aerospace and civil infrastructure to computer technology and biomedical applications.

There are numerous branches of engineering, each focusing on specific areas of expertise. Some of the major branches of engineering include:

1. **Civil Engineering:** Civil engineers design and oversee the construction of infrastructure such as roads, bridges, buildings, and water supply systems.
2. **Mechanical Engineering:** Mechanical engineers work with machines, engines, and mechanical systems, designing, analyzing, and improving them.
3. **Electrical Engineering:** Electrical engineers are involved in the design and maintenance of electrical systems, including power generation, distribution, and electronic devices.
4. **Computer Engineering:** Computer engineers develop and design computer hardware and software, including computer systems, networks, and embedded systems.
5. **Chemical Engineering:** Chemical engineers work with chemicals and chemical processes to design and optimize the production of various products, from pharmaceuticals to petrochemicals.
6. **Aerospace Engineering:** Aerospace engineers focus on the design and development of aircraft, spacecraft, and related systems.
7. **Biomedical Engineering:** Biomedical engineers combine principles from engineering and biology to create medical devices, artificial organs, and diagnostic equipment.
8. **Environmental Engineering:** Environmental engineers work on projects related to environmental protection and sustainability, such as water treatment and pollution control.
9. **Materials Engineering:** Materials engineers study and develop new materials with specific properties for various applications, from metals to polymers and composites.
10. **Industrial Engineering:** Industrial engineers focus on optimizing complex systems and processes, often in manufacturing or logistics.
11. **Petroleum Engineering:** Petroleum engineers are involved in the exploration and production of oil and gas resources.
12. **Software Engineering:** Software engineers design and develop software applications and systems, including computer programs and mobile apps.

Engineers use their knowledge of mathematics, physics, and various tools and technologies to design, test, and implement solutions to real-world problems. They often work in multidisciplinary teams and collaborate with professionals from other fields. The field of engineering continues to evolve with advancements in technology, and engineers play a critical role in shaping the future by solving complex challenges and improving our quality of life.

Role of Civil Engineers in Society:

Civil engineers play a crucial role in society by designing, constructing, and maintaining the infrastructure and facilities that are essential for the functioning and development of communities. Their work has a significant impact on public safety, the environment, and the overall quality of life. Here are some of the key roles and responsibilities of civil engineers in society:

- 1. Infrastructure Development:** Civil engineers are responsible for planning, designing, and supervising the construction of critical infrastructure, including roads, bridges, highways, tunnels, and public transportation systems. This infrastructure is vital for transportation and economic development.
- 2. Building Construction:** Civil engineers are involved in the design and construction of various structures, such as residential buildings, commercial complexes, and industrial facilities. They ensure that these structures are safe, durable, and comply with building codes and regulations.
- 3. Water Resources Management:** Civil engineers work on projects related to water supply, distribution, and wastewater treatment. They design and maintain water supply systems, dams, reservoirs, and sewage treatment plants to ensure access to clean water and the proper disposal of waste.
- 4. Environmental Protection:** Civil engineers help mitigate the environmental impact of construction projects. They develop strategies for minimizing pollution, managing stormwater runoff, and designing eco-friendly and sustainable infrastructure.
- 5. Disaster Preparedness and Mitigation:** Civil engineers are involved in disaster preparedness and response efforts. They design and construct buildings and infrastructure that can withstand natural disasters like earthquakes, hurricanes, and floods, reducing potential loss of life and property.
- 6. Public Health and Safety:** Civil engineers are responsible for ensuring public safety by designing infrastructure that meets safety standards and codes. They evaluate existing structures for safety and recommend necessary repairs or upgrades.
- 7. Urban Planning:** Civil engineers contribute to urban development by designing and planning cities and communities. They consider factors like land use, traffic flow, zoning regulations, and environmental sustainability.
- 8. Transportation Systems:** Civil engineers work on transportation systems, including the planning and design of road networks, public transit systems, and airports. They aim to improve the efficiency and safety of transportation.
- 9. Energy Infrastructure:** Civil engineers are involved in the construction and maintenance of energy-related infrastructure, such as power plants, electrical grids, and renewable energy facilities.
- 10. Project Management:** Civil engineers often take on project management roles, overseeing budgets, schedules, and resources to ensure that projects are completed efficiently and within specified constraints.
- 11. Community Development:** Civil engineers contribute to the growth and development of communities by designing and constructing parks, recreational facilities, and public spaces that enhance the quality of life for residents.
- 12. Sustainability:** In recent years, civil engineers have increasingly focused on sustainability, striving to design and build infrastructure that is environmentally friendly, energy-efficient, and socially responsible.

Civil engineers are essential in shaping the physical environment of society, and their work impacts the safety, health, and well-being of people. They must balance the demands of economic development with environmental and social responsibility to create a sustainable and prosperous future for communities.

Various Disciplines of Civil Engineering:

Civil engineering is a diverse field with various sub-disciplines, each specializing in different aspects of the design, construction, and maintenance of infrastructure and structures. Here are some of the major disciplines within civil engineering:

1. Construction Engineering
2. Structural Engineering
3. Geotechnical Engineering
4. Transportation Engineering
5. Environmental Engineering
6. Water Resources Engineering
7. Surveying and Geomatics
8. Materials Engineering
9. Earthquake Engineering
10. Urban and Regional Planning
11. Hydraulics Engineering
12. Risk and Safety Engineering
13. Forensic Engineering
14. Structural Health Monitoring

1. Construction Engineering:

Construction engineers oversee the actual construction of projects, ensuring that designs are implemented correctly and efficiently. They manage resources, schedules, and budgets.

Construction engineering, also known as construction management, is a specialized field within civil engineering that focuses on the planning, coordination, and management of construction projects. Construction engineers are responsible for ensuring that construction projects are completed safely, on time, within budget, and according to design specifications. Here's an overview of construction engineering and its scope:

- **Project Planning:** Construction engineers are involved in the initial planning of construction projects. They help define project objectives, develop project schedules, and create budgets, taking into account the scope of work, materials, labor, and equipment requirements.
- **Budgeting and Cost Control:** They play a critical role in budget management, ensuring that construction projects stay within the allocated budget. They monitor expenses, analyze cost variations, and make necessary adjustments to control costs.
- **Project Scheduling:** Construction engineers develop and maintain project schedules to ensure that construction activities are executed in the right sequence and that deadlines are met. They may use project management software to plan and track progress.
- **Procurement and Material Management:** They oversee the procurement of construction materials and equipment. This includes selecting suppliers, negotiating contracts, and managing the timely delivery of materials to the construction site.
- **Site Management:** Construction engineers manage the construction site, including coordinating the work of subcontractors, labor, and equipment. They ensure that construction activities adhere to safety regulations and quality standards.
- **Quality Control:** They are responsible for quality control and quality assurance processes, which involve monitoring construction activities to ensure that the work complies with project specifications and industry standards.
- **Safety Management:** Construction engineers prioritize safety on the construction site, implementing safety protocols, conducting safety inspections, and addressing potential hazards to protect workers and the public.

