# Civil Engineering
## Problems and Solutions

**Dr. Tanjina Nur, Ph.D.**



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Tanjina finished her PhD in Civil and Environmental Engineering in 2014 from University of Technology Sydney (UTS). Now she is working as Post-Doctoral Researcher in the Centre for Technology in Water and Wastewater (CTWW) and published about eight International journal papers with 80 citations. Her research interest is wastewater treatment technology using adsorption process.

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# Preface

This book presents review examines of methods developed for dealing with and applied to solve problems of civil engineering. The book is focused on formal methods of solving different parts of civil engineering problems using numerical methods and also fuzzy and uncertainty methods. Civil Engineering is concerned with such projects as roads, bridges, railways, harbours and docks, water supply and wastewater treatment, dams, tunnels and underground construction, power projects, offshore structures, and commercial and industrial buildings. The effective practice of civil engineering necessitates a strong background in the mathematical and physical sciences, an understanding of the properties of construction materials such as steel, concrete, timber and soils. Firstly, we discuss current state and future research methods for solving civil engineering problems by means of fuzzy and stochastic methods and the interval-valued intuitionistic fuzzy method. Then we present an interval-parameter fuzzy linear programming with stochastic vertices model for water resources management under uncertainty and attractor of beam equation with structural damping under nonlinear boundary conditions. Seismic behavior of substandard RC columns retrofitted with embedded aramid fiber reinforced polymer (AFRP) reinforcement and determination of the impact behavior of concrete and reinforced concrete beams are also discussed.

In the middle part of the book, we focus on neural network model for moment-curvature relationship of reinforced concrete sections and an approximate solution for boundary value problems in structural engineering and fluid mechanics. Then solving the problem of multiple-criteria building design and free vibration analysis of symmetrically laminated folded plate structures are also discussed. We also try to present solution of the porous media equation by a compact finite difference method and architecture of wireless vehicle weight measurement system for structural health monitoring in Civil Engineering application.

The last chapters of the book describe parametric optimization for the vibration control of building structures and non-invasive sensing techniques and geophysical methods for cultural heritage and civil infrastructures monitoring. We also try to find out analytical solution for free vibration analysis of beam on elastic foundation with different support conditions and engineering solutions to enhance traffic safety performance on two-lane highways. At the end, we describe comparison of fuzzy AHP and fuzzy TOPSIS for road pavement maintenance.

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# INTRODUCTION

Civil engineering is a technology that includes numerous other disciplines that produce useful facilities for the human beings, including roads, dams, waste disposal and other facilities that are used in our daily life. Civil engineering is progressing at a fast pace as are other technologies.

Civil engineering is considered as the first discipline of the various branches of engineering after military engineering, and includes the designing, planning, construction, and maintenance of the infrastructure. The works include roads, bridges, buildings, dams, canals, water supply and numerous other facilities that affect the life of human beings. Civil engineering is intimately associated with the private and public sectors, including the individual homeowners and international enterprises.
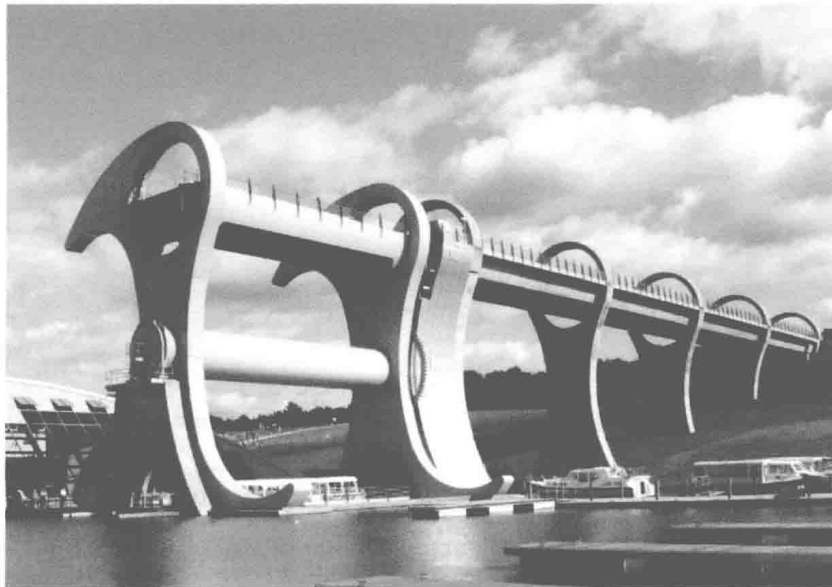


