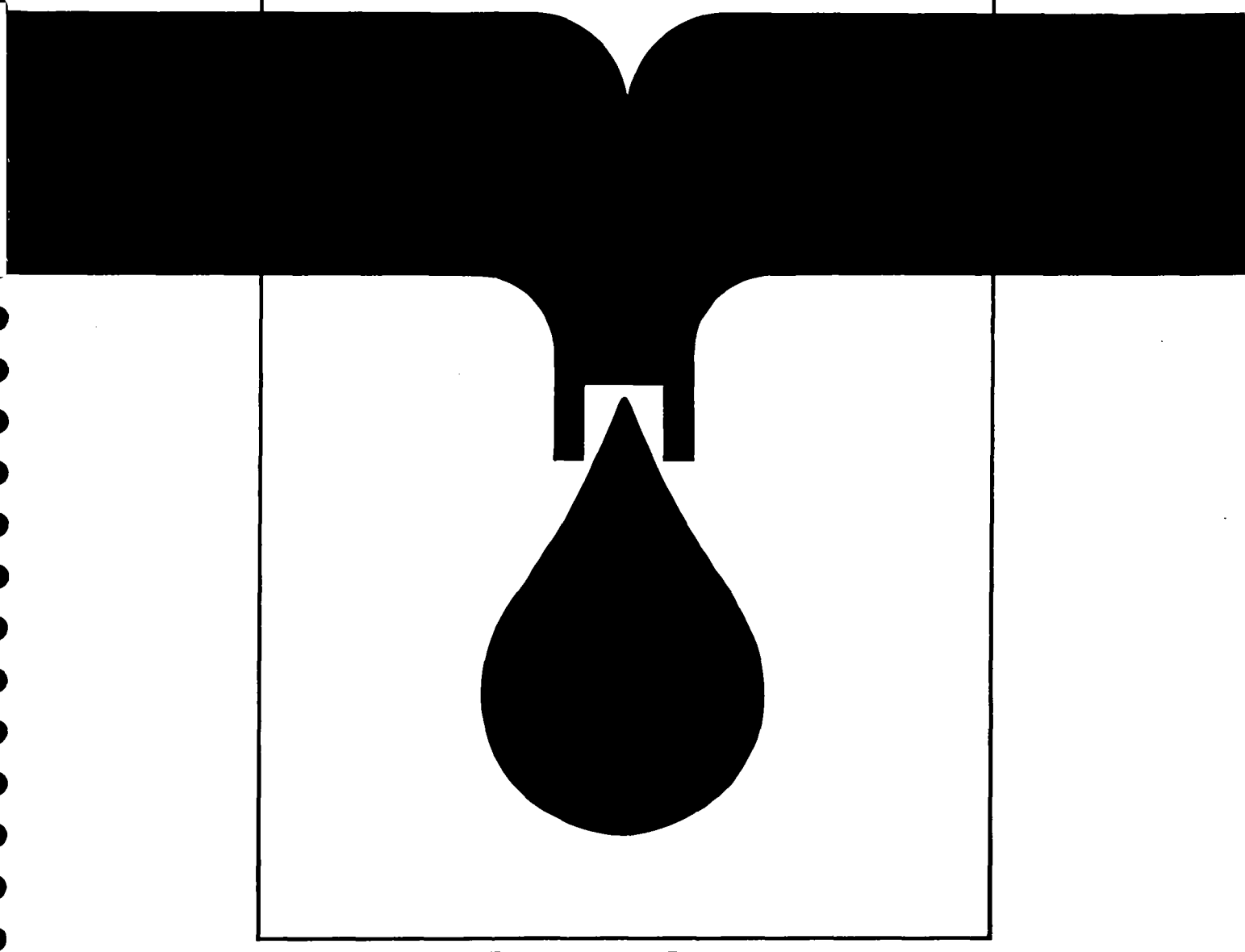
TRAINING MODULES
FOR
WATERWORKS PERSONNEL



Special Skills

3.8 a

Construction in concrete and masonry

Foreword

Even the greatest optimists are no longer sure that the goals of the UN "International Drinking Water Supply and Sanitation Decade", set in 1977 in Mar del Plata, can be achieved by 1990. High population growth in the Third World combined with stagnating financial and personnel resources have led to modifications to the strategies in cooperation with developing countries. A reorientation process has commenced which can be characterized by the following catchwords:

- use of appropriate, simple and – if possible – low-cost technologies,
- lowering of excessively high water-supply and disposal standards,
- priority to optimal operation and maintenance, rather than new investments,
- emphasis on institution-building and human resources development.

