Unit-I
CIVIL ENGINEERING – BUILDING THE FUTURE

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 congestion, drinking water and energy needs, urban development and community planning.

During the past century, clean water supplies have extended general life expectancies. Transportation systems serve as an economic and social engine. New bridges, blending strength and beauty, speed transport and bring communities closer together. Public and private construction, for which engineers provide the essential underpinnings of design and project oversight, produces hundreds of thousands of jobs and drives community development. From the functional and beautiful Golden Gate Bridge in the United States, Petronas Towers in Malaysia, and Pont du Gard in France to the largely hidden water supply and sanitary sewer systems, civil engineers have made their mark in many aspects of the daily life of essentially everyone around the globe.

The American Society of Civil Engineers 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 judgment to develop ways to utilize, economically, the materials and forces of nature for the progressive well-being of humanity in creating, improving and protecting the environment, in providing facilities for community living, industry and transportation, and in providing structures for the use of humanity."

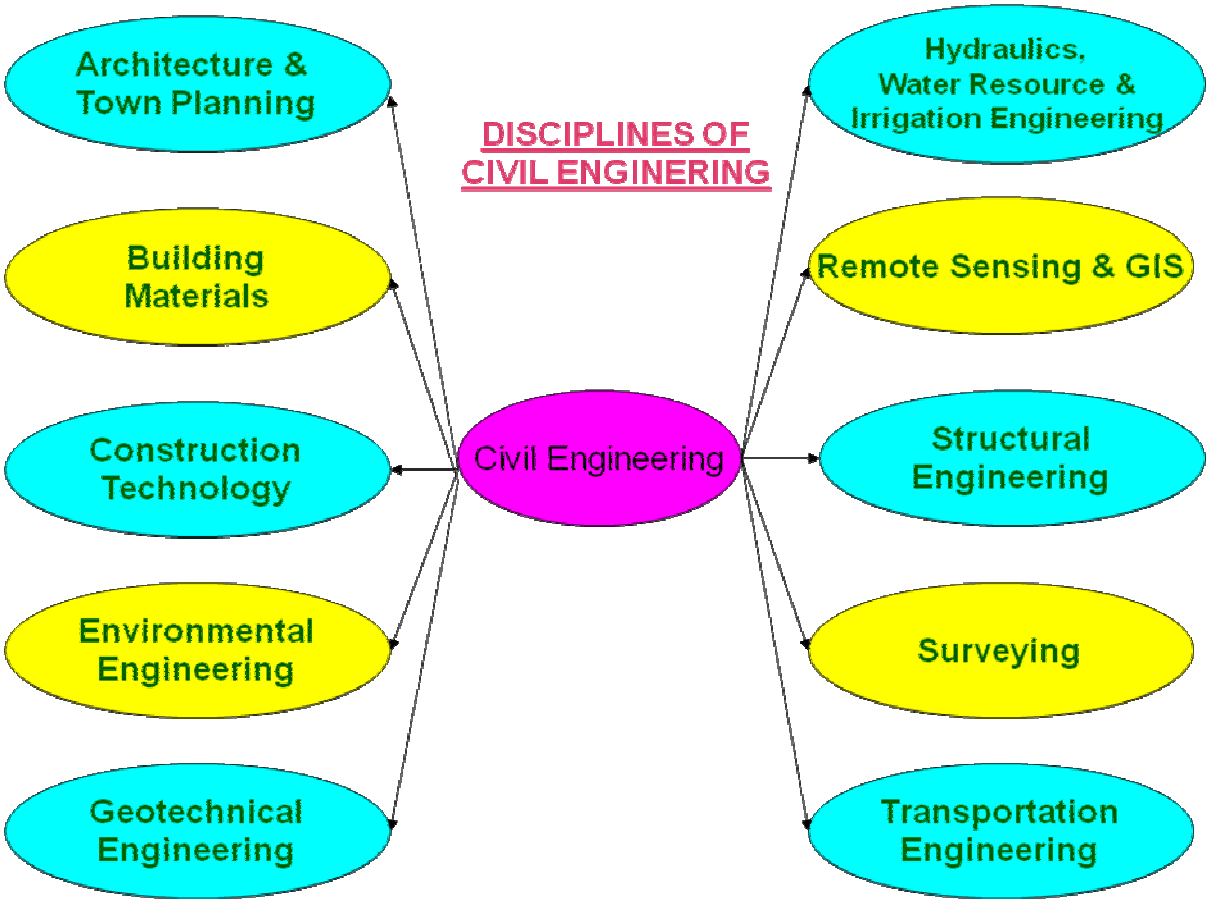
Entrusted by society to create a sustainable world and enhance the global quality of life, civil engineers serve competently, collaboratively, and ethically as master:

