

control lines, standards, technical and legal prescriptions. An engineering way of thought enters, whenever these regulations are fixed and checked on a rational or economic basis. Even purely political decisions require some kind of objective control as to their consequences.

### 3.4 Hydraulic engineering

Hydraulic engineering is concerned with the design, operation and maintenance of hydraulic structures and tools like canals, pipelines, dams, pumps, etc. Various phenomena, which are linked to specific properties of water have to be considered in controlling flow velocities, distribution of static and dynamic pressures as well as some aspects of water quality. Studies on flood waves and wave forms, turbulences, scour, sediment transport and ground water seepage, to quote only a few examples, require considerable engineering know-how and can be highly fascinating. Boundary conditions for a spillway discharge may be so complicated that even computer solutions won't cope with them and the engineer has to rely on hydraulic models. But even for such simple structures as small irrigation channels or diversion boxes a basic understanding of flow phenomena is essential for proper design.

All that, although related to purely technical aspects should nevertheless also include awareness of the needs and capabilities of those for whose benefit these structures are being built.

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#### **CURRICULUM IN CIVIL ENGINEERING AT THE UNIVERSITY OF DAR ES SALAAM**

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After two years experience with the curriculum in Civil Engineering, and after arrival of new staff members with new ideas, it was realized that there was room for improvement of the teaching programme. It was also necessary to develop the final concepts for the 3rd and 4th year, since only very rough outlines existed for this part of the course.

After a series of three seminars the "Objectives" given below were arrived at. They will serve as a basis for redrafting the curriculum and syllabi, presently in discussion.

It may appear that quite a number of trivialities are listed and that not every statement represents a fundamental new finding. However, it is important to include these points in order to be able to draw all the necessary conclusions and consequences for the teaching programme and methods.

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## Objectives of the Curriculum in Civil Engineering

### A. Some general remarks concerning the training of the Civil Engineer

1. A graduate leaving the University after completing his studies for the Bachelor's degree in Engineering, is by no means a fully trained professional engineer. Besides lacking practical experience, he does not possess all the abilities and knowledge needed for his professional career. He will require guidance to enable him to develop his abilities further, extend his knowledge and acquire full professional competence.
2. The engineer's work is determined not only by technical aspects, but also by social, economic, ecological and other non-technical factors. A basic knowledge and an appreciation of these factors must be included in his education.
3. The civil engineer's work is closely related to other branches of engineering, especially mechanical and electrical engineering. A basic knowledge of these fields also must be included in the Civil Engineering curriculum.

### B. Some remarks concerning the training of Civil Engineers in Tanzania

1. The educational policy in Tanzania receives its orientation from the society's commitment to socialism and to the policy of self-reliance. The Civil Engineer must accept his responsibility to the people and his work is governed by the society's ideals.
2. The vast majority of Tanzanians are living in the rural areas where they are engaged in agriculture, which is the basis of their livelihood and the backbone of Tanzania's economy. In order to facilitate agricultural production, the activities of the Civil Engineer must concentrate more on the development of the infrastructure and other amenities necessary for rural development than on the development of sophisticated urban facilities.
3. Economically, Tanzania is a poor country which is short of foreign exchange and of manufactured products sold on the world market. Emphasis has therefore to be given to indigenous materials and to techniques that can be implemented with local resources.
4. In Tanzania, as a comparatively young country, there is a lack of basic physical, economic and sociological data. Planning and design of new projects therefore might involve field research and data collection to a larger extent than elsewhere.
5. Tanzania is suffering from a shortage of trained manpower, especially in technical fields. The consequences to be considered for the concept of education of Civil Engineers are:

- many engineers find their professional activities shifting from purely technical to managerial, involving management of personnel, materials and equipment;
- the fresh graduate may be in a position where professional guidance is not available in the early stages of his professional career;
- the graduate is likely to find himself in a position of high responsibility after a rather short period of experience;
- the civil engineer must, as far as possible, be conversant in all branches of the profession, as he may not be able to find suitable specialists to be contacted for special problems;
- the shortage of medium level technical personnel (technicians) leaves part of their normal duties to be undertaken by engineers;
- the engineer might find himself working under an experienced technician.

### C. Attributes of a professional Civil Engineer

A professional civil engineer must be competent, through technical education and post-graduate experience, to

plan, design, and supervise the construction and maintenance of various kinds of civil engineering works.

In Tanzania such works include:

- irrigation and drainage works, water supplies and sewage schemes, hydraulic structures;
- harbour and coastal works, erosion control structures;
- trunk and feeder roads, low cost roads, urban streets;
- railways, airfields;
- residential, administrative, commercial and industrial buildings;
- bridges, culverts, and tunnels.

The attributes required to be competent can be divided into the following 4 categories. It must be emphasized that this is for ease of reference only; many of these attributes are interrelated.

#### 1. Attitudes

The civil engineer shall

- be confident of his own abilities, but equally aware of his limitations;
- appreciate the competence of others, and be prepared to learn from them;

- understand his work in all its aspects, including social and economic ones, and those of other branches of engineering;
- realise that a degree alone does not produce a competent engineer.

## 2. Abilities

A civil engineer must be able to

- recognize all aspects of a project, including problems likely to arise, and decide upon his competence to solve them;
- collect and evaluate necessary data and information;
- idealize a physical problem so that it can be solved by analytical methods available;
- convert analytical findings into design, and design into drawings to serve as the basis of implementation not only by himself;
- select construction materials and techniques, with regard to technical, environmental and especially economic limitations;
- execute the construction of a project on the basis of design drawings given to him;
- adapt a design to changes in the availability of materials, equipment and labour;
- co-operate with economists, architects, planners, and engineers in the various stages of planning, design and construction;
- guide and supervise staff and workers at various levels;
- work independently, and seek solutions he can implement with the available resources;
- tackle problems new to him, using all his knowledge and experience, and learning from nature and experience of others;
- find quickly approximate solutions, by guessing reasonably, or by applying simple analytical methods to a largely idealized model of the problem;
- realise the impact of works he designs or constructs on people and the environment;
- judge the work of himself and others critically.

## 3. Knowledge

The civil engineer shall know

- what is Civil Engineering, and what tasks are performed by civil engineers;
- the social, political, and economic nature of the society in which he works;

- the history of civil engineering, the present situation, particularly in Tanzania, and prospects for the future;
- the institutions dealing with civil engineering works, and other allied professions, and their particular competence and responsibilities;
- the basic data determining his work, how they have been obtained, and their reliability;
- the laws, regulations, and standards relevant to his work;
- the technologies, tools, and machinery required to process engineering materials;
- important laws and facts in the physical sciences;
- the analytical methods based on these laws, relevant to engineering projects;
- experimental methods of obtaining data, and supplementing analytical investigation;
- about methods of numerical computations, and graphical methods, and their suitability for a specific problem;
- management techniques appropriate to planning and construction of projects.

#### 4. Skills

The civil engineer shall be skilled in

- obtaining quickly and with appropriate accuracy the results of experimental and analytical analyses, using various means;
- handling necessary equipment;
- explaining himself briefly and clearly, orally and on paper;
- preparing and reading sketches, diagrams and drawings.

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