

Civil Engineering

Sub branches in Civil Engineering

INTRODUCTION

- Civil engineers have one of the world's most important jobs: they build our quality of life.
- With creativity and technical skill, civil engineers plan, design, construct and operate the facilities essential to modern life, ranging from bridges and highway systems to water treatment plants and energy efficient buildings.
- Civil engineers are problem solvers, meeting the challenges of pollution, traffic, drinking water and energy needs, urban development and community planning.

Specializations in Civil Engineering

- Civil engineering being the oldest engineering discipline, has the largest number of specializations
- All branches of civil engineering are directly related to design, construction and maintenance of the physical and naturally built environment
- Civil engineering provides the infrastructure required for all human activities

Branches of Civil Engineering

- Structural Engineering
- Geotechnical Engineering
- Environmental Engineering
- Hydraulics and Water Resources Engineering
- Transportation Engineering
- Surveying and Geospatial Science
- Construction Engineering and Management

Structural Engineering

- Concerned with designing structures so that they can safely withstand the loads they are subjected to, during their life time
- Structural engineers mainly work with
 - Structural material such as steel, concrete, prestressed concrete and their behaviour when subjected to loads
 - Loads that are expected to act on the structure being considered

Structural Engineering

- Deformation of structures when loads are applied on them
- Shape and size of structure and its members so that the structure is both safe and economical
- Structural engineering is based on the principles of mechanics, starting with Newton's Laws of Motion
- Structural materials such as high performance concrete
 - Self compacting concrete – flows under its own weight without application of external energy
 - High strength concrete (120 N/mm^2)

Specializations within Structural Engineering

- Structural Dynamics and Earthquake Engineering - study of vibration of structures
- Bridge engineering

Geotechnical Engineering

- Geotechnical engineering is concerned with engineering behaviour of earth materials
- Concerned with
 - Design of foundations to support weight of structures and machines
 - Stability of earth slopes and embankments such as on hilly roads, dams and tanks
 - Earth retaining structures such as retaining walls
 - Tunnels, Rock slopes, underground structures

Geotechnical Engineers



Charles-Augustine de Coulomb
(14-06-1736 to 23-08-1806)

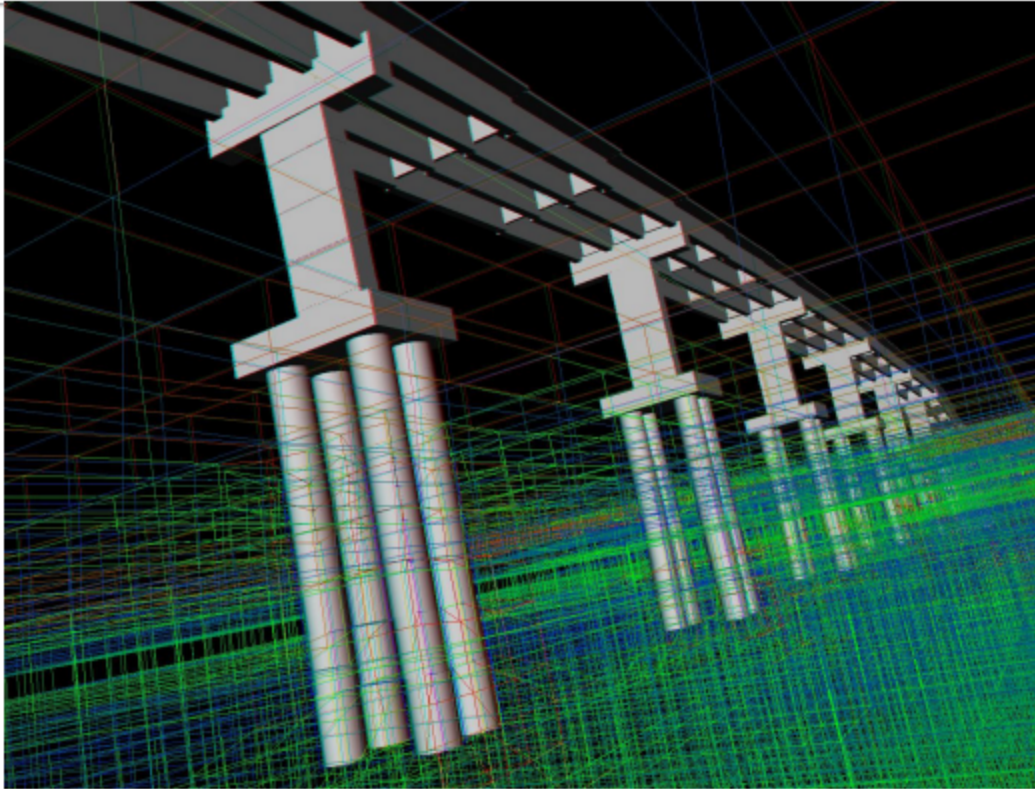


Karl von Terzaghi
(2-10-1883 to 25-10-1963)