- Planners, designers, constructors, and operators of society's economic and social engine – the built environment
- Stewards of the natural environment and its resources
- Innovators and integrators of ideas and technology across the public, private, and academic sectors
- Managers of risk and uncertainty caused by natural events, accidents, and other threats and
- Leaders in discussions and decisions shaping public environmental and infrastructure policy.

As the technological revolution expands, as the world's population increases, and as environmental concerns mount, civil engineering skills will be needed throughout the

world. Whatever area you choose, be it design, construction, research, planning, teaching or management, civil engineering offers you a wide range of career choices. And there's no limit to the personal satisfaction you will feel from helping to make our world a better place to live.

Civil engineering is an umbrella field comprised of many related specialties. The following figure shows the broad categories of fields under civil engineering.



Building materials technology deals with proper use of desired material for construction economically and safely. Brick, tiles, soil, cement, stone, sand, steel, aggregates, glass, wood, plastics etc. include construction materials. Some are natural and many are manmade. The mechanical properties of these materials shall be sufficient to avoid failure and excessive deformation and provide durability. The chemical properties shall be to maintain good environment.

Structural engineers face the challenge of designing structures that support their own weight and the loads they carry, and that resist extreme forces from wind, earthquakes, bombings, temperature and others. Bridges, buildings, amusement park rides and many other kinds of projects are included within this speciality. Structural engineers develop appropriate combinations of steel, concrete, timber, plastic and new exotic materials. They also plan and design, and visit project sites to make sure work is done properly.

The skills of environmental engineers have become increasingly important as we protect our fragile resources. Environmental engineers translate physical, chemical and biological processes into systems to destroy toxic substances, remove pollutants from water, reduce nonhazardous solid waste volumes, eliminate contaminants from the air and develop groundwater supplies. Environmental engineers are called upon to resolve the problems of providing safe drinking water, cleaning up contaminated sites with hazardous materials, disposing of wastewater and managing solid wastes.

Geotechnical engineering is required in all aspects of civil engineering because most projects are supported by the ground. A geotechnical engineer may develop projects below the ground, such as tunnels, foundations and offshore platforms. They analyse the properties of soil and rock that support and affect the behaviour of these structures. They evaluate potential settlements of buildings, the stability of slopes and fills, the seepage of ground water and the effects of earthquakes. They investigate rocks and soils at a project site and determine the best way to support a structure in the ground. They also take part in the design and construction of dams, embankments and retaining walls.

Water is essential to our lives, and water resources engineers deal with the physical control of water. They work with others to prevent floods, supply water for cities, industry and agriculture, to protect beaches or to manage and redirect rivers. They design, construct and maintain hydroelectric power facilities, canals, dams, pipelines, pumping stations, locks, seaport facilities or even waterslides.

The quality of a community is directly related to the quality of its transportation system. Transportation engineers work to move people, goods and materials safely and efficiently. They find ways to meet our ever-increasing travel needs on land, air and sea. They design, construct and maintain all types of transportation facilities, including airports, highways, railroads, mass transit systems and ports. An important part of transportation engineering is upgrading our transportation capability by improving traffic control and mass transit systems, and by introducing highspeed trains, people movers and other intermodal transportation methods.

The construction phase of a project represents the first tangible result of a design. Using technical and management skills, construction engineers turn designs into reality on time and within budget. They apply their knowledge of construction methods and equipment, along with the principles of financing, planning and managing, to turn the designs of other engineers into successful facilities.

Planners are concerned with the full development of a community. They analyse a variety of information to co-ordinate projects, such as projecting street patterns, identifying park and recreation areas, and determining areas for industrial and residential growth. They employ their technical and people skills to co-ordinate with other authorities to integrate freeways, airports and other related facilities.

