

Scope of Civil Engineering

Civil engineering is the oldest branch of engineering which is growing right from the stone age of civilisation. American society of civil engineering defines *civil engineering as the profession in which a knowledge of the mathematical and physical sciences gained by study, experience and practice is applied with judgement to develop ways to utilise economically the materials and forces of the nature for the progressive well being of man.*

In this chapter various fields of civil engineering are listed and their scope is explained. Impact of infrastructural development on the economy of a country, the role of civil engineers in it is explained. Finally the importance of planning scheduling and construction management in civil engineering is emphasised.

1.1 FIELDS OF CIVIL ENGINEERING AND THEIR SCOPE

Civil engineering may be divided into the following fields:

- (i) Building materials
- (ii) Building construction
- (iii) Structural engineering
- (iv) Geotechnical engineering
- (v) Hydraulics, water resources and irrigation engineering
- (vi) Water supply and sanitary engineering
- (vii) Environmental engineering
- (viii) Transportation engineering
- (ix) Town planning and architecture
- (x) Surveying
- (xi) Drawing
- (xii) Estimation and specification
- (xiii) Management techniques
- (xiv) Computer application.

(i) **Building Materials.** Shelter is the basic need of civilised society. Stones, bricks, timber and lime concrete are the traditional materials used for the construction of houses and other buildings. The invention of cement and concrete has provided durable buildings. Reinforced concrete which is composite construction of steel and concrete has helped in building large structures. Steel, aluminium, glass, plastics, glazed tiles, plaster of paris, linoleum, paints and varnishes have improved the quality of buildings. Improved versions of many building materials keep on appearing in the market regularly. A civil engineer has to make use of all these materials judiciously.

(ii) **Building Construction.** Fast rate of urbanisation and increase in the cost of land has forced to go for the vertical growth of buildings. In metropolitan cities, 25 storey buildings are becoming common. Even in small towns 3 to 4 storey buildings have become common. This requirement has brought in new building technologies. Continuous research and development in construction technology is going on to see that huge investment in building is utilised at the earliest. Civil engineers have to look into the problems of rural areas and urban poor people also. There are 23 million Indians without home. Low cost housing is the need of the day to make poor people afford their own houses.

(iii) **Structural Engineering.** Before building a structure, it should be analysed and designed to decide about its size to resist the possible forces coming on it. The structure should be safe and at the same time its components should be as small as possible. Up to mid sixties lot of improvements were seen in the classical methods of analysis. Need of tall structures and improvements in computers gave rise to matrix method and finite element method of analysis. Requirement of large column free structures gave rise to analysis and design of shell roofs (curved surfaces), geodetic towers and tension structures. Disasters due to earthquakes have made civil engineers to study earthquake forces and build earthquake resistant structures. It needs the knowledge of structural dynamics. A civil engineer has to not only give a safe structure but he has to give an economical structure also. Hence, there is need for studying mathematical optimisation techniques. All these aspects of analysis and design fall under structural engineering field.

(iv) **Geotechnical Engineering.** All structures have to finally transfer the load acting on them to soil safely. Soil property changes from place to place. Even in the same place it may not be uniform at different depth and in different seasons. Hence, a civil engineer has to properly investigate soil and decide about the safe load that can be spread on the soil. This branch of study in civil engineering is known as geotechnical engineering. Apart from finding safe bearing capacity for foundation of buildings, geotechnical engineering involves various studies required for the design of pavements, tunnels, earthen dam, canals and earth retaining structures. It involves study of ground improvement techniques also.

(v) **Hydraulics, Water Resources and Irrigation Engineering.** Water is an important need for all living beings. Study of mechanics of water and its flow characteristics is another important field in civil engineering and it is known as hydraulics.

Requirement of water in cities for domestic purpose and for industries is continuously increasing. Rural areas need water for agricultural field also. Hence civil engineers have to look for new water resources and for storing them. This branch of civil engineering is known as water resources engineering.

Water stored in reservoirs by building bunds and dams should be brought to agricultural fields through canals and distributories. Study connected with this aspect is known as irrigation engineering.

(vi) **Water Supply and Sanitary Engineering.** When water is required for drinking purpose it should be purified and made potable. Purification of water and the technology involved in taking it to the houses is known as water supply engineering.

Waste water and solid waste should be treated and disposed so that they do not create health hazard. This branch of civil engineering is known as sanitary engineering.

(vii) **Environmental Engineering.** Apart from tackling solid and waste water disposal civil engineers have to tackle air pollution problem also. Due to industrialisation air pollution is becoming a major problem. It is estimated that for every tonne of cement produced one tonne of CO₂ is released to environment. Vehicles also produce lot of CO₂. During the last one century, the environmental pollution has resulted in global warming by 4°C. An environmental disaster will be unavoidable if China, India and other developing countries start consuming as much energy and materials as the West did it in its march to industrialisation. Hence environmental engineering is emerging as an important field of study in civil engineering.