- **Risk Management:** They identify and assess project risks, such as unforeseen conditions, weather delays, and labor shortages, and develop risk mitigation strategies to minimize project disruptions.
- **Contract Management:** Construction engineers administer contracts, ensuring that contractors and subcontractors fulfill their contractual obligations. This includes managing change orders, progress payments, and dispute resolution.
- **Documentation and Reporting:** They maintain project records, document progress, and generate reports for project stakeholders. Clear documentation is essential for project accountability and compliance.
- **Environmental Compliance:** Construction engineers ensure that construction projects comply with environmental regulations and take steps to minimize the environmental impact of construction activities.
- **Stakeholder Communication:** Effective communication is a vital aspect of construction engineering. Engineers interact with clients, government agencies, architects, designers, and other project stakeholders to ensure that everyone is informed about project progress.
- **Sustainable Construction:** With a growing emphasis on sustainability, construction engineers are increasingly involved in green building practices, sustainable materials, energy-efficient construction methods, and environmentally responsible construction projects.
- **Career Opportunities:** Construction engineers work in various sectors, including construction companies, general contractors, real estate development, government agencies, and consulting firms. They manage projects of different scales, from residential and commercial buildings to large infrastructure projects.

The scope of construction engineering is diverse, and professionals in this field are essential for the successful execution of construction projects. They ensure that projects are completed on time, within budget, and according to quality and safety standards. Construction engineers contribute to the development of infrastructure and the built environment, playing a crucial role in shaping the physical landscape of society.

2. Structural Engineering:

Structural engineers design and analyze the structural components of buildings and infrastructure, ensuring they can withstand various loads and environmental conditions. They work on projects such as bridges, buildings, dams, and towers.

Structural engineering is a specialized branch of civil engineering that focuses on the design, analysis, and construction of structures to ensure their safety, stability, and durability. Structural engineers are responsible for creating the framework of buildings, bridges, dams, and other infrastructure, making them strong enough to withstand various loads, environmental conditions, and potential hazards. Here are key aspects of structural engineering and its scope:

- **Design and Analysis:** Structural engineers design the framework of structures and analyze the loads, forces, and stresses acting on them. They use mathematical models and computer simulations to determine the best materials and shapes to achieve structural stability.
- **Materials Selection:** Structural engineers choose appropriate building materials, such as concrete, steel, wood, and composites, based on their strength, durability, and cost-effectiveness for a specific project.
- **Safety and Regulations:** They ensure that structures comply with building codes, safety regulations, and environmental standards to protect public safety and the environment. They also consider seismic and wind load requirements.
- **Sustainability:** In the modern construction industry, structural engineers play a critical role in incorporating sustainable practices by optimizing designs for energy efficiency and using environmentally friendly materials.

- **Project Management:** They coordinate with architects, construction managers, and other professionals to ensure that the design and construction processes run smoothly, within budget, and on schedule.
- **Retrofitting and Rehabilitation:** Structural engineers assess existing structures and recommend repairs, retrofits, or rehabilitation to extend their lifespan or bring them up to current safety standards.
- **Specialization:** Structural engineering has various specializations, such as earthquake engineering, where engineers focus on designing structures to withstand seismic activity, and offshore engineering, which deals with structures in marine environments.
- **Software and Technology:** The field of structural engineering has seen significant advancements in software and technology, which allow engineers to create sophisticated designs, conduct complex simulations, and use digital tools for analysis and modeling.
- **Research and Development:** Structural engineers often engage in research and development to discover new materials and construction techniques that can improve the efficiency and sustainability of structures.
- **Career Opportunities:** Structural engineers work in various sectors, including construction, consulting firms, government agencies, and research institutions. They may also specialize in specific types of structures, such as high-rise buildings, bridges, or industrial facilities.
- **Global Opportunities:** Structural engineers have opportunities to work on projects worldwide, including large-scale infrastructure and architectural marvels. Their expertise is in demand for the construction of iconic structures and to address the growing infrastructure needs of urbanization.

The scope of structural engineering continues to expand as society's infrastructure needs evolve. Structural engineers are at the forefront of creating innovative solutions for the construction of safe, sustainable, and resilient structures. They play a vital role in shaping the built environment and ensuring that the world's infrastructure is both functional and safe for generations to come.

3. Geotechnical Engineering:

Geotechnical engineers study the behavior of soil and rock and how it interacts with structures. They provide foundation design and solutions to mitigate issues like soil settlement and landslides.

Geotechnical engineering is a specialized branch of civil engineering that focuses on the behavior of Earth materials, including soil and rock, and their interaction with infrastructure and construction projects. Geotechnical engineers play a crucial role in ensuring the safety, stability, and longevity of civil engineering projects by addressing geologic and geotechnical challenges. Here's an overview of geotechnical engineering and its scope:

- **Site Investigation and Characterization:** Geotechnical engineers assess the physical and mechanical properties of soils and rocks at construction sites. They use techniques such as drilling, sampling, and testing to determine the subsurface conditions, including soil types, compaction, permeability, and bearing capacity.
- **Foundation Design:** One of the primary responsibilities of geotechnical engineers is to design suitable foundations for structures. They analyze the soil properties to ensure that foundations can support the loads and maintain stability over time. This includes designing shallow foundations (e.g., spread footings) or deep foundations (e.g., piles or caissons).
- **Slope Stability Analysis:** Geotechnical engineers evaluate and mitigate the risks of landslides and slope instability. They design measures such as retaining walls, slope stabilization systems, and embankment reinforcements to prevent or mitigate slope failures.
- **Earthquake Engineering:** In regions prone to seismic activity, geotechnical engineers play a vital role in designing structures and foundations that can withstand ground shaking. They evaluate the liquefaction potential of soils and develop earthquake-resistant designs.

- **Tunneling and Underground Construction:** Geotechnical engineers work on tunneling and underground projects, addressing issues related to tunnel design, excavation support, and ground stabilization. They ensure the safety and integrity of tunnels and underground structures.
- **Dams and Levees:** Geotechnical engineers are involved in the design and assessment of dams and levees. They focus on ensuring the stability of these structures and addressing issues related to seepage, erosion, and embankment materials.
- **Soil Improvement and Ground Improvement:** Geotechnical engineers develop techniques to improve the engineering properties of soils. This can involve methods like compaction, grouting, and soil reinforcement to enhance bearing capacity and reduce settlement.
- **Environmental Geotechnics:** Geotechnical engineers are concerned with issues related to waste disposal, landfill design, and environmental contamination. They assess the suitability of soils for waste containment and design systems to protect the environment.
- **Offshore Geotechnics:** In marine and offshore projects, geotechnical engineers address challenges associated with seabed conditions, foundation design for offshore platforms, and submarine pipelines.
- **Research and Development:** Geotechnical engineers often engage in research to develop new geotechnical materials, methods, and technologies to improve the field's practices and sustainability.
- **Geotechnical Consulting:** Geotechnical engineers work in consulting firms, construction companies, government agencies, and research institutions. They provide expertise to various industries, from civil construction to mining and environmental protection.
- **Global Opportunities:** Geotechnical engineers have opportunities to work on projects worldwide, particularly in regions with diverse geological conditions and infrastructure development needs.