Infrastructure

It is the framework of supporting system consisting of transportation, energy, communication, lifeline facilities, irrigation facilities, etc., for the economic development of a country by the growth of industrial and agricultural fields. Economic infrastructure contributes directly to the economic development of the country while social infrastructure like education & training, social welfare, housing, water supply, etc., will have indirect influence on the economic development. Urban growth only can lead to population drift from rural sectors leading to explosion in population in cities and inadequate development of villages and improper care for agricultural sector. Use of infrastructural facility only by upper class leads to imbalance. Demands for sustainable energy, fresh water, clean air, and safe waste disposal drive global infrastructure development.

The infrastructural development has the following major impacts on a country

- Increase in food production
- Protection from drought, famine, flood
- Healthy and comfortable housing facility
- Safe domestic and industrial water supply
- Safe and scientific waste disposal
- Improvement in communication and transportation
- Generation of electricity from, nuclear, hydel, thermal, solar or wind energy
- Improved, wealth, prosperity, standard of living
- Overall growth of a nation

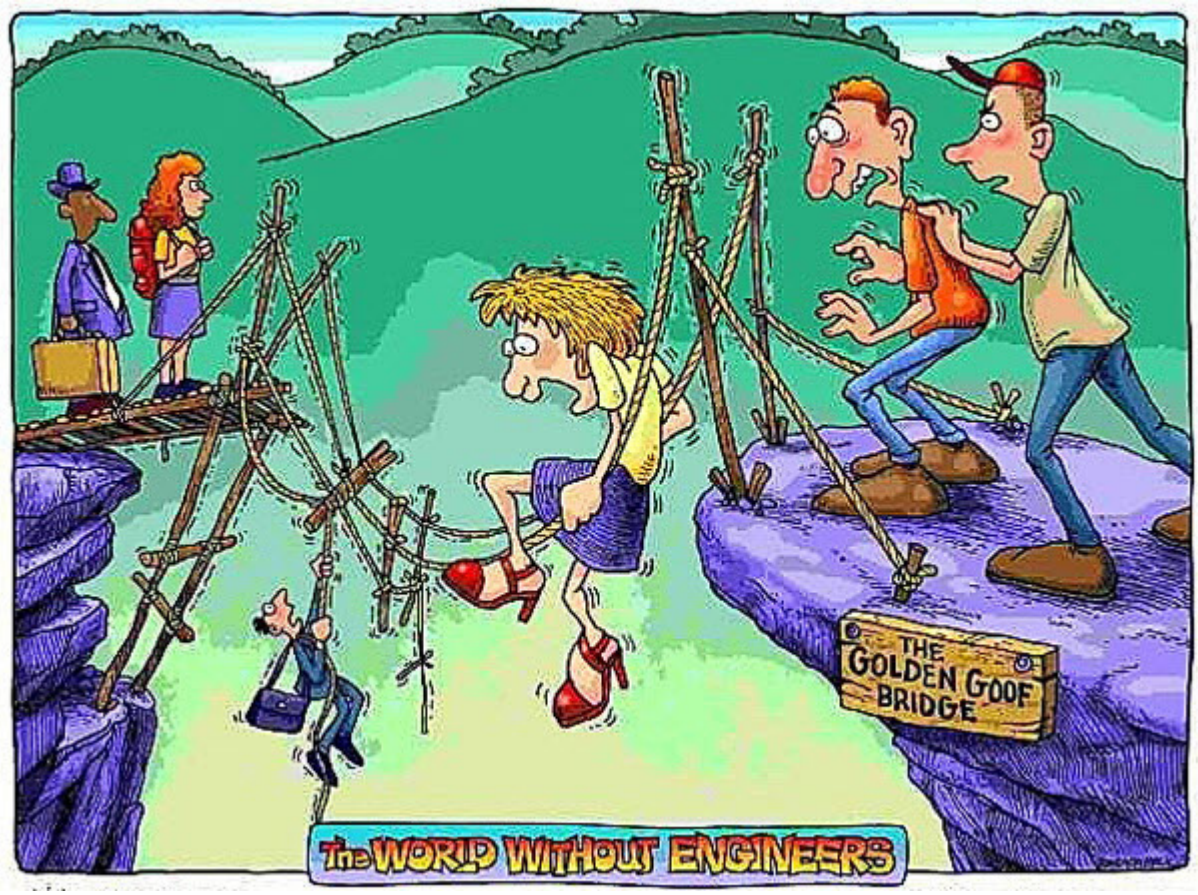
Large-scale budget allocation for infrastructure leads to agricultural and industrial developments. It provides employment, eradicates poverty and enhances per capita income.