(viii) **Transportation Engineering.** Transportation facility is another important need. Providing good and economical road links is an important duty of civil engineers. It involves design and construction of base courses, suitable, surface finishes, cross drainage works, intersections, culverts, bridges and tunnels etc. Railways is another important long-way transport facility. Design, construction and maintenance of railway lines are parts of transportation engineering. Globalisation has resulted into requirement of airports and harbours. For proper planning of these transport facilities, traffic survey is to be carried out. Carrying out traffic survey and then planning, designing, construction and maintenance of roads, railways, bridges, tunnels, airports and harbours is known as transportation engineering.

(ix) **Town Planning and Architecture.** With the growth of population and industries new towns are coming up and existing ones are growing. Proper town planning is to be made by civil engineers. Structures should be aesthetically good also. Architecture covers this area. This field of civil engineering has grown up so much that it has become a separate branch of engineering.

(x) **Surveying.** For planning all developmental activities, proper maps are required. The science of map making is known as surveying. Survey maps provide the relative positions of various objects of the area in the horizontal as well as vertical directions. Earlier conventional instruments like chain, tape, compasses, theodolites and levels were used for various measurements in surveying. In this electronic era the modern equipments like electronic distance meters and total stations are used for measurements. Modern technology like remote sensing has made surveying vast area in a short period possible.

(xi) **Drawing.** Drawing is the language of engineers. The survey maps and plans, the building description etc. are to be provided with neat scaled drawings.

(xii) **Estimation and Specification.** Civil engineers have to prepare estimation and detailed specifications for each and every work to be taken up.

(xiii) **Management Techniques.** Civil engineers must manage, men, materials and equipments efficiently. Since huge funds are to be handled in civil engineering projects, a civil engineer must know the basics in financial management and legal obligations. Knowledge of management techniques is an asset to practising civil engineer.

(xiv) **Computer Applications.** Since the magnitude of designing the structures and storing information is increasing very fast nowadays civil engineers go for computer applications. Nowadays neat drawings are also produced using computers. There are a good number of civil engineering software commercially available.

1.2 IMPACT OF INFRASTRUCTURAL DEVELOPMENT ON THE ECONOMY OF THE COUNTRY

Civil engineering activities in the infrastructural development are:

- (i) Good planning of towns and extension areas in the cities. Each extension area should be self sufficient in accommodating offices, educational institutions, markets, hospitals, recreational facilities and residential accommodation.
- (ii) Assured water supply.
- (iii) A good drainage system.
- (iv) Pollution free environmental conditions.
- (v) A well planned and built network of roads and road crossings.
- (vi) Railways connections to all important cities and towns.
- (vii) Airports and harbours of national and international standards.

Infrastructure also involves electricity supply, without assured electric supply no city town can develop. Internet and telephones are also desirable features.

Educational facility also forms part of infrastructure. Proximity of good primary and secondary schools to residential areas is desirable. Collegiate and professional education also form part of infrastructure of a city.

Good health care facility is a necessity. Primary health centres, specialised hospitals and doctors add to the desirable infrastructure facility.

Effect of infrastructure facilities are:

1. Connecting producing centres to marketing places minimise exploitation of producers by middlemen. Imports and exports became easy and as a result of which whole world becomes a village.
2. Improved irrigation facility enhances agricultural products and hence producers as well as consumers are benefitted.
3. Infrastructural facility develops scope for a number of industries and it creates job opportunities.
4. Improved education and health care give rise to skilled and healthy work force. Quality of life of the people is improved.
5. Utilisation of manpower for the benefit of mankind brings down antisocial activities.
6. In case of natural calamities assistance can be easily extended to the affected areas and misery of affected people minimised.
7. Infrastructural facility improves defence system and peace exists in the country.
8. Improved economical power of the country brings a respectable status in the world.

The world has realised that a government should not involve itself in production and distribution but should develop infrastructure to create an atmosphere for economical development.

1.3 ROLE OF CIVIL ENGINEERS

A civil engineer has to conceive, plan, estimate, get approval, create and maintain all civil engineering activities. Civil engineer has very important role in the development of the following infrastructure:

- (i) Measure and map the earth's surface.
- (ii) Plan new townships and extension of existing towns.
- (iii) Build the suitable structures for the rural and urban areas for various utilities.
- (iv) Build tanks and dams to exploit water resources.
- (v) Build river navigation and flood control projects.
- (vi) Build canals and distributaries to take water to agricultural fields.
- (vii) Purify and supply water to the needy areas like houses, schools, offices etc.
- (viii) Provide and maintain communication systems like roads, railways, harbours and airports.
- (ix) Devise systems for control and efficient flow of traffic.
- (x) Provide and maintain solid and waste water disposal system.
- (xi) Monitor land, water and air pollution and take measures to control them. Fast growing industrialisation has put heavy responsibilities on civil engineers to preserve and protect environment.

1.4 IMPORTANCE OF PLANNING, SCHEDULING AND CONSTRUCTION MANAGEMENT

Planning, Scheduling and Management form the basis for any construction activity. Though discussion here is about construction, the same principles hold good for any organisation.

