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Civil Engineering

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Abstract

Civil engineering is the planning, design, construction, and management of the built environment. This environment includes all structures built according to scientific principles, from irrigation and drainage systems to rocket launching facilities.

Civil engineers build roads, bridges, tunnels, dams, harbors, power plants, water and sewage systems, hospitals, schools, mass transit, and other public facilities essential to modem society and large population concentrations. They also build privately owned facilities such as airport, railroads, pipelines, skyscrapers, and other large structures designed for industrial, commercial, or residential use. In addition, civil engineers plan, design, and build complete cities and towns, and more, recently have been planning and designing space platforms lo self-contained communities.

Keywords: Civil Engineering Structural engineering Water resources Environmental engineering Construction engineering

Introduction

The word civil derives from the Latin for citizen. In 1782, Englishman John Seaton used the term to differentiate his non-military engineering work from that of the military engine that predominated at the time. Since then, the term civil engineer has often been used to refer to engineers who build public facilities, although the field is much broader

Scope Because it is so broad, civil engineering is subdivided into a number of technical specialties. Depending on the type of project, the skills of many kinds of civil engineer specialists may be needed. When a project begins, the site is surveyed and mapped by civil] engineers who experiment to determine if the earth can bear the weight of the project. Environmental specialists study the project's impact on the local area, the potential for air and groundwater pollution, the project's impact on local animal and plant life, and how the project can be designed lo meet government requirements aimed at protecting the environment

Transportation specialists determine what kind of facilities are needed to ease the burden on local roads and other transportation networks that will result from the completed project. Meanwhile, structural specialists raise preliminary data to make detailed designs, plans, and specifications for the project. Supervising and coordinating the work of these civil engineer specialists, from beginning to end of the project, are the construction management specialists. Based (in information supplied by the other specialists, construction management civil engineers estimate quantities and costs of materials and labor, schedule all work, order materials and equipment for the job, hire contractors and subcontractors, and perform other supervisory work to ensure the project is completed on time and as specified.

Throughout any given project, civil engineers make extensive use of computers. Computers are used lo design the project's various elements (computer-aided design, or CAD) and lo manage it. Computers are a necessity for the modem civil engineer because they permit the engineer to efficiently handle the large quantities of data needed in determining the best way to construct a project.

Structural engineering In this specialty, civil engineers plan and design structures of all types, including bridges, dams, power plants, supports for equipment, special structures for offshore projects, the United Slates space program, transmission towers, giant astronomical and radio telescopes, and many other kinds of projects.

Using computers, structural engineers determine the forces a structure roust resist, its own weight, wind and hurricane forces, temperature changes that expand or contract construction materials, and earthquakes. They also determine the combination of appropriate materials: steel, concrete, plastic, stone, asphalt, brick, aluminum, or other construction materials.

Water resources engineering Civil engineers in this specialty deal with all aspects of the physical control of water. Their projects help prevent floods, supply water for cities and for irrigation, manage and control rivers and water runoff, and maintain beaches and other waterfront facilities. In addition, they design and maintain harbors, canals, and locks, build huge hydroelectric dams and smaller dams and water impoundments of all kinds, help design offshore structures, and determine the location of structures affecting navigation.

Geotechnical engineering Civil engineers who specialize in this field analyze the properties of soils and rocks that support structures and affect structural behavior. They evaluate and work to minimize the potential settlement of buildings and other structures that stems from the pressure of their weight on the earth. These engineers also evaluate and determine how to strengthen the stability of slopes and how to protect structures against earthquakes and the effects of groundwater.

Environmental engineering In this branch of engineering, civil engineers design, build, and supervise systems to provide safe drinking water and to prevent and control pollution of water supplies, both on the surface and underground. They also design, build, and supervise projects to control or eliminate pollution of the land and air. These engineers build water and wastewaters treatment plants, and design air scrubbers and other devices to minimize or eliminate air pollution caused by industrial processes, incineration, or other smoke - producing activities. They also work to control toxic and hazardous wastes through the construction of special dump sites or the neutralizing of toxic and hazardous substances. In addition the engineers design and manage sanitary landfills to prevent pollution of surrounding land.