Our training modules are an effort to translate the last two strategies into practice. Experience has shown that a standardized training system for waterworks personnel in developing countries does not meet our partners' varying individual needs. But to prepare specific documents for each new project or compile them anew from existing materials on hand cannot be justified from the economic viewpoint. We have therefore opted for a flexible system of training modules which can be combined to suit the situation and needs of the target group in each case, and thus put existing personnel in a position to optimally maintain and operate the plant.

The modules will primarily be used as guidelines and basic training aids by GTZ staff and GTZ consultants in institution-building and operation and maintenance projects. In the medium term, however, they could be used by local instructors, trainers, plant managers and operating personnel in their daily work, as check lists and working instructions.

45 modules are presently available, each covering subject-specific knowledge and skills required in individual areas of waterworks operations, preventive maintenance and repair. Different combinations of modules will be required for classroom work, exercises, and practical application, to suit in each case the type of project, size of plant and the previous qualifications and practical experience of potential users.

Practical day-to-day use will of course generate hints on how to supplement or modify the texts. In other words: this edition is by no means a finalized version. We hope to receive your critical comments on the modules so that they can be optimized over the course of time.

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It is my sincere wish that these training modules will be put to successful use and will thus support world-wide efforts in improving water supply and raising living standards.

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CONSTRUCTION IN CONCRETE AND MASONRY

1.	Introduction	1
	1.1 Purpose	1
	1.2 Consideration of important side issues	1
	1.3 Planning	1
	1.4 Preparation of construction site	2
2.	Concrete and Reinforced Concrete	3
	2.1 Materials	4
	2.2 Making Concrete	5
	2.3 Reinforcement	8
	2.4 Formwork	9
3.	Mortar, Masonry Walls, and Plastering	10
	3.1 Mortar	10
	3.2 Construction of masonry walls	10
	3.3 Plastering	11

CONSTRUCTION IN CONCRETE AND MASONRY

1. Introduction

1.1 Purpose

As described in Module 2.8, concrete and masonry are widely used in the construction of water supply units. This Module 3.8a describes the making of concrete, preparation of mortar and construction of masonry.

1.2 Consideration of important side issues

Before dealing with the subject, the author of this module wishes to consider some of the preparatory work that preceeds actual construction. This preparatory work includes:

- the planning of the whole construction; and
- the preparation and installation of the site.

A full treatment of these issues would be beyond the scope of this Module; as most of the persons involved in the actual construction have no role to play in the planning phase. However, planning is mentionned here to provide a check list that enhances discussions with those concerned.

When the construction team arrives at the site, one of the first things that it will have to do is to check the sources for local materials and labour. Local materials include sand, coarse aggregates, and water. The other is to prepare and install the construction site.

1.3 Planning

Construction is the transformation of materials into a stable and functional structure by the best use of labour, funds, equipment, and construction methods; and planning is necessary to achieve this.

Planning includes the preparation of time schedule for the entire construction, schedule of materials, and schedule of labour. Drawings, specifications and bills of qualities must be checked to ensure that they are correct and complete. It is advisable to decide on the season for construction, in

regions where there are distinct dry and wet months. Arrangement should be made for the purchase or provision from stores of construction materials and equipment which will not be available in the vicinity of the construction site. Timber, cement, reinforcement steel, tying wires, pipe, fittings, pumps are typical examples. A check list should be made based on local conditions. Similar preparations should be made for the provision of construction equipment and tools.

Logistics must be considered too. Transportation for personnel, material, and construction equipment must be planned. If the construction is in a remote area the provision of accommodation, for example tents, cooking facilities, preventive and curative medicine and first aid kits has to be organized in time.

Water is necessary both for the consumption by personnel and for use in construction. Adequate means of providing water, or transporting it to and storing it at the site should be determined in advance, as should the treatment of drinking water. In some places special consideration should be given to the provision of adequate supply of fuel.

Finally it is necessary to assign persons to perform defined activities.

This is just an example that can be used to establish a check list. Such a check list should be completed and modified by the trainer and trainees according to local conditions and regulations.