Planning

Planning is the decision-making process about What, Where, Who and How (WWWH) to start a project.

What: An individual or a group of enterprising people plan to start a project. They form a group of high level managers. They identify goals, frame the objective and identify opportunities. The planning done by them may be called as strategic planning.

Where: The strategic planners decide the time and the place of starting the organisation.

Who: The strategic planners identify the middle level managers and operational level planners to carry out the task. The middle level management deals with financial management and coordinates with operational planners and strategic planners.

How: The operational planners have to work at minute details of the work assigned, find the requirement of machinery and work force and plan day to day activities. They should be ready with alternative plans, if uncertainty creeps in at any stage.

Importance of Planning

Although events can never be predicted exactly, planning is important. Factors beyond control may interfere and upset plans, but no work can be achieved successfully without planning. Advantages of planning are:

(i) *It minimises uncertainties.* Certain uncertainties like availability of work force, equipment, raw materials etc., due to strikes and natural calamities may upset plans. However with short term alternate plans, many adverse effects of these uncertainties can be minimised. Without a plan, many uncertainties will creep into project work and hamper the other wings of work force. Hence a planning is a must.

(ii) *It exercises good control.* With proper planning there is optimum use of materials and man power, which result is cost reduction in construction industry. There will be good control on every wing of the construction activity. Cashflow for the activity is streamlined avoiding unnecessary holding of the funds or hampering of the work due to cash shortage. Hence planning is necessary for exercising good control on the construction work.

(iii) *Planning focusses on objectives.* A construction industry may have an objective of specializing itself in irrigation projects, road projects, building construction, producing precast products etc. It has equipment and expertise in achieving particular objectively. Planning helps the managers of all department to work for achieving the objective, periodically revise the plan in the interest of achieving the objective.

(iv) *Planning leads to success.* Occasionally unforeseen factors may affect success to some extent but planning puts the organisation definitely on the path to success. If the work is carried out as per the plan without any hinderance, an organisation can make good profit and become competent for obtaining more works.

Scheduling

A construction work may be proposed to be started on a particular day and completed within the specified period. The entire project is to be subdivided into a number of events. For example, the construction of a building may be divided into the following stages:

1. Mobilising
2. Laying Foundation
3. Building Super Structure
4. Finishing

Laying of foundation may be subdivided into the following events:

- (i) Digging
- (ii) Laying bed concrete
- (iii) Building stone masonry courses
- (iv) Providing coping concrete
- (v) Pointing joints and
- (vi) Filling the trenches.

Like this all stages involve a number of events. For each event, scheduled dates of completion are to be fixed and to complete each event in the prescribed days material and labour requirements are to be identified. For this, the tool used in construction industry is bar chart method, in which each activity with number of days required for completion are marked. Starting and completing day of works are shown. Network representation of the events is a superior method. In this method interconnectivity of various events are clearly indicated. It helps in identifying critical activities. Delay in starting and completing a critical activity delays the entire project. The path joining the critical activity is called critical path. *Identifying various events, time, labour, material requirements for each event and representing the sequence of events by bar charts or by network is called scheduling.*

Importance of Scheduling

Scheduling fixes up the precise task and responsibilities for all the personnel involved in the construction. The various persons involved are the owner, financial managers, architect, design engineer, site engineer, labour contractor, contractors for material supply etc. Without scheduling, coordination among the above persons cannot be achieved. Scheduling is necessary for the success of project implementation.

Construction Management

Management is the science and art of planning, organising, staffing, scheduling and executing the work. Planning, scheduling and executing work need well trained engineers. Achieving coordination among various people involved in the work needs proper management training. In fact in any work involving a common goal, management is essential to *coordinate* the individual efforts. It is necessary to maintain a proper work environment for all the individuals to work together. A manager not only *directs* his subordinates but also *motivates* them to do the work. *Decision-making and leadership* are the basic qualities of a good manager. Good *communication skill* is to be developed by the managers with their seniors and subordinates to keep the work going on smoothly and review the execution of various activities.

Importance of Construction Management

- (i) Planning and Scheduling helps in recruiting right people at right time.
- (ii) Leadership, decision-making ability and properly directing subordinates avoid the wastage of labour.
- (iii) Communication skill and proper coordination helps in maintaining the continuity of the works and avoids delays.
- (iv) Motivating the work force with various schemes and awards help in extracting maximum work and increases efficiency.
- (v) Proper management avoids locking of funds and ensures proper inflow of cash. As a result.
 - (a) Resource utilisation is optimised
 - (b) Efficiency is achieved
 - (c) Construction cost is reduced and
 - (d) Schedule is maintained.

The organisation achieves good name and makes profit. The success of the company benefits itself and the society.

QUESTIONS

1. Briefly explain the scope of civil engineering.
2. What are the civil engineering infrastructure systems required for the socio-economical development of a country ?
3. Write short note on impact of infrastructure development on the economy of the country.
4. Explain briefly the role of a civil engineer.
5. Why planning is important in the construction works ?
6. What do you understand by planning of a work ?
7. What is scheduling? Explain its importance in the construction work.