Transportation engineering Civil engineers working in (his specialty build facilities to ensure safe and efficient movement of both people and goods. They specialize in designing and maintaining all types of transportation facilities, highways and streets, mass transit items, railroads and airfields ports and harbors. Transportation engineers apply technological knowledge as well as consideration of the economic, political, and social factors in designing each project. They work closely with urban planners since the quality of the community is directly related to the quality of the transportation system

Pipeline engineering In this branch of civil engineering, engineers build pipelines and related facilities which transport liquids, gases, or solids ranging from coal slurries (mixed coal and water) and semi liquid wastes, to water, oil and various types of highly combustible and noncombustible gases. The engineers determine pipeline design, the economic and environmental impact of a project on regions it must traverse, the type of materials to be used-steel, concrete, plastic, or combinations of various material; installation techniques, methods for testing pipeline strength , and controls for maintaining proper pressure and rate of flow of materials being transported. When hazardous materials are being carried, safety is a major consideration as well

Construction engineering Civil engineers in this field oversee the construction of a project from beginning to end. Sometimes called project engineers, they apply both technical and managerial skills, including knowledge of construction methods, planning, Organizing, financing, and operating construction projects.

They coordinate the activities of virtually everyone engaged in the work; the surveyors, workers who lay out and construct the temporary roads and ramps, excavate for the foundation, build the forms and pour the concrete; and workers who build the steel frame-work. These engineers also make regular progress reports lo the owners of the structure.

Community and urban planning Those engaged in this area of civil engineering may plan and develop communities within a city, or entire cities. Such planning involves far more than engineering considerations; environmental, social, and economic factors in the use and development of land and natural resources are also key elements. These civil engineers coordinate planning of public works along with private development. They evaluate the kinds of facilities needed, including streets and highways, pubic transportation systems, airports, port facilities, water-supply and wastewater-disposal systems, public buildings, parks, and recreational and other facilities to ensure social and economic as well as environmental well-being.

Photogrammetry, surveying, and mapping The civil engineers in this specialty precisely measure the Earth's surface to obtain reliable information for locating and designing engineering projects. This practice: often involves high-technology methods such as satellite and aerial surveying, and computer processing of photographic imagery. Radio signs from satellites, scanned by laser and sonic beams, are converted to maps to provide very accurate measurements for boring tunnels, building highways and dams, plotting flood control and irrigation projects, locating subsurface geologic formations that may affect a construction project and a host of other building uses.

Other specialties Two additional civil engineering specialties that are not entirely within the scope of civil engineering but are essential to the discipline are engineering management and engineering teaching

Engineering management Many civil engineers choose careers that eventually lead to management. Others are able to start their careers in management positions. The civil engineer manager combines technical knowledge with an ability to organize and coordinate worker power, material, machinery, and money. These engineers may work in government municipal, county, stale, or federal; in the U. S. Army Corps of Engineers as military or civilian management engineers; or in semiautonomous regional or city authorities or similar organization. They may also manage private engineering firms ranging in size from a few employees to hundreds.

Engineering teaching The civil engineer who chooses a teaching career usually teaches both graduate and undergraduate students in technical specialties. Many teaching civil engineers engage in basic research that eventually leads to technical innovations in construction materials and methods. Many also serve as consultants on engineering projects, or on technical hoards and commissions associated with major projects.

Careers in Civil

Engineering is a profession, which means that an engineer must have a specialized university education. Many government jurisdictions also have licensing procedures which require engineering graduates to pass an examination, similar to the bar examination for a lawyer, before they can actively start on their careers.