The scope of geotechnical engineering is essential for ensuring the safety, stability, and performance of various civil engineering projects, ranging from buildings and bridges to tunnels and dams. Geotechnical engineers are responsible for understanding and mitigating geological challenges to create sustainable and resilient infrastructure. They work at the intersection of geology, soil mechanics, and civil engineering, and their expertise is crucial for the success of construction projects and the protection of the environment.

4. Transportation Engineering:

Transportation engineers plan, design, and manage transportation systems, including roads, highways, railways, airports, and public transit. They aim to improve traffic flow, safety, and sustainability.

Transportation engineering is a sub-discipline of civil engineering that deals with the planning, design, operation, and maintenance of transportation systems and infrastructure. It plays a vital role in ensuring the efficient, safe, and sustainable movement of people and goods. Here's an overview of transportation engineering and its scope:

- **Road and Highway Engineering:** Transportation engineers design and maintain road networks, highways, and streets. They consider factors like traffic flow, road safety, pavement design, and the incorporation of intelligent transportation systems (ITS) for efficient traffic management.
- **Bridge Engineering:** Bridge engineers specialize in designing, inspecting, and maintaining bridges and other structures that cross bodies of water, highways, railways, and other transportation routes. They ensure structural integrity and safety.
- **Traffic Engineering:** Traffic engineers analyze and manage traffic flow, traffic control devices (e.g., signals and signs), and intersections. They use traffic modeling and simulation to optimize signal timing and road design to minimize congestion.

- **Public Transportation:** Transportation engineers work on the planning, design, and operation of public transit systems, such as buses, trams, light rail, and subway systems. They aim to improve accessibility, safety, and efficiency.
- **Railroad Engineering:** Railroad engineers design and maintain railway systems, tracks, stations, and facilities. They focus on track alignment, signaling, and railway safety.
- **Airport Engineering:** Airport engineers design and plan airport facilities, including runways, terminals, hangars, and ground support equipment. They ensure airport safety, efficiency, and compliance with aviation regulations.
- **Port and Harbor Engineering:** Port and harbor engineers deal with the design and management of port facilities, including piers, docks, navigation channels, and waterfront infrastructure. They enhance maritime transportation and cargo handling.
- **Intelligent Transportation Systems (ITS):** ITS engineers work on technology-based solutions to improve transportation efficiency. This includes traffic management systems, electronic toll collection, and connected and autonomous vehicles.
- **Transportation Planning:** Transportation planners work on long-term strategies and policies for transportation systems. They address urban planning, land use, and multimodal transportation to reduce congestion and improve accessibility.
- **Urban Mobility:** Transportation engineers contribute to urban mobility by developing strategies for improving the flow of people and goods within cities. This includes pedestrian-friendly design, bike lanes, and traffic calming measures.
- **Career Opportunities:** Transportation engineers can find employment in government transportation departments, consulting firms, construction companies, research institutions, and more. They work on a variety of projects, from small local roads to large-scale infrastructure developments.

The scope of transportation engineering continues to evolve with advances in technology, urbanization, and environmental considerations. Transportation engineers play a crucial role in shaping the way people and goods move in a sustainable and efficient manner. They work to reduce traffic congestion, improve safety, and enhance the overall quality of transportation systems while considering the environmental impact.

5. Environmental Engineering:

Environmental engineers work on projects related to water supply, wastewater treatment, air quality, and pollution control. They focus on preserving the environment and public health while meeting infrastructure needs.

Environmental engineering is a specialized field within civil engineering that focuses on the application of scientific and engineering principles to protect and improve the environment. Environmental engineers work on a wide range of projects aimed at minimizing and mitigating the impact of human activities on the environment. Here's an overview of environmental engineering and its scope:

- **Water and Wastewater Management:** Environmental engineers design and implement systems for the treatment and distribution of clean drinking water and the collection and treatment of wastewater. They work on projects related to water supply, sewage treatment, and stormwater management.
- **Air Quality Management:** Environmental engineers are involved in air quality monitoring and control. They develop strategies to reduce air pollution and emissions from industrial facilities, vehicles, and other sources. They also design and implement air pollution control systems.
- **Solid and Hazardous Waste Management:** Environmental engineers manage the disposal of solid waste and hazardous materials. They design landfills, recycling programs, and waste-to-energy systems. They also develop strategies for the safe disposal and remediation of hazardous waste sites.

- **Environmental Impact Assessment:** Environmental engineers assess the potential environmental impact of various projects, such as construction, industrial development, and infrastructure projects. They ensure that these projects comply with environmental regulations and standards.
- **Remediation of Contaminated Sites:** Environmental engineers work on the remediation of contaminated sites, such as brown fields and Superfund sites. They develop and implement strategies to clean up polluted soil and groundwater, making them safe for human and environmental health.
- **Environmental Compliance:** They help industries and organizations comply with environmental laws and regulations by monitoring and reporting on emissions, water quality, and waste management practices.
- **Water Resources Management:** Environmental engineers are involved in the sustainable management of water resources, including water conservation, watershed management, and the design of systems for water storage and distribution.
- **Urban Planning and Green Infrastructure:** They collaborate with urban planners to develop green infrastructure solutions, including parks, green roofs, and sustainable urban design, to enhance the quality of urban environments.
- **Research and Development:** Environmental engineers engage in research to develop innovative technologies and strategies for environmental protection, sustainability, and resource conservation.
- **Regulatory and Policy Development:** Environmental engineers often contribute to the development of environmental policies and regulations at the local, regional, and national levels.
- **Climate Change Mitigation:** Given the growing concern over climate change, environmental engineers are increasingly involved in projects aimed at reducing greenhouse gas emissions and adapting to the impacts of a changing climate.
- **Career Opportunities:** Environmental engineers can find employment in various sectors, including government agencies, consulting firms, research institutions, nonprofit organizations, and industries involved in environmental management.

The scope of environmental engineering is broad, and it continues to evolve as society faces increasingly complex environmental challenges. Environmental engineers play a crucial role in protecting and improving the environment, promoting sustainability, and ensuring a healthier and more sustainable future for both human communities and the natural world.

6. Water Resources Engineering: Water resources engineers manage and develop water-related infrastructure, including dams, reservoirs, flood control systems, and irrigation projects. They address water supply, quality, and distribution issues.

7. Surveying and Geomatics : Surveyors and geomatics engineers are responsible for accurate measurement and mapping of land and structures. They provide data critical for design, construction, and land management.