Challenges in Geotechnical Engineering

- Soil is a natural material and its properties are highly variable and hence difficult to characterize
- Geotechnical engineers apply the laws of mechanics and fluid mechanics in understanding the behaviour of soil
- Geotechnical engineers extensively use software to simulate behaviour of soils under loads

Finite element analysis of a bridge foundation



Specialization in Geotechnical Engineering

- **Foundation engineering** – Design of foundations for structures
- **Soil dynamics** – study of soils under vibration, such as during earthquakes
- **Rock mechanics** – behaviour of rocks is quite different compared to that of soil
- **Environmental geotechnical engineering** – study of transport of liquid contaminants in soil and their effect on soil properties

Environmental Engineering

- Environmental engineering is the application of science and engineering principles to improve the natural environment – air, water and land resources
- Concerned with
 - Treatment and supply of water for human activities
 - Treatment of industrial waste and its safe disposal
 - Control of air pollution

Environmental Engineering

- Environmental engineers design systems for treatment of water, industrial wastes and polluted air
- Environmental engineers are also engaged in monitoring parameters related to environment and develop regulations to prevent mishaps.
- Environmental engineers use knowledge of chemistry, biochemistry and biology
- Design of treatment units is similar to design of systems in chemical engineering and biotechnology

Environmental Engineering

- Environmental engineers use knowledge of fluid mechanics in designing pipe networks and pumping equipment

Specializations in Environmental Engineering

- **Water supply engineering** – Identification of sources of water, estimating water requirements, systems for their treatment, systems for supplying treated water to consumers
- **Sanitation engineering** – Treatment of wastewater so that it is safe for disposal into the environment
- **Air pollution and control**
- **Environmental impact assessment** – Quantify impact of human activities on natural resources to decide whether a proposed work can be undertaken
- **Environmental geotechnical engineering**

Water Treatment Plant



Hydraulics and Water Resources Engineering

- Hydraulics engineering is the study of flow of fluids, mainly water, in pipes, open channels (canals, rivers), and inside the earth
- Water resources engineering is the study of water requirement of crops and design of systems to store and supply water for irrigation
- Hydraulics is based on fluid mechanics
- Water resources engineering requires knowledge of mathematics, statistics and operations research to
 - Estimate rain fall based on past rain fall records
 - Determine optimum operations of reservoirs to supply water for crops as well as avoid floods during heavy rain fall

Transportation Engineering

- Transportation engineering is the application of technology and engineering principles to the planning, functional design, operation and management of facilities for any mode of transportation
- It ensures transportation of people and goods is safe, rapid, comfortable, convenient, economical and environmentally compatible
- It includes all modes of transportation – road, rail, air and water

Specializations in Transportation Engineering

- **Traffic planning** – Estimation of existing and future traffic, optimal design of routes, cost of construction and cost recovery in reasonable time
- **Pavement design** – Design of pavements for roads and airport runways. Requires knowledge of some aspects of geotechnical and structural engineering

Specializations in Transportation Engineering

- **Railway engineering** – Design of subgrade and embankments for railway tracks
- **Airport engineering** – Design of runways, terminals
- **Port and harbor engineering** – Design, construction and operation of ports, harbors and other marine facilities for berthing of ships and handling goods
- Capacity and functional design of bridges, interchanges, grade separators

Surveying and Geospatial Engineering

- Surveying is the science of accurately determining three dimensional position of points and the distances and angles between them
- This can be done at different levels of sophistication
- Using surveying instruments such as total station and theodolites
- Using Global Positioning Systems (GPS) using signals from GPS satellites
- Photogrammetry and remote sensing using aerial photographs
- Geographical Information Systems (GIS) using satellite imagery

Surveying

- Surveying requires knowledge of geometry and trigonometry
- Surveying furnishes information required for many civil engineering activities
 - Area of catchment of a river
 - Volume of water that will be stored by a dam
 - Amount of cutting and/or filling required to construct a dam, road or rail embankment
- Surveying is the first activity in any major civil engineering project

Specializations in Surveying

- **Trigonometric surveying** – Measurement considering the spherical nature of earth's surface. Plane surveying assumes that earth's surface is plane
- **Digital Terrain Modelling (DTM)** – 3D modelling of earth's surface from survey data
- **GIS** – Not only measures distances and elevations but also recognizes features on earth's surface such as, vegetation, soil type, water bodies etc. from satellite imagery

Construction Engineering and Management

- Construction engineering and management deals with the designing, planning, construction and management of infrastructure
- It is concerned with the use of materials, labours and equipment
- It aims to increase efficiency, reduce cost and assure quality of construction

Construction Engineering and Management

- Construction engineering is based on knowledge of construction materials, methods and technologies
- Requires knowledge of
 - Estimation of quantity of **materials** required for construction
 - Estimation of **time** required to complete construction
 - Estimation of **labour** required for construction
 - Sequence of construction to plan each phase
 - Construction equipment and methods to reduce time and cost and increase efficiency and safety