In the university, mathematics, physics, and chemistry are heavily emphasized throughout the engineering curriculum, but particularly in the first two or three years Mathematics is very important in all branches of engineering, 30 it is greatly stressed Today, mathematics includes courses in statistics, which deals with gathering, classifying, and using numerical data, or pieces of information. An important aspect of statistical mathematics is probability, which deals with what may happen when there are different factors, or variables, that can change the results of a problem. Before the construction of a bridge is undertaken, for example, a statistical study is made of the amount of traffic the bridge will be expected to handle. In the design of the bridge, variables such as water pressure on the foundation, impact, the effects of different wind forces, and many other factors must be considered.

Because a great deal of calculation is involved in solving these problems, computer programming is now included in almost all engineering curricula. Computers, of course, can solve many problems involving calculations with greater speed and accuracy than a human being can. But computers are useless unless they are given clear rind accurate instructions and information---in other words, a good program.

In spite of the heavy emphasis on technical subjects in the engineering curriculum, a current trend is to require students to take courses in the social science and the language arts. The relationship between engineering and society is getting closer; it is sufficient, therefore, to say again that the work performed by an engineer affects society in many different and important ways that he or she should he aware of. An engineer also needs a sufficient

command of language to be able to prepare reports that a-M clear and, in. many cases, persuasive. An engineer engaged in research will need to be able to write up, his or her findings for scientific publications,

The last two years of an engineering program include subjects within the student's field of specialization. For the student who is preparing to become a civil engineer, these specialized courses may deal with such subjects as geodetic surveying, soil mechanics, or hydraulics.

Active recruiting for engineers often begins before: the student's last year in the university. Many different corporation and government agencies have competed for, the services of engineers in recent years. In the science-oriented society of today, people who have technical training are, of courser, in demand. Young engineers: may choose to go, into environmental or sanitary engineering, for example, where environmental concerns have created many openings; or they may choose construction fines that specialize in highway wonk; or they may prefer to work with cane of the government agencies that deal with water resource. Indeed, the choice is large and varied.

When the young engineer has finally started actual practice, the theoretical knowledge acquired in the university must be applied. He or she will probably be assigned at the beginning to work with a team of engineers thus, on-the-job training cam be acquired that will demonstrate his or her ability to translate theory into practice to the supervisors.

The civil engineer may work in research, design, construction supervision, maintenance, or even in Sales or management. Each of these areas involves different duties, different emphases, and different uses of engineer's knowledge and experience.

Research is one of the most important aspects of scientific and engineering practice. A researcher usually works as a member of a team with other scientists and engineers. He or she is often employed in a laboratory that is financed by government or industry. Areas of research connected with civil engineering include soil mechanics and soil stabilization techniques, and also the development and testing of new structural materials.

Civil engineering projects are almost always unique; that is, each has its own problems and design features. Therefore, careful study is given to each project even before design work begins. The study includes a survey both of topography acid subsoil features of the proposed site. It also includes a consideration of possible alternatives, such as a-concrete gravity clam or an earth-fill embankment dam. The economic factors involved in each of the possible alternatives must also be weighed. Today, a study usually includes a consideration of the environmental impact of the project. Many engineers, usually working as a team that includes surveyors, specialists in soil mechanics, and experts in design and construction are involved in making these feasibility studies

Many civil engineers, among them the top people in the field, work in design. As we have seen, civil engineers work on many different kinds of structures, so it is normal practice for an engineer to specialize in just one kind. In designing buildings engineers often work as consultants to architectural or construction firms. Dams, bridges, water supply systems, and other large projects ordinarily employ several engineers whose work h coordinated by a system engineer who is in charge of the entire project. In many cases engineer from other disciplines are involved. In a dam project, for example, electrical and mechanical engineers work on the design of the powerhouse and its equipment. In other cases civil engineers are assigned to work on a project in another field; in the space program, for instance, civil engineers were necessary in the design and construction of such structures as launching pads and rocket storage facility

Construction is a complicated process on almost all engineering projects. It involves scheduling the work and utilizing the equipment and the materials so that coats are kept as low as possible. Safety factor must also be taken into account, since construction can be very dangerous. Many civil engineers therefore specialize in the construction phase.

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