In many cases it is seen that making concrete, placing reinforcement or installing appurtenances is easier than implementing logistics. It would not be difficult to imagine how lack of construction materials and other supplies can disrupt the progress of the work and delay its completion. Therefore, we should all strive to minimize these disruptions and delays.

1.4 Preparation of construction site

The site is chosen following the location criteria given in Module 2.8. (See in Module 2.8, Section 3.2; and then Sections 4.4; 5.4; 6.4; 7.4 and 8.4 for particular units)

The construction team should identify the chosen site, and then

1. clear the site and provide an adequate working space;
2. stake the position of the unit;
3. explore the site and its surroundings, prepare a sketch and mark out areas for
   (a) storage of sand, gravel, stones, reinforcement steel, shuttering, timber, water, construction equipment, etc.
   (b) store for cement, tools and equipment;
   (c) mixing platform for concrete;
   (d) sieving and washing of aggregates;
   (e) storage of sieved and washed aggregates;
   (f) cutting and bending of reinforcement steel;
   (g) manufacturing area, including curing shed, for prefabricated concrete elements, where applicable;
   (h) dumping excavated material; and
   (i) camp for personnel, where applicable.

This preparation ensures that there is adequate working space for each operation, and that no work hampers another; the preparation should be made irrespective of the size of the unit.

The layout of the site depends on the size and nature of the unit to be built, local site conditions, direction of access, location of source of water for construction, position of suitable dumping area for excavated material, available construction equipment, etc.

2. Concrete and Reinforced Concrete

Reinforced concrete is the most suitable construction material for the majority of water supply units. The quality of the reinforced concrete, and therefore the safety and durability of the structure depends on the materials, skills, construction equipment available locally, and the care and precautions taken in the execution of the work. Although workmen can be trained, close supervision is necessary.

2.1 Materials

The materials for concrete are cement, sand, coarse aggregate, and water. Reinforcement steel is required for reinforced concrete.

2.1.1 Cement

Use ordinary Portland cement. Store the cement in unbroken bags in a waterproof shed with a raised boarded floor. Use cement in the order of delivery. Do not use lumpy cement or cement from broken bags.

2.1.2 Sand

Sieve and wash the sand; and ensure that it is free from clay, organic matter and other impurities.

2.1.3 Coarse aggregate

Sieve and wash the gravel or other suitable material; and ensure that it is free from sand, clay, quarry refuse and other impurities.

2.1.4 Water

Use water that is free from organic or other harmful substances.

2.1.5 Reinforcement steel

Before using the reinforcement steel, ensure that it is free from oil, grease, dirt, paint, and any loose rust.

2.1.6 Stocks of materials

To avoid the possibility of the work being delayed because of lack of materials, maintain an adequate stock to cover requirements. This applies also to water.

2.1.7 Area for storing aggregates

Aggregate should be stored on a hard dry ground. If there is not such a place, construct a thin layer of lean concrete as a storage area, particularly for sieved and washed aggregates. Use cement from broken bags (if any).

2.2 Making concrete

Cement, sand, coarse aggregate, and water are mixed in definite proportions to make concrete. The process consists of determining mix proportions; batching of materials, mixing, transporting, placing, compacting, and curing concrete; inspecting surface finish and making improvements that are necessary.

2.2.1 Mixing platform for concrete

Where it is not possible to provide concrete mixing equipment, the concrete has to be mixed by hand on a mixing platform. The area marked for this purpose, about 2 metres square is cleared and levelled. A layer of gravel is laid and compacted to a thickness of about 5 cm. Cement mortar (4 parts sand to 1 part cement) is spread over the surface and a ridge formed arround the edge. Finally the platform is cured for about three days.

2.2.2 Mix proportions

Concrete for plain or reinforced concrete shall comply with the requirements of the standards used in the country.

Determine the mix proportions according to the standards to meet your needs.

Mix proportions are best specified by weight. Where this is difficult to implement use is made of proportions by volume.

2.2.3 Gauging of materials for concrete

Where mix proportions are defined by volume use gauge boxes for measuring sand and coarse aggregates. The gauges should be available as a standard part of the construction equipment. If this is not the case build them at the site. The gauge boxes should be so dimensioned that only whole bags of cement are used for each batch.

Cement is thus gauged by weight. Use one or more 50 kg bags of cement to each batch.

When measuring fine aggregate by the gauge box make an allowance for bulking of the sand.

Water is gauged by volume. Use a clean container calibrated for the purpose.