8. Materials Engineering: Materials engineers focus on the properties and behavior of construction materials like concrete, steel, and asphalt. They aim to develop materials that are strong, durable, and sustainable.

9. Earthquake Engineering: Earthquake engineers design structures and infrastructure to resist seismic forces and protect against earthquake damage. They consider factors like building codes, retrofitting, and foundation design.

10. Urban and Regional Planning: Urban and regional planners work on the overall development and organization of communities and cities. They consider land use, zoning, transportation, and environmental sustainability.

11. Hydraulic Engineering: Hydraulic engineers deal with the flow and management of water. They work on projects such as river and floodplain management, water conveyance systems, and hydroelectric power generation.

12. Risk and Safety Engineering: Risk and safety engineers assess and manage risks associated with engineering projects, ensuring the safety of workers and the public. They work on hazard analysis and safety planning.

13. Forensic Engineering: Forensic engineers investigate structural failures and accidents to determine their causes and provide expert opinions in legal and insurance matters.

14. Structural Health Monitoring: Engineers in this discipline focus on the continuous monitoring and assessment of the health and condition of existing structures, such as bridges and buildings, to ensure safety and longevity.

These sub-disciplines within civil engineering demonstrate the wide range of specialties that professionals in this field can pursue. Civil engineers often work in multidisciplinary teams to address complex challenges in the design, construction, and maintenance of infrastructure and the built environment.

Building Construction and Planning:

Building construction and planning involve the processes and activities related to designing, constructing, and managing buildings and other structures. This field encompasses various aspects, from architectural design and engineering to regulatory compliance and project management. Here are some key components and steps involved in building construction and planning:

1. Project Planning:

- Define the project scope and objectives.
- Determine the budget and timeline.
- Identify stakeholders and their requirements.

2. Site Selection and Preparation:

- Choose an appropriate location for the building.
- Prepare the site by clearing it, leveling the land, and addressing environmental considerations.

3. Architectural Design:

- Develop the building's design, including its layout, aesthetics, and functionality.
- Consider factors such as space utilization, aesthetics, and sustainability.
- Create architectural drawings and blueprints.

4. Engineering and Structural Design:

- Ensure the building's structural integrity and safety.
- Determine the materials and construction methods to be used.
- Design the building's foundation, framework, and systems (electrical, plumbing, HVAC, etc.).

5. Regulatory Approvals:

- Obtain necessary permits and approvals from local authorities.
- Ensure compliance with building codes and zoning regulations.

6. Construction Documents:

- Create detailed construction documents that include architectural and engineering plans.
- Specify the materials, equipment, and construction methods to be used.

7. Bidding and Contracting:

- Select contractors through a bidding process or negotiation.
- Establish contracts that outline project scope, cost, and timeline.

8. Construction Phase:

- Mobilize the construction team and equipment.
- Manage the construction process, including quality control, safety, and progress tracking.
- Address any changes or unforeseen issues that may arise during construction.

9. Quality Control and Inspections:

- Conduct regular inspections to ensure work is done according to plans and specifications.
- Address any defects or issues promptly.

10. Project Management:

- Oversee the project schedule and budget.
- Coordinate the activities of contractors and subcontractors.
- Communicate with stakeholders and provide regular updates.

11. Safety and Environmental Considerations:

- Implement safety measures to protect workers and the public.
- Address environmental concerns, such as waste management and sustainability.

12. Completion and Commissioning:

- Complete the construction work and ensure all systems are functional.
- Obtain occupancy permits and certifications.

13. Post-Construction:

- Hand over the building to the owner.
- Address any post-construction issues or warranty claims.

14. Maintenance and Facility Management:

- Develop a maintenance plan to ensure the building's long-term functionality and safety.
- Manage the ongoing operation of the building and its systems.

Building construction and planning require collaboration among various professionals, including architects, engineers, contractors, project managers, and regulatory authorities. Effective communication and adherence to quality standards and regulations are essential for successful projects. Additionally, sustainability and energy efficiency considerations are increasingly important in modern building construction and planning to address environmental concerns and reduce operational costs.

Construction Materials:

1.Cement:

Cement is a binding material made up of mixture of Argillaceous, Calcareous and siliceous materials.

The earliest known occurrence of Cement dates back to twelve million years ago. Cement was formed after oil shale adjacent to limestone burned naturally. These ancient deposits were studied in the 1960s and 1970s and identified as Cement.

Cement is abundantly used in construction as a binding material, and its applications in various fields have made it an important civil engineering material. It is even a common household name for fixing spots or cracks on walls. Let us study Cement in detail, composition, and its use these days. Let's look at some of the frequently asked questions about Cement:

In the early 19th century (1824), limestone was used as the binder material for buildings. This limestone was an excellent binding material that is still used but could not impart great strength and hence failed as a binding material in modern-day architecture. At that time, Joseph Aspdin of Yorkshire, England, discovered a new building material by heating limestone and clay together in a specific proportion and then giving birth to our modern-day Cement. The Cement prepared was Hydraulic cement, one that hardens after adding water into it and is known as Ordinary portland cement.

What is the Composition of Cement?

The composition of Cement broadly consists of the following two types of constituents: a constituent in its body, which are calcareous compounds like lime, chalk, and marine shells which have a heavy amount of calcium in them, along with argillaceous compounds like clay, marl, and shale having a good amount of silica in them. So, the elemental composition of Cement is lime (obtained from calcareous compounds) and silica (obtained from argillaceous compounds) which covers a significant portion of the Cement body. Alongside vast lime and silica, there are few other constituents like Alumina, Calcium sulphate, Iron oxide, magnesia, sulphur, and alkalies.

Constituents of Ordinary Portland Cement

Compound	Chemical Formula	Percentage
Lime	CaO	62% – 67%
Silica	SiO ₂	17% – 25%
Alumina	Al ₂ O ₃	3% – 8%
Calcium Sulphate	CaSO ₄	3% – 4%
Iron Oxide	Fe ₂ O ₃	3% – 4%
Magnesia	MgO	1% – 3%
Sulphur	SS	1% – 3%
Alkalies	Na ₂ O, K ₂ O	0.2% – 1%

Types of Cement:

There are several types of cement, each with specific properties and intended uses. The choice of cement type depends on the requirements of the construction project and the environmental conditions. Here are some common types of cement:

1. Ordinary Portland Cement (OPC):

- OPC is the most commonly used type of cement in construction.
- It is available in different grades, including Type I, Type II, Type III, Type IV, and Type V, each with specific characteristics.
- Type I is the general-purpose cement, while the other types are used in specialized applications.

2. Portland Pozzolana Cement (PPC):

- PPC is a blend of Portland cement and pozzolanic materials such as fly ash, volcanic ash, or calcined clay.
- It offers improved workability, reduced heat of hydration, and enhanced durability.
- PPC is commonly used in projects where environmental considerations are important.