Role of Civil engineers in Infrastructural development are

- Construction of roads, railway, ports, harbors and airports
- Construction of dams and proper utilization of water resources
- Construction of Housing, commercial and industrial complexes
- Maintenance of facilities
- Rebuilding, Rehabilitation, Retrofitting and Repair

Concluding Remarks

- Civil engineers served, serving and will serve as master builders, environmental stewards, innovators and integrators, managers of risk and uncertainty, and leaders in shaping public policy.
- Civil Engineering is about community service, development, and improvement
- In essence, Civil Engineering may be regarded as the profession that makes the world a more agreeable place to live



Roads

Transportation is a non-separable part of any society and is responsible for the development of civilizations. It meets travel requirement of people and transport requirement of goods and it is one of the key infrastructures of a country & considered a mark of its progress.

The roles of transportation in society are:

- Advancement of community
- Economic prosperity and general development of a country
- Strategic movement in emergency
- Safety, Pollution, Energy consumption
- Other impacts

Roadways or Highways are one of the primary modes of transportation. Roads provide best bet for achieving inclusive growth of our society than any other modes of transport. Following are the characteristics of roadways

- Maximum flexibility for travel
  - ✓ Route, Direction, Time and Speed
  - ✓ Safety decreases
- Door to door service
- Feeder system for other modes
- Used by various types of vehicles
- For short distance travel – saves time
- Requires relatively small investment

India has the second largest road network in the world, next only to USA. However, large stretches of our roads still suffer from deficiencies in road geometry and riding quality resulting in hazardous conditions and poor road safety. Civil engineers face the challenge of designing safe highways and at the same time improving the operational speeds of the vehicles to reduce the travel time.

Classification of Roads

Based on road pavement

- Paved roads
- Unpaved roads

Based on use during different seasons

- All-weather roads
- Fair-weather roads

Based on traffic volume

- Heavy
- Medium and
- Light traffic

Based on tonnage

- Class I, II etc. or Class A, B etc.

Based on location and function

Non-Urban Roads – as per Nagpur Road Plan

- National Highways (NH)
- State Highways (SH)
- Major District Roads (MDR)
- Other District Roads (ODR)
- Village Roads (VR)

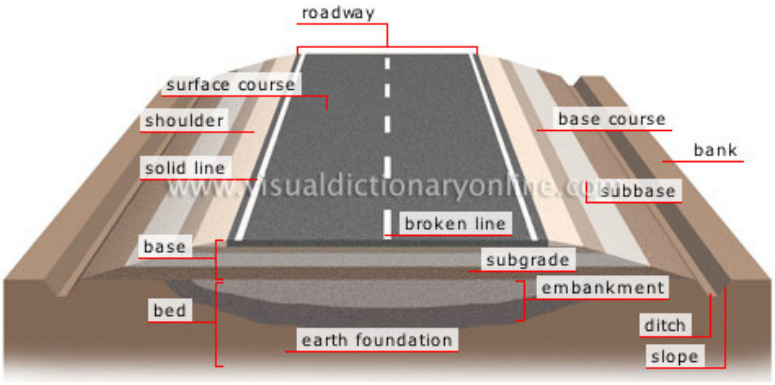
Non-Urban Roads – as per third road development plan

- Primary system – Expressways and NH
- Secondary system – SH and MDR
- Tertiary system or rural roads – ODR and VR

Urban Roads

- Arterial roads
- Sub-arterial roads
- Collector streets
- Local streets

Components of a Road



Typical section of a roadway

A roadway consists of Geometric Elements and Structural Elements. The geometric elements are the visible elements across the roadway while the various layers in the carriage way constitute the structural elements. The geometric elements include Cross section Elements, Sight distance considerations, Horizontal and Vertical alignment details, and Intersection elements. The structural elements consist of typical layers of varying thicknesses and materials. The common layers in a roadway are: Soil Subgrade, Sub-base course, Base course and Surface course.