Civil engineering has a significant role in the life of every human being, though may not truly sense its importance in our daily routine. The function of civil engineering commences with the start of the day when we take a shower, since the water is delivered through a water supply system including a well-designed network of pipes, water treatment plant and other numerous associated services. The network of roads on which we drive while proceeding to school or work, the huge structural bridges we come across and the tall buildings where we work, all have been designed and constructed by civil engineers. Even the benefits of electricity we use are available to us through the contribution of civil engineers who constructed the towers for the transmission lines. In fact, no sphere of life may be identified that does not include the contribution of civil engineering. Thus, the importance of civil engineering may be determined according to its usefulness in our daily life.

### Scope of Different Fields of Civil Engineering

Civil Engineering may be divided into the following fields:

- Surveying

- Building Materials

- Construction Technology

- Structural Engineering

- Geotechnical Engineering

- Hydraulics

- Water Resources and Irrigation Engineering

- Transportation Engineering

- Environmental Engineering and

- Architecture and Town planning

Scope of each one of these is discussed below.

## Surveying

Surveying is the science of map making. To start any development activity in an area the relative positions of various objects in the horizontal and vertical directions are required. This is approved by surveying the area. Earlier, the conventional instruments like chain, tape and levelling instruments were used. In this electronic era, modern equipments like distance meters and total stations are used to get more accurate results easily. The modern technologies like photogrammetry and remote sensing have made surveying easier.



## Building Materials

Shelter is the basic need of civilization. To get good shelter continuous efforts are going on right from the beginning of civilization. Stones, bricks, timber, lime, cement, sand, jellies and tiles are the traditional building materials. Use of steel, aluminium, glass, glazed tiles, plaster of paris, paints and varnishes have improved the quality of buildings. The appropriate mixture of binding materials like lime and cement with sand is known as mortar. The mixture of cement, sand and jelly (crushed stones) with water is known as concrete. The use of concrete with steel bars placed in appropriate position has helped in building strong and durable tall structures. The composite material of concrete and steel is called reinforced cement concrete which is popularly known as R C C. A civil engineer must know the properties of all the building materials so that they can be used appropriately. Improved versions of many building materials appear in the market. A good civil engineer will make use of them at the earliest.

## Construction Technology

Construction is the major activity of civil engineering which is continuously improving. As land cost is going up there is demand for tall structures in urban areas while in rural areas need is for low cost constructions. One has to develop technology using locally available materials.

## Structural Engineering

Load acting on a structure is ultimately transferred to ground. In doing so, various components of the structure are subjected to internal stresses. For example, in a building, load acting on a slab is transferred by slab to ground through beams, columns and footings. Assessing the internal stresses in the components of a structure is known as Structural Analysis and finding the suitable size of the structural component is known as design of structure. The structure to be analyzed and designed may be of masonry, R. C. C. or steel. Upto midsixties considerable improvements were seen in classical analysis. With the advent of computers numerical methods emerged and analysis and design packages are becoming popular. Matrix Method of analysis and Finite Elements Analysis have helped in the analysis of complex structures. A civil engineer has not only to give a safe structure but he

has to give economical sections. To get economical section mathematical optimization techniques are used. Frequent earthquakes in the recent years have brought, importance of analysis of the structure for earthquake forces. Designing earthquake resistant structures is attracting lot of researches. All these aspects fall under structural engineering field.

## Geotechnical Engineering

Soil property changes from place to place. Even in the same place it may not be uniform at various depths. The soil property may vary from season to season due to variation in moisture content. The load from the structure is to be safely transferred to soil. For this, safe bearing capacity of the soil is to be properly assessed. This branch of study in Civil Engineering is called 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 dams, canals and earth retaining structures. It involves study of ground improvement techniques also.



## Hydraulics

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.

## Water Resources and Irrigation Engineering

Water is to be supplied to agriculture field and for drinking purposes. Hence suitable water resources are to be identified and water is to be stored. Identifying, planning and building water retaining structures like tanks and dams and carrying stored water to fields is known as water resources and irrigation engineering.

## Transportation Engineering

Transportation facility is another important need. Providing good and economical roads is an important duty of civil engineers. It involves design of base courses, suitable surface finishes, cross drainage works, road intersections, culverts, bridges, tunnels etc. Railway is another important long-way transport facility. Design, construction and maintenance of railway lines, signal system are part of transportation engineering. There is need for airports and harbors. For proper planning of these transportation facility, traffic survey is to be carried out Carrying out traffic survey, design, construction and maintenance of roads, bridges, railway, harbor and airports is known as transportation engineering.