3. Rapid Hardening Cement (RHC):

- RHC, also known as Quick-Setting Cement, gains strength rapidly and sets quickly.
- It is used in applications that require early strength development, such as repair work and precast concrete production.

4. High Alumina Cement (HAC):

- HAC contains a higher percentage of alumina and less silica and iron oxide compared to OPC.
- It offers exceptional heat resistance and strength, making it suitable for refractory applications and in the construction of structures exposed to high temperatures.

5. Sulfate-Resistant Cement (SRC):

- SRC is designed to resist the chemical attacks of sulfates, which can occur in soils or water with high sulfate content.
- It is commonly used in coastal and marine construction projects.

6. White Cement:

- White cement is produced from raw materials with low iron content, resulting in a white or off-white color.
- It is primarily used for decorative and architectural purposes, such as in the production of white concrete or for making terrazzo.

7. Oil-Well Cement:

- Oil-well cement is specially designed for cementing oil wells and is used in the petroleum industry.
- It must meet specific requirements for downhole conditions, including high temperature and pressure.

8. Masonry Cement:

- Masonry cement is a blend of Portland cement and finely ground sand.
- It is specifically designed for use in masonry applications, such as bricklaying, plastering, and stucco.

9. Expansive Cement:

- Expansive cement expands slightly while setting, which can be useful in applications where tight sealing is required, such as grouting anchor bolts.

10. Low Heat Cement:

- Low heat cement generates less heat during hydration, making it suitable for large concrete pours to minimize the risk of cracking due to temperature differentials.

11. Blast Furnace Slag Cement (BFSC):

- BFSC is made by blending ground granulated blast furnace slag with Portland cement.

- It offers improved resistance to chemical and physical attacks and is often used in marine and chemical-resistant structures.

These are some of the common types of cement used in the construction industry. The choice of cement type depends on the specific project requirements, including factors such as strength, durability, setting time, and environmental considerations.

Field Tests of Cement:

1. **Date of Manufacturing:** As the strength of cement reduces with age, the date of manufacturing of cement bags should be checked.
2. **Cement Color:** The color of cement should be uniform. It should be typical cement color i.e. gray color with a light greenish shade.
3. **Whether Hard Lumps are Formed:** Cement should be free from hard lumps. Such lumps are formed by the absorption of moisture from the atmosphere.
4. **Temperature Inside Cement Bag:** If the hand is plunged into a bag of cement, it should be cool inside the cement bag. If hydration reaction takes place inside the bag, it will become warm.
5. **Smoothness Test:** When cement is touched or rubbed in between fingers, it should give a smooth feeling. If it felt rough, it indicates adulteration with sand.
6. **Water Sinking Test:** If a small quantity of cement is thrown into the water, it should float some time before finally sinking.
7. **The smell of Cement Paste:** A thin paste of cement with water should feel sticky between the fingers. If the cement contains too much-pounded clay and silt as an adulterant, the paste will give an earthy smell.
8. **Glass Plate Test:** A thick paste of cement with water is made on a piece of a glass plate and it is kept under water for 24 hours. It should set and not crack.
9. **Block Test:** A 25mm × 25mm × 200mm (1"×1"×8") block of cement with water is made. The block is then immersed in water for three days. After removing, it is supported 150mm apart and a weight of 15kg uniformly placed over it. If it shows no sign of failure the cement is good.

2.Aggregates:

Definition: Aggregates are coarse particulate rock-like material consisting of a collection of particles ranging in size from < 0.1 mm to > 50 mm. It includes gravel, crushed rock, sand, recycled concrete, slag, and synthetic aggregate.

Aggregate is a granular material, such as sand, gravel, crushed stone, crushed Hydraulic- cement concrete, or iron blast-furnace slag, used with a hydraulic cementing medium to produce either concrete or mortar. Types of aggregates include Coarse aggregate and fine aggregate. The aggregate of each type is further sub-divided into many types and classification based on its size. The technique of Sieve Analysis is used for gradation of aggregate for use in concrete and for other applications.

Aggregate is called bound material when it is mixed with cement or binding materials and referred to as unbound material when used without cement or binding materials.

Aggregate Origin and Geology:

Aggregates are commonly obtained by crushing naturally occurring rock. The properties of aggregates depend on the parent rock which can be igneous, sedimentary, or metamorphic. Aggregates are evaluated

through tests to determine their suitability for various applications. Mineralogy, grain size and texture, and petrographic description of rock samples are also used to evaluate suitability.

Types of Aggregates:

1. Coarse Aggregate:

Coarse-grained aggregates will not pass through a sieve with 4.75 mm openings (No. 4).

Those particles that are predominantly retained on the 4.75 mm (No. 4) sieve and will pass through 3-inch screen, are called **coarse aggregate**. The coarser the aggregate, the more economical the mix. Larger pieces offer less surface area of the particles than an equivalent volume of small pieces. Use of the largest permissible maximum size of coarse aggregate permits a reduction in cement and water requirements. Using aggregates larger than the maximum size of coarse aggregates permitted can result in interlock and form arches or obstructions within a concrete form. That allows the area below to become a void, or at best, to become filled with finer particles of sand and cement only and results in a weakened area.



For Coarse Aggregates in Roads following properties are desirable:

1. Strength
2. Hardness
3. Toughness
4. Durability
5. Shape of aggregates
6. Adhesion with bitumen

2. Fine aggregate:

The other type of aggregates are those particles passing the 9.5 mm (3/8 inches.) sieve, almost entirely passing the 4.75 mm (No. 4) sieve, and predominantly retained on the 75 μ m (No. 200) sieve are called fine aggregate. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

Properties of Aggregates also have effect on resulting concrete. e.g. variation in size, grading, texture, shape and strength of aggregates means variation in the properties of resulting concrete

Purpose & Uses of Aggregates:

In concrete, an aggregate is used for its economy factor, to reduce any cracks and most importantly to provide strength to the structure.

1. Aggregates are used as the base, subbase, and/or surface of roads in several forms
2. In roads and railway ballast, it is used to help distribute the load and assist in ground water running off the road.
3. Increases the volume of concrete, thus reduces the cost. Aggregates account for 60-75% of the volume of concrete and 79-85% weight of PCC
4. Provide dimensional stability

5. Influence hardness, abrasion resistance, elastic modulus and other properties of concrete to make it more durable, strong and cheaper.
6. Other uses include fills, backfills, and drainage and filtration applications.

3.Bricks:

Bricks are the small rectangular blocks typically made of fired or sun-dried clay, typically used in building. The bricks are obtained by moulding clay in rectangular blocks of uniform size and then by drying and burning these blocks. As bricks are of uniform size, they can be properly arranged and further, as they are light in weight, no lifting appliance is required to them. The bricks don't require dressing and the art of laying bricks is so simple that the brickwork can be carried out with the help of unskilled labours. Thus, at places where stones are not easily available, but if plenty of clay suitable for the manufacturing of bricks, the bricks replace stones.