2.2.4 Mixing of concrete

Mix the concrete in a mixer or by hand.

(a) Use of mixer
If you ar using a mixer empty the drum completely before refilling it. At the beginning and at the end of each mixing period, wash out the drum thoroughly with clean water. Ensure that it is kept free from hardened or partly set concrete.

Mix all materials until tne concrete is uniform in colour and consistency.

(b) Hand-mixing
Mix the dry ingedients on the mixing platform (paragraph 2.2.1) until a uniform colour is obtained. Add clean water through a rose head and turn over the mass in a wet state until it attains a uniform colour and consistency. Do not mix too much at a time.

2.2.5 Transporting concrete

Transport the concrete from where it is mixed to where it will be placed as soon as possible and by a satisfactory method. A satisfactory method is one that does not allow segregation of the ingredients or loss or contamination of the concrete.

2.2.6 Placing concrete

Before placing the concrete, clean the formwork and other adjoining surfaces, and ensure that they are free from all foreign matter. Care should be taken to prevent workmen from introducing clay or other harmful matter into the concrete or formwork.

Thoroughly work the concrete into all parts of the formwork, and between and around the reinforcement steel. Ensure that the mass is compacted to give a dense and compact concrete, and that it is free from voids.

Take great care to prevent the displacement or deformation of the reinforcement steel, and the displacement of pipes during placing and compacting of concrete.

Deposit the concrete in layers and keep the surface reasonably level, concrete continuously between construction joints.

2.2.7 Blinding layer

Do not lay concrete directly on the sub-grade. Place a blinding layer on the ground or the gravel layer before placing the reinforcement in position.

2.2.8 Construction joints

Place the construction joints in places where they cause the least harm, and in accordance with the drawings.

As soon as the concrete has attained its final set, clean the surface of the construction joint by means of a wire brush to remove laitance and to expose the aggregate. Wash the surface. Within 20 minutes apply a coat of cement mortar.

2.2.9 Surface finish

Concrete should be placed and compacted against formwork to produce an exposed surface with a perfectly smooth finish.

Inspect the concrete faces after formwork has been removed.

Fill any honeycombed surfaces wiht cement mortar having the same proportions of cement and sand as the concrete and finish to a smooth surface.

2.2.10 Curing concrete

Cover the exposed concrete surfaces with sacks, cement bags or other suitable material and keep moist for ar least 14 days after placing the concrete.

2.3 Reinforcement steel

2.3.1 Cutting and bending reinforcement

Cut and bend the reinforcement, according to drawings, to exact dimensions and shapes.

2.3.2 Placing reinforcement

Set out reinforcement exactly, as shown on the drawings, and support it by an adequate number of spacers to ensure correct cover. Spacers should preferably be precast concrete blocks with tying wire cast in. Do not use pieces of steel, blocks of wood, or pieces of aggregates as permanent spacers.

2.3.3 Cover to reinforcement

Provide sufficient concrete cover to reinforcement according to the drawings. Concrete cover is necessary to ensure adequate strength and to prevent the rusting of the reinforcement, and therefore the spalting of the concrete.

2.4 Formwork

2.4.1 Construction of formwork

Formwork can be timber or steel. In either case it should be adapted to the structure and the required surface finish of the concrete.

Securely fix the formwork to the correct dimensions so that it can withstand the loads of construction and the movement of persons, materials and equipment. Make sure that all joints are sufficiently close to prevent leakage of liquid from the concrete.

Where a smooth finish to the concrete surface is required, line the timber formwork with hardboard. Firmly fix all pipes, ducts, etc., which are required to be built in or through the concrete, in the formwork that should be neatly and accurately cut and fitted arround them. Caulk the joints, where necessary, to prevent leakage.

At the bottom of the formwork to walls provide small temporary openings that permit the removal of debris.

2.4.2 Preparation of formwork

Immediately before concreting is started carefully examine and clean out the formwork.

Coat the inside surfaces of the formwork with approved oil to prevent adhesion of the concrete.

2.4.3 Removal of formwork

Remove formwork only after the elapse of the prescribed minimum time between concreting and removal of formwork.

3. Mortar, Masonry Walls, and Plastering

3.1 Mortar

Cement mortar is used for

- bonding the courses in masonry;
- plastering;
- pointing; and
- filling hollow portions of concrete blocks.