## Environmental Engineering

Proper distribution of water to rural areas, towns and cities and disposal of waste water and solid waste are another field of civil engineering. Industrialization and increase in vehicular traffic are creating air pollution problems. Environmental engineering while tackling all these problems provides healthy environment to public.

## Architecture and Town Planning

Aesthetically good structures are required. Towns and cities are to be planned properly. This field of engineering has grown considerably and has become a course separate from Civil Engineering.

## *Types of Infrastructure*

Infrastructure facilities involve various civil engineering amenities, electricity, telephone, internet facility, educational and healthcare facilities.

Civil engineering amenities in the infrastructure developments are:

- A good town planning and developing sites

- Providing suitable roads and network of roads

- Railway connection to important places

- Airports of national and international standards

- Assured water supply to towns, cities and rural areas

- A good drainage and waste disposal system

- Pollution free environment
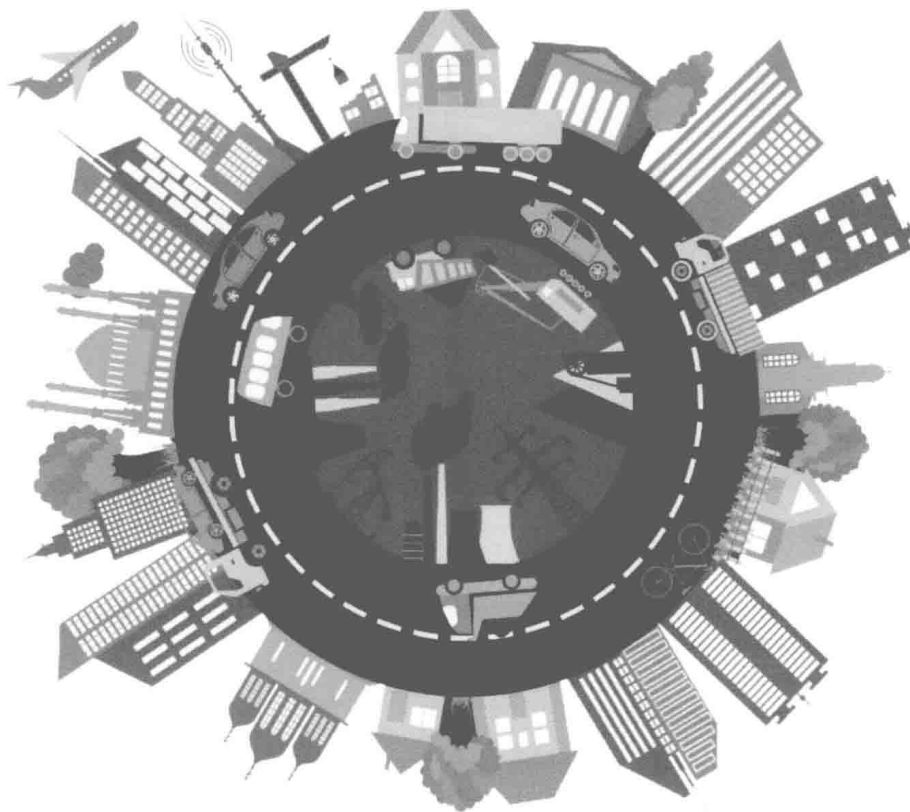


## *Effect of Infrastructure Facilities*

Connecting producing center to marketing places minimizes exploitation from middlemen. Both producer and consumers are benefitted. Imports and exports become easy as a result of which whole world becomes a village. The infrastructure development generates scope for lots of industries. Manpower is utilized for the benefit of mankind. Antisocial activities come under control. Improved education and healthcare give rise to skilled and healthy work force. Quality of life of the people is improved. In case of natural calamities assistance can be extended easily and misery of affected people is reduced. Infrastructure facility improves defense system and peace exists in the country. Improved economical power of the country brings a respectable status in the world. The world has realized that a government should not involve itself in production and distribution but should develop infrastructure to create an atmosphere for economical development.

## *Role of Civil Engineers in the Infrastructure Development*

A civil engineer has to conceive, plan, estimate, get approval, create and maintain all civil engineering infrastructure activities. He has to carry out research and training programmes to improve the technology.

Civil engineer has a very important role in the development of the following infrastructures:

- Town and city planning

- Build suitable structures for the rural and urban areas for various utilities.