The common brick is one of the oldest building materials and it is extensively used at present as a leading material of construction because of its durability, strength, reliability, low cost, easy availability, etc.

Qualities of good bricks:

The good bricks which are to be used for the construction of important structures should possess the following qualities:

1. The bricks should be table-mounted, well burnt in kilns, copper-coloured, free from cracks and with sharp & square edges. The colour should be uniform and bright.
2. The bricks should be uniform in shape and should be of standard size.
3. The bricks should give a clear metallic ringing sound when struck with each other.
4. The bricks when broken or fractured should show a bright homogeneous and uniform compact structure free from voids.
5. The bricks shouldn't absorb water more than 20 percent by weight for first class bricks and 22 percent by weight for second class bricks, when soaked in cold water for a period of 24 hours.
6. The bricks should be sufficiently hard. No impression should be left on brick surface, when it is scratched with finger nail.
7. The bricks should not break into pieces when dropped flat on hard ground from a height of about one meter.
8. The bricks should have low thermal conductivity and they should be sound-proof.
9. The bricks, when soaked in water for 24 hours, should not show deposits of white salts when allowed to dry in shade.
10. No brick should have the crushing strength below 5.5 N/mm^2 .

Strength of bricks:

Following factors affect the strength of bricks:

1. Composition brick making material
2. Preparation of clay and blending of ingredients
3. Nature of moulding adopted

4. Care taken in drying and stacking of raw or green bricks
5. Type of kiln used including type of fuel and its feeding
6. Burning and cooling processes
7. Care taken in unloading

It is thus obvious that not only the bricks of different brick fields will have different strengths, but in the same brick field, the bricks of the same batch may have different strengths.

The average crushing strength and tensile strength of hand moulded bricks are $60,000 \text{ kN/m}^2$ and 2000 kN/m^2 respectively. The shearing strength of bricks is about one-tenth of the crushing strength. In practice, however, the bricks are not subjected to the tensile stresses.

It may be noted that the strength of brickwork mainly depends on the type of mortar used and not so much on the individual strength of the bricks.

4. Concrete:

Definition: *Concrete*, an artificial stone-like mass, is the composite material that is created by mixing binding material (cement or lime) along with the aggregate (sand, gravel), water, admixtures, etc in specific proportions. The strength and quality are dependent on the mixing proportions.

The formula for producing concrete from its ingredients can be presented in the following equation:

Concrete = Binding Material + Fine & Coarse Aggregate + Water + Admixture (optional)

An ever-evolving world needs constantly developing construction ways. In the present world, concrete is one of the most widely used construction materials. This can be due not alone to the large choice of applications that it offers, however, besides, its behavior, strength, affordability, durability, and flexibility play vital roles. Therefore, constructing-building works have faith in concrete as a secure, strong, and simple object. It is utilized in all sorts of buildings (from residential to multi-story workplace blocks) and infrastructure comes (roads, bridges, etc). Concrete is used for the development of foundations, columns, beams, slabs, and different load-bearing components.

Concrete is a very necessary and useful material for construction work. Once all the ingredients - cement, aggregate, and water unit of measurement mixed inside the required proportions, the cement and water begin a reaction with one another to bind themselves into a hardened mass. This hardens the rock-like mass in the concrete.

Composition of Basic Concrete Mix:

If we evaluate the concrete composition to see what concrete is made of, we can see there are four basic ingredients within the concrete material mix:

- Binding materials like cement or lime
- Aggregates or Inert Materials
 - Fine aggregate (sand)
 - Coarse aggregate (stone chips, brick chips)
- Water
- Admixture (e.g. Pozzolana)

There are other various types of concrete for different applications that are created by changing the proportions of the main ingredients. Such as:

- Regular Concrete
- High-strength Concrete
- Stamped Concrete
- High-Performance Concrete
- Self-consolidating Concretes
- Vacuum Concrete
- Shotcrete
- Roller-Compacted Concrete
- Glass Concrete
- Asphalt Concrete
- Rapid Strength Concrete
- Polymer Concrete
- Limecrete
- Light-Transmitting Concrete

Brief Descriptions of all these 21 types of concrete are discussed below:

Lime Concrete:

Lime concrete uses Lime as the binding material. Lime is usually mixed with surki and khoa or stones in the proportion 1:2:5 unless otherwise specified. The khoa or stones are soaked in water before mixing. Lime concrete is used mainly in foundation and terrace roofing.

Advantages of Lime Concrete:

- Lime concrete is cheaper than cement concrete.
- Lime concrete is more workable than cement concrete.
- Lime concrete has a lower heat of hydration, which makes it suitable for mass concrete works.
- Lime concrete has good resistance to fire.
- Lime concrete has good resistance to sulfate attack.

Disadvantages of Lime Concrete:

- Lime concrete has a lower strength than cement concrete.
- Lime concrete is not as durable as cement concrete.
- Lime concrete is susceptible to attack by frost.

Cement Concrete:

Most engineering construction uses cement concrete composites as the main building material. It consists of cement, sand, brick chips, or stone chips of the required size. The usual proportion is 1:2:4 or 1:3:6. After mixing the required amounts of concrete materials, the mix is cured with water for 28 days for proper strength building.

Cement concrete is a versatile construction material with a wide range of applications. It can be used in structural applications such as beams, columns, slabs, and foundations. It can also be used in non-structural applications such as paving, curbing, and landscaping. Cement concrete is also a popular choice for precast applications such as pipes, paving stones, and sewer systems.

The main advantages of cement concrete are its strength, durability, and fire resistance. It is also relatively low maintenance and can be easily repaired if damaged. However, cement concrete is a relatively heavy material and can be difficult to work with. It is also susceptible to cracking and can be damaged by extreme weather conditions.

Reinforced Cement Concretes:

For enhancing the tensile strength of concrete, steel reinforcements are added. Sometimes, RCC is prestressed under compression to eliminate or reduce tensile stresses. The resulting concrete is known as Prestressed Concrete.

The word 'Reinforced' means 'strengthened' or 'supported'. Reinforced Cement Concrete, therefore, is a composite material consisting of concrete and steel reinforcements.

The steel reinforcements used in RCC can be in the form of rods, bars, wires, meshes, etc. The concrete is cast around these steel reinforcement bars or rods to form the desired shape. The steel reinforcement bars are placed in such a way that they provide enough support to the concrete against the expected loads.

The steel reinforcement bars are placed in such a way that they provide enough support to the concrete against the expected loads.

Dry Ready Mix Concrete:

This is the combination that may be found at most home improvement and hardware stores. It comes in baggage typically starting from sixty to eighty pounds. Dry ready mix is simple to combine and this is often the combination that almost all homemade comes would require. The tools needed for the mixture are a bucket or cart, shovel or hoe, trowel, and a measured quantity of water.