BRIDGES

A bridge is a structure built to span a gorge, valley, road, railroad track, river, body of water, or any other physical obstacle. A bridge is designed for trains, pedestrian or road traffic, or pipeline or waterway for water transport or barge traffic. A road-rail bridge carries both road and rail traffic.

Types of Bridges

Based on Action

- Beam bridges
- Cantilever bridges
- Arch bridges
- Suspension bridges
- Cable-stayed bridges
- Truss bridges

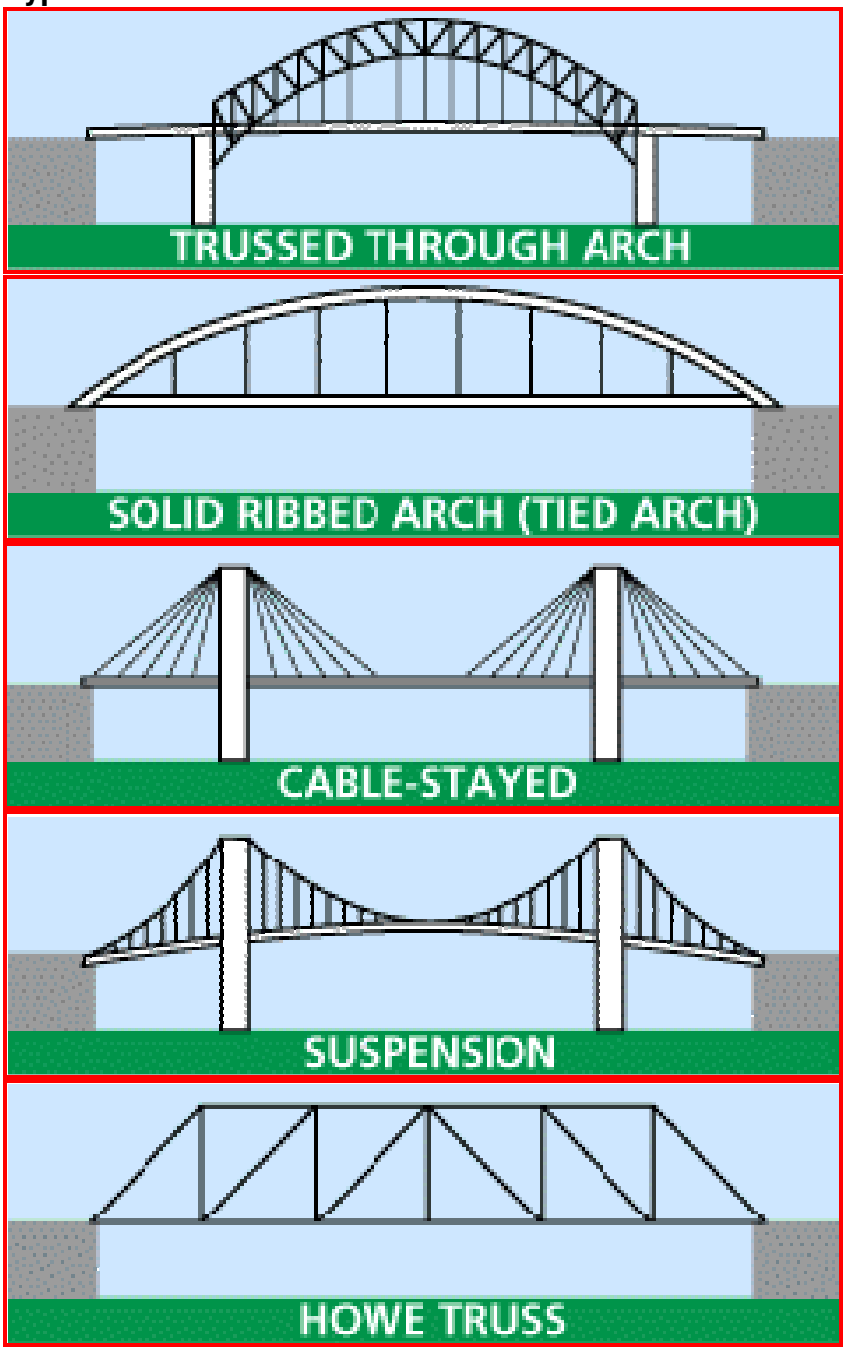
Based on Material used

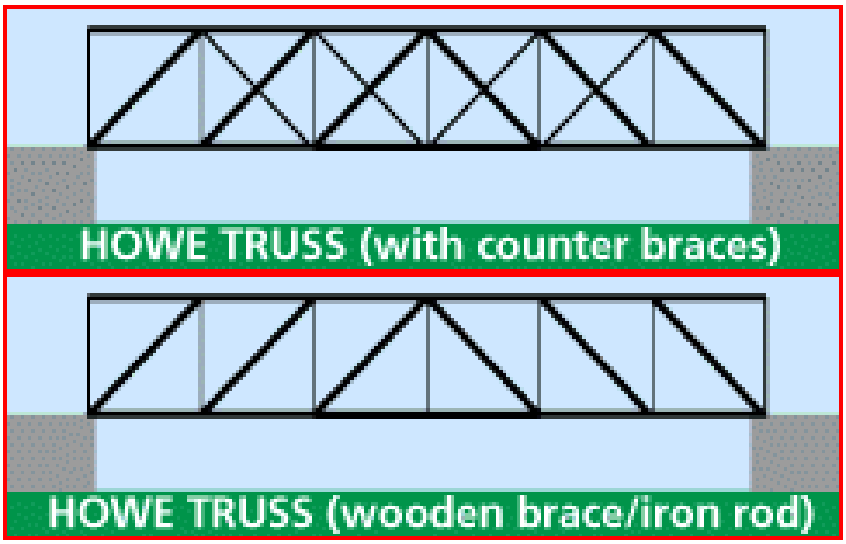
- Concrete Bridge
- Steel Bridge
- Timber Bridge
- Composite Bridge

Based on purpose

- Road Bridge
- Rail Bridge
- Rail & Road Bridge