It is prepared by mixing cement with clean fine sand and water. The strength depends on the mix proportion of cement to sand. The normal mix proportion is 1 part of cement to 3 parts of sand. Mortar should be used before it has stiffened by setting. As all mortar that has stiffened by setting must be discarded, prepare it only in such quantities that can be used in time.

3.2 Construction of masonry walls

1. Mark out the position of the wall on the foundation or floor slab.
2. Carefully place corner pieces with mortar.
3. Lay the first course carefully, ensuring that it is properly aligned, leveled, and plumbed.
4. Lay the subsequent courses by first placing the corner pieces; aligning, levelling, and plumbing properly; and ensuring that the joints are staggered.
5. Remove excess and extruding mortar.
6. Patch all holes with fresh mortar.

3.3 Plastering

Plastering can be in one or two coatings; the thickness depending on the wall materials.

a) Plastering in one coating

1. Clean wall surface.
2. Wet wall surface by spraying water.
3. Apply plaster (full thickness).
4. Keep platered surface moist for at least 48 hours.

b) Plastering in two coatings

1. Clean wall surface.
2. Wet wall surface by spraying water.
3. Apply first coat of plaster (thickness = 1/2 of total thickness).
4. Allow first coat to partially harden and then roughen its surface to provide a good bond for the second coat.
5. Keep the first coat damp for 24 hours.
6. Dampen the first coat with water and apply the second coat immediately.
7. Keep the plastered surface moist for a further period of at least 48 hours

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The government-owned GTZ operates in the field of Technical Cooperation. Some 4,500 German experts are working together with partners from some 100 countries in Africa, Asia and Latin America in projects covering practically every sector of agriculture, forestry, economic development, social services and institutional and physical infrastructure. – The GTZ is commissioned to do this work by the Government of the Federal Republic of Germany and by other national and international organizations.

GTZ activities encompass:

- appraisal, technical planning, control and supervision of technical cooperation projects commissioned by the Government of the Federal Republic of Germany or by other authorities
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- provision of materials and equipment for projects, planning work, selection, purchasing and shipment to the developing countries
- management of all financial obligations to the partnercountry.

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TRAINING MODULES FOR WATERWORKS PERSONNEL

List of training modules:

Basic Knowledge

0.1 Basic and applied arithmetic
0.2 Basic concepts of physics
0.3 Basic concepts of water chemistry
0.4 Basic principles of water transport
1.1 The function and technical composition of a watersupply system
1.2 Organisation and administration of waterworks

Special Knowledge

2.1 Engineering, building and auxiliary materials
2.2 Hygienic standards of drinking water
2.3a Maintenance and repair of diesel engines and petrol engines
2.3b Maintenance and repair of electric motors
2.3c Maintenance and repair of simple driven systems
2.3d Design, functioning, operation, maintenance and repair of power transmission mechanisms
2.3e Maintenance and repair of pumps
2.3f Maintenance and repair of blowers and compressors
2.3g Design, functioning, operation, maintenance and repair of pipe fittings
2.3h Design, functioning, operation, maintenance and repair of hoisting gear
2.3i Maintenance and repair of electrical motor controls and protective equipment
2.4 Process control and instrumentation
2.5 Principal components of water-treatment systems (definition and description)
2.6 Pipe laying procedures and testing of water mains
2.7 General operation of water main systems
2.8 Construction of water supply units
2.9 Maintenance of water supply units Principles and general procedures
2.10 Industrial safety and accident prevention
2.11 Simple surveying and technical drawing

Special Skills

3.1 Basic skills in workshop technology
3.2 Performance of simple water analysis
3.3a Design and working principles of diesel engines and petrol engines
3.3b Design and working principles of electric motors
3.3c –
3.3d Design and working principle of power transmission mechanisms
3.3e Installation, operation, maintenance and repair of pumps
3.3f Handling, maintenance and repair of blowers and compressors
3.3g Handling, maintenance and repair of pipe fittings
3.3h Handling, maintenance and repair of hoisting gear
3.3i Servicing and maintaining electrical equipment
3.4 Servicing and maintaining process controls and instrumentation
3.5 Water-treatment systems: construction and operation of principal components: Part I - Part II
3.6 Pipe-laying procedures and testing of water mains
3.7 Inspection, maintenance and repair of water mains
3.8a Construction in concrete and masonry
3.8b Installation of appurtenances
3.9 Maintenance of water supply units Inspection and action guide
3.10 –
3.11 Simple surveying and drawing work

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