Ready Mix Concrete:

The distinction between dry ready-mix and ready-mix concrete is that the water is already supplementary to ready combine. This concrete comes pre-mixed and is for larger homemade comes or for people who do not need to combine their own concrete. It is typically brought in an exceedingly little trailer, typically with an intermixture drum connected to stay it dampish and mixed. The ready combine is usually costlier and might be troublesome to search out. It additionally should be used quickly as an alternative it will set while not unfolding properly.

Bulk Dry Materials:

It is price effective to purchase dry materials in bulk. This may let the project be custom-built to the particular wants and usage of the concrete. The drawback of shopping in bulk is that there will be much space for the materials to be kept before getting used. The materials will over probably be delivered to the positioning.

Transit Mix Concrete:

This is the mix that almost all cast-in-place concrete comes can use. it is typically trucked in using concrete trucks that have a massive drum that keeps the concrete from setting up while in transit. It permits for one continuous pour so fewer seams and stronger concrete overall. For big comes, transit combine is a far additional value effective than getting bulk materials or ready-mix since in each those the workforce to combine the concrete would get to be patterned into the value.

Regular Concrete:

The most common type used is regular concrete which is referred to as traditional weight concrete or traditional strength concrete. This pertains to the concrete that is promptly on the market within the retailer's marketplace for personal and residential usage. This includes usage directions that are written within the packaging of the product. It utilizes sand and different materials to function as aggregates and is consolidated in temporary vessels.

High-strength Concrete:

High-strength concrete combined possesses compressive strength that is over six thousand pounds per area unit. This can be processed by lowering the water-cement quantitative relation to a minimum of 0.35 or lower. The low water-cement quantitative relation makes this sort of cement less feasible to combat this weakness, superplasticizers are other than the present concrete combine.

Stamped Concrete:

Stamped concrete is a subject area concrete wherever realistic patterns almost like natural stones, granites, and tiles will be obtained by inserting the impression of skilled stamping pads. This stamping is applied to the concrete once it is in its plastic condition. totally different coloring stains and texture work can finally provide an end that's terribly almost like costlier natural stones. A high aesthetic look will be obtained from a sealed end economically. This is often utilized in the development of driveways, interior floors, and patios.

High-Performance Concrete:

High-performance concrete refers to a freshly developed concrete combine that has properties that are a notch higher compared to regular concrete mixes. This includes increased strength, durability, and workability, simplicity of usage, compaction while not segregation, long-run mechanical properties, porosity, density, toughness, and volume stability. Air-entrained agents may be utilized to customize this concrete combine for severe environments.

Self-Consolidating Concrete:

The concrete combined once placed can compact by its own weight and is considered self-consolidated concrete. No vibration should be provided for an equivalent individually. This combination has higher workability. The slumping price is going to be between 650 and 750. This concrete because of its higher workability is named flowing concrete. In the areas wherever there is thick reinforcement, self – consolidating concrete works best.

Vacuum Concretes:

Concrete with a water content of quite the desired amount is poured into the formwork. The surplus water is then removed out with the assistance of an air pump while not looking forward to the concrete to endure setting. Thus, the concrete structure or the platform is going to be able to use earlier in comparison with traditional construction techniques. These concretes can attain their 28 days compressive strength within an amount of 10 days and therefore the crushing strength of this structure is 25 you bigger compared with the standard concrete sorts.

Shotcrete:

Shotcreting refers to a method within which compressed air forces mortar or concrete through a tube and taps onto a surface at a high speed and forms structural or non-structural parts of buildings. Shotcrete is currently applied to the wet-mix method and has gained universal acceptance in several countries. In wet-mix application cement, aggregate, admixture, and water are mixed along before being wired through a hose and atmospherically designed. On the opposite hand, in dry-mix applications cement, aggregate, and admixture are mixed along, and sent pneumatically through a tube so, at the tap via a water ring, water is injected equally throughout the combination because it is being designed.

Roller-Compacted Concrete:

This type of concrete has been placed and compacted with the assistance of earthmoving instrumentality like serious rollers. This concrete is principally utilized in excavation and filling wants. These concretes have cement content in lesser quantity and are stuffed for the realm necessary. once compaction, these concretes give high density and eventually cure into a powerful monolithic block.

Glass Concrete:

The recycled glass may be used as aggregates in concrete. Thus, we tend to get concrete of recent times, glass concrete. This concrete can increase the aesthetic appeal of concrete. They can give long strength and higher thermal insulation.

The use of recycled glass in concrete has become more popular in recent years. It has been used as a decorative aggregate, to provide a sparkle effect in concrete countertops and flooring. It is also used as a partial replacement for traditional aggregates in concrete.

There are a number of benefits to using recycled glass in concrete. It is a sustainable material that can help reduce the demand for traditional aggregates. It is also lighter than traditional aggregates, which can reduce the overall weight of concrete. Additionally, it can provide a unique look to concrete.

However, there are a few challenges to using recycled glass in concrete. It is a difficult material to work with and can be difficult to get a consistent color. Additionally, it is more expensive than traditional aggregates.

Asphalt Concrete:

Asphalt concrete may be a material, the mixture of aggregates and asphalts ordinarily accustomed surface roads, parking tons, and airports, yet because of the core of mound dams. Asphalt concrete is known as asphalt, blacktop, or pavement and tarmac or bitumen, macadam, or rolled asphalt in other countries.

Rapid Strength Concrete:

As the name implies these concretes can acquire strength within a few hours once it's manufactured. Therefore, the formwork removal is created simply and the building construction is roofed quickly. These have a widespread application within road repairs, as they'll be reused once in some hours.

Polymer Concrete:

In polymer concrete, the aggregates are restrained with the polymer rather than cement. The assembly of polymer concrete can facilitate the reduction of the volume of voids within the mixture. This may cut back the quantity of polymer that is necessary to bind the aggregates used. Hence, the aggregates are ranked and mixed consequently to attain minimum void. This kind of concrete has totally different classes:

- Polymer Impregnated Concrete
- Polymer cement concrete

- Partially Impregnated

Limecrete:

The cement is replaced by lime during this concrete kind. The most application of this product is on floors, domes, likewise as vaults. These not unlike cement have several environmental and health advantages. These products are renewable and simply clean.

Advantages of Limecrete

- Limecrete is a more sustainable product than cement since it is made from renewable materials.
- Limecrete is also much easier to clean than cement since it does not absorb dirt and stains as easily.
- Limecrete is also much cooler than cement, making it more comfortable to walk on in hot weather.

Disadvantages of Limecrete

- Limecrete is not as strong as cement, so it is not suitable for all applications.
- Limecrete can also be more expensive than cement since it is not as widely available.

Light-Transmitting Concrete:

Concrete that has a density lesser than 1920kg/m^3 is classified as lightweight concrete. The utilization of lightweight aggregates in a concrete style can provide us with lightweight aggregates. Aggregates are the vital part that contributes to the density of the concrete. The samples of lightweight aggregates are stone, perlites, and scoria. The lightweight concrete is applied for the protection of steel structures and is used for the development of long-span bridge decks. These are used for the development of the building blocks.