- Pedestrian Bridge
- Aqueduct

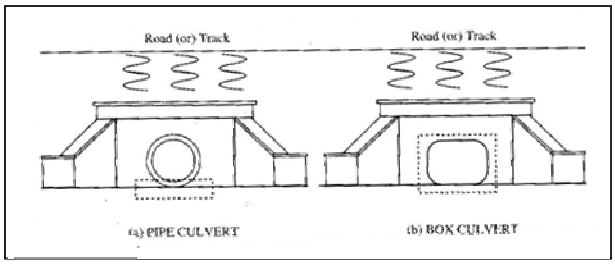
Basic Bridge Types

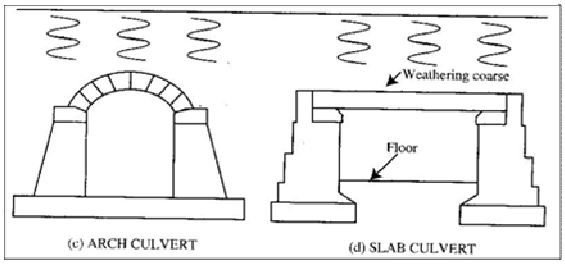




Culverts

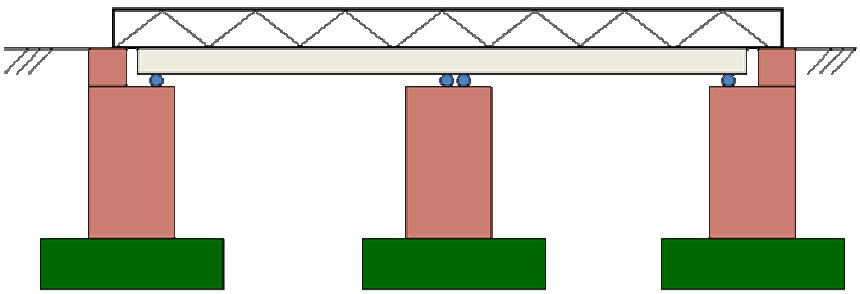
Culverts are smaller bridges, normally with one span built across small streams, drains or sewer carrying road on top





Bridge Components

- Foundation
- Abutment
- Bridge Pier
- Bearing
- Deck Slab
- Roadway
- Railing



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1) ASCE (2007), The Vision for Civil Engineering in 2025, American Society of Civil Engineers
2) Syed Shakeeb Ur Rahman and Madhava Rao V (2006), Elements of Civil Engineering and Engineering Mechanics, Sanguine Technical Publishers.