To conclude, concrete is the basic need for building or other constructional works. Thus, the knowledge of different types of concrete should use wisely by consumers to take advantage of its properties for their construction engagements.

5. Steel:

Steel is a strong and versatile metal. It is an alloy consisting of iron with a small amount of carbon and occasionally other elements. The carbon directly influences the steel's strength and durability. However, a vast array of different steels have been developed through the addition of other alloying elements such as chromium, nickel, molybdenum, and silicon. These can provide enhanced properties like abrasion resistance or corrosion resistance. There is a grade of steel for almost any application. This article will define steel, its composition, types, properties, and applications.

Steel, in its simplest form, is iron metal that's been alloyed with less than 2% carbon. However, many other elements can be added as well to create multiple grades of steel alloys with varying properties. Common alloying elements include chromium, manganese, and nickel.

Characteristics of Steel:

The common characteristics of steel are listed below:

1. **Strength:** Steel is a high-strength material, particularly in tension, and can be used for structural loads.
2. **Durability:** Steel is highly durable with a potential lifespan of over 100 years. It does not swell or creep, instead remaining very rigid.

3. **Versatility:** Steel is an incredibly versatile material. Its many grades can be applied to thousands of uses.
4. **Machinability:** Most steel is easily machinable, depending on the grade. Some specific grades of steel (free-cutting steels) are highly machinable.
5. **Weldability:** Most grades of steel are easily weldable, although some need specialized welding procedures.
6. **Corrosion Resistance:** Steel can be alloyed with other elements such as chromium, nickel, and molybdenum to better resist corrosion.
7. **Conductivity:** Steel generally has lower thermal and electrical conductivity compared to other metals. It can be employed as a strong and heat-resistant shielding material.
8. **Recycling:** Steel can be completely recycled, and due to its value, a large portion (>60%) of steel globally is recycled.

Steel Usage in Construction:

- **Structural sections:** these provide a strong, stiff frame for the building and make up 25% of the steel use in buildings.
- **Reinforcing bars:** these add tensile strength and stiffness to concrete and make up 44% of steel use in buildings. Steel is used because it binds well to concrete, has a similar thermal expansion coefficient and is strong and relatively cost-effective. Reinforced concrete is also used to provide deep foundations and basements and is currently the world's primary building material.
- **Sheet products:** 31% is in sheet products such as roofing, purlins, internal walls, ceilings, cladding, and insulating panels for exterior walls.
- **Non-structural steel:** steel is also found in many non-structural applications in buildings, such as heating and cooling equipment and interior ducting.
- Internal fixtures and fittings such as rails, shelving and stairs are also made of steel.
- Transport networks: steel is required for bridges, tunnels, rail track and in constructing buildings such as fueling stations, train stations, ports and airports. About 60% of steel use in this application is as rebar and the rest is sections, plates and rail track.
- Utilities (fuel, water, power): over 50% of the steel used for this application is in underground pipelines to distribute water to and from housing, and to distribute gas. The rest is mainly rebar for power stations and pumping houses.

Introduction to Prefabrication Techniques:

What Is Prefabrication?

Prefabrication is a method which the components are cast and cured at any manufacturing site and transported to the actual site then erected according to plan.

Prefabrication is the process of making buildings, or components of buildings, in a different location than the job site itself. Construction companies will transport the completed unit to the final site, where they will also complete the setup and handover buildings to their new owners. This process eliminates the need for traditionally sourced construction materials because off-site assembled parts result in less waste. As the raw materials are built off-site and shipped partially assembled, prefabrication reduces the cost of labor and the cost of materials.

There is controversy regarding prefabrication because, in the past, it was a low-mass development method. Prefabrication is getting more and more relevant in the construction industry, but more

significant in commercial construction. However, civil engineers use prefabrication the most because mass amounts of pre-assembled concrete and steel sections are made then transported to sites.

Need of Prefabrication

- Prefabrication is a modern construction technique that is growing in popularity. Prefabrication enables time and cost savings, quality control, and an eco-friendly construction process.
- Prefabricated sections are cast and cured in large quantity at the factory site and then transported to various construction sites.
- This procedure works in any poor weather conditions and also reduces time and material wastage at the site.
- This technique allows the erection of structures in less time.

Prefabrication Building Components and their Connections :

1. COLUMN:

A column is a vertical member carrying the beam and floor load and transfers to the foundation.

It is a compression member and therefore The columns to be connected properly.

The main principle involved in making column connections proper is through continuity.

2. BEAM:

Beams are horizontal members which take loads from the slab and transfers to the column.

So these have to be connected at columns and explained below,

Methods of Connecting Beams and Columns are

- A pre-cast haunch is fixed to the column and a dowel or stud helps to connect the beam and column
- A projecting metal corbel is fixed to the column and the beam is bolted to the corbel.
- Column and beam reinforcement, generally in the form of hooks, are left exposed.
- The two members are hooked together and covered with concrete to complete the joint

3. SLAB:

Here, this component resists on the beams and transfers the load directly on the beam.

- They are laid in a grid pattern.
- These units are cast in moulds.
- The saving achieved is not much.
- Time consumption for construction is less

Prefabrication Is Done In Two Stages,

1. Manufacturing at factory condition
2. Erection of components at the required location.

Steps Involved In Prefabrication :

CASTING:

Precast components are cast with controlled cement concrete for required shape and size.

Here the Reinforcement is placed before Pouring any concrete and The vibrator is used to vibrate concrete,

this removes any honeycombing inside the components.



fig : Casting in factories

CURING:

After 24 hours of casting, the casted components are released from the moulds and shifted to the curing tanks.

For certain special components where high strength is required are steam cured for faster gaining of strength.

This curing will be done for at least 3 days and further it will be cured after erecting these components at the site.



fig : showing cured in controlled environment

TRANSPORTATION AND ERECTION:

After 3 day period the components are transported to the site with heavy trucks and erection will be done using cranes with skilled labour force.



fig : Erecting at the site

Advantages and Disadvantages of Pre-Fabrication

Advantages :

- Saving in cost, material, time & manpower.
- Shuttering and scaffolding is not necessary.
- Installation of building finishes can be done immediately.
- Independent of weather condition.
- Components produced at close supervision .so quality is good
- Clean and dry work at site.
- Possibility of alterations and reuse
- Correct shape and dimensions and sharp edges are maintained.
- Very thin sections can be entirely precast with accuracy.

Disadvantages :

- Handling and transportation may cause breakages of members so care has to be taken.
- It is a non monolithic construction.

- Placement of members plays a major role
- High transport cost
- Need of erection equipment
- Skilled labour and supervision is required.

Conclusion :

Advantages are more predominant than the disadvantages but due to Indian psychological barrier. These Modern techniques haven't penetrated into our roots. But there is a hope that future desires and situations can definitely convince